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Pseudoscience Charges and the Demarcation Problem[1]

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Abstract: Philosophers of science have long tried to identify some demarcation line capable of distinguishing science from pseudoscience. Nonetheless, no ultimate set of requirements has so far been achieved, leaving demarcation uncertain and fluctuating, if not merely rhetorical. The habit of using the word 'science' to address a specific kind of knowledge is a modern practice, with 'science' having gradually taken over terms like 'natural philosophy' and 'natural history.' Thereby, the term 'pseudoscience' is also a recent one, with its meaning running alongside scientific endeavors of the nineteenth century. The article contributes to the debate aiming to pragmatically describe the function of pseudoscience in epistemology. To account for this, we argue that questions like *What is pseudoscience?* or *What makes science science?* would be better replaced by the question *What do people do with the word pseudoscience?*

Keywords: *demarcation problem, epistemology, philosophy of science, pseudoscience, psychiatry*

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Introduction

> *If you say that there was a full moon on February 1st and another on March 1st; and then you link these two observations together in any way, the statement which links them is an hypothesis.*
>
> Gregory Bateson (1972, p. 39)

I would like to raise some of the topics discussed in this article by quoting a singular claim found in the literature of psychiatry. The subject is an interesting case of a pseudoscience charge involving the erasure of the nosological category of hysteria, scientifically considered a disease until 1987 (see Paulon, 2022). Among the forerunners of the revision, we find psychiatrist Thomas Szasz, a professor at New York State University, well known as a social critic of the moral and scientific foundations of psychiatry. Long before the scientific community realized that medical categories like hysteria, homosexuality, or multiple personality had little, if any, scientific foundation, Dr Szasz entered the debate precisely adopting a charge of pseudoscience.

In his 1961 book, dedicated to an unconventional interpretation of hysteria, Dr Szasz stated:

> Psychiatry is conventionally defined as a medical speciality concerned with the diagnosis and treatment of mental diseases. I submit that this definition [...] places psychiatry in the company of alchemy and astrology and commits it to the category of pseudoscience. The reason for this is that there is no such thing as "mental illness." (Szasz, 1961, p. 455)

The statement is interesting for a number of reasons. First, we have a physician and psychiatrist[2] claiming that an established assumption at the foundation of his own discipline makes it a pseudoscience. Quite a radical criticism indeed. In fact, while the author could have argued that such a claim was just wrong, biased or unjustified, he called for a bold distinction between fields: science against pseudoscience. What kind of a statement is that, and what sort of charge does it imply? Is it a descriptive allegation or rather a normative one?

Elsewhere, Szasz pushed his criticism towards taxonomic matters, too, broadly questioning the scientific "discoveries" of DSM diagnoses:

[2] Apparently, the distinction is an appropriate one. Entry 1509 of the University of California STEM disciplines listing shows the need for distinguishing and uniting medicine and psychiatry, with quite a unique remark among scientific specialities.

> Except for a few objectively identifiable brain diseases, such as Alzheimer's disease, there are neither biological or chemical tests nor biopsy or necropsy findings for verifying or falsifying DSM diagnoses. [...] However, the APA did not declare hysteria to be a nondisease; instead, it renamed it "conversion reaction" and "somatization disorder." Similarly, in 1973, when the APA removed homosexuality from its roster of mental illnesses, it first replaced it with ego-dystonic homosexuality; when that term, too, became an embarrassment, it too was abolished. However, psychiatric researchers lost no time "discovering" a host of new mental maladies, ranging from attention deficit hyperactivity disorder to caffeinism and pathological gambling. (Szasz, 2008, p. 2)

Szasz is not alone in blaming psychiatry for its lack of scientificity, nor is the issue an outdated one. Quite the opposite. Albeit not involving any pseudoscience charge, contemporary researchers are still addressing such criticism, claiming that the disjunctive categories of DSM are "scientifically meaningless" (Allsopp *et al.*, 2019, p. 15). Echoing similar concerns, James Ladyman wrote:

> In psychiatry not that long ago women in the UK were incarcerated for what is now considered nothing more than a healthy interest in sex. Until 1973, the American Psychiatric Association regarded homosexuality as a mental disorder. And surely some medical researchers are corrupted by corporate interests and either exaggerate the efficacy of potential lucrative treatments or downplay or deny their negative effects. (Ladyman, 2013, p. 58)

However, most relevantly, neither homosexuality nor hysteria have been withdrawn from the DSM because of an advance in theory, contrary evidence, or experiments performed, nor by reason of a shift in scientific paradigms and methods within psychiatry, but rather because of a change of narrative due to the impact of feminist movements. Does that validate Szasz's statement? Or should we enrich our classification to distinguish, as some theoreticians do, between pseudoscience, bad science, and non-science instead? (Pirosca *et al.*, 2022; Mathew, 2020; Nickles, 2013)

Szasz's statement also identifies astrology, alchemy, and psychiatry as pseudosciences, predicated on a sentence they may contain, or an assumption they would rest upon. This implies that, within a logical-linguistic approach to scientific models, the modification of a claim within a theory can shift the boundary between science and pseudoscience—an allegation which is worth an analysis. Furthermore, Szasz concisely identifies the category of pseudoscience

as a whole, leaving us with the task of defining what can bring together alchemy, astrology, and psychiatry under such a unified label.[3] Indeed, we have as many reasons to doubt the scientific status of psychiatry as there are to refuse it to astrology, but is there any specific feature that all so-called pseudosciences may share?

Partially answering some of these questions (while motivating more), in a later publication, Szasz sheds light on his personal demarcation policy in medicine—including psychiatry. His criterion is indeed a philosophical one, to some extent ascribable to Popper's proposals and further related to the modern materialist reduction paradigm. Thus he writes:

> The claim that "mental illnesses are diagnosable disorders of the brain" is not based on scientific research; it is a lie, an error, or a naive revival of the somatic premise of the long-discredited humoral theory of disease. My claim [...] rests on the materialist-scientific definition of illness as a pathological alteration of cells, tissues, and organs. If we accept this scientific definition of disease, then it follows that mental illness is a metaphor, and that asserting that view is stating an analytic truth, not subject to empirical falsification. (Szasz, 2011, p. 179)

Materialist reductionism and empirical falsification are mentioned as demarcation criteria. We can understand why Szasz still held the distinction between brain diseases and mental disorders: after all, if the concern were brain diseases, those would be treated by neurology, not by psychiatry. However, since mind was the subject, how could scientists think about the abstract mind adopting devices developed for and from the material body? The contradiction between methods and object is strikingly evident. Yet, is it enough to define a pseudoscience? Ultimately, that principle proved to be too stringent, as no evidence suggests that science should be strictly confined to materialism. Slipping away from materialist reductionism may not be a sufficient condition to justify the label of pseudoscience.

To make the picture even more complex, as noticed by Feyerabend (1975), the coexistence of conflicting methodologies and theoretical contradictions is fully intrinsic to science at any stage of its history and, for some reason, it is

[3] The word *category* is not used in a historical-philosophical perspective. It does not refer to the twelve Kantian a priori forms of knowledge, nor to the five Platonic determinations for the intelligible realm, or to Sophistical or Aristotelian doctrines. The "category of pseudoscience" seems to be intended as a mere partition in which things and elements of the same nature or kind are tautologically included.

only philosophers who tend to struggle with it. Also, he critically claimed that philosophers simply do not have the tools to address topics they do not fully understand. Science represents for him a whole culture on its own, irreducible to other disciplines. Feyerabend is not alone in claiming that the demarcation problem is a dilemma only among philosophers. Sven Ove Hansson recently echoed that idea:

> Scientists have no difficulty in distinguishing between science and pseudoscience. We all know that astronomy is science and astrology not, that evolutionary theory is science and creationism not, and so on. A few borderline cases remain (psychoanalysis may be one [...]) but the general picture is one of striking unanimity. (Hansson, 2013, p. 61)

The reason why philosophers have so far missed the target, according Hansson, is that they have been searching for a criterion "on the wrong level of epistemological specificity." However, the problem does not seem to involve philosophers only, for scientists as well, as proved by Szasz, diverge dramatically in considering the status of specific cases. Seen up close, the picture does not look unanimous at all. So how should we understand and justify the use of the category of pseudoscience?

In the 1980s, while no conclusive step had been taken into the issue, Larry Laudan (1983) argued that the demarcation problem was an unfounded one, and ought to be abandoned along the categories of pseudoscience and non-science. Truly, so far none of the proposals for a demarcation criterion managed to meet a consensus, for every and any of those criteria revealed some fatal deficiencies. Nonetheless, despite Laudan, philosophers do not seem to be willing to give up the challenge and scientists themselves keep on making pseudoscience accusations both in public and scientific debate. And that despite the profound confusion over its meaning. In fact, both the climate change theory (Schipani, 2016) and climate change denialism (Yoshi, 2014) have been called a pseudoscience over time, and recently we could read in *The Lancet* that a Nobel laureate had fellow scientists "accusing him of promoting dangerous pseudoscience" (Kazi & Mushtaq, 2022, p. 458) due to a research program he was pursuing.

How is that possible? Does holding a potentially erroneous belief automatically qualify one a pseudoscientist? Apparently not, for it is well known that Albert Einstein believed in a static eternal cosmos, without a Big Bang, until Hubble showed him contradicting evidence. Yet, no one considered him a pseudoscientist due to his stubbornness about the cosmological constant, a belief he held that

outright contradicted his own equations. Nor has he been called a pseudoscientist for having returned to that first idea later in his life. So, again, what is the logic behind distinguishing between science and pseudoscience, if any?

Contemporary researchers are defining various multi-criteria approaches, taking into account many other elements in their puzzles, such as the distinction between science and the sciences, the consideration of single scientists, the interaction among sciences, the role of "scientific communities" and their agenda, the power structures in, around, and between scientific disciplines, bad sciences, science frauds, biases, and more. Do any of these proposed approaches shed light on the nature of the category of pseudoscience? I argue that there are reasons to doubt this, and that the tools and criteria elaborated to define what makes science science have little to do with the category of pseudoscience.

One additional consideration, if we step back from the initial assertion: alchemy is there grouped together with psychiatry and astrology as a striking example of pseudoscience. However, if we consider alchemy in the light of its evolution over time, namely as a direct precursor to modern chemistry, why should we define it as a pseudoscience and not, say, a protoscience? (See Mahner, 2013.) What conditions are sufficient and necessary to sort these theories and practices into the right folder?

To consider those questions, I will revisit the beginnings of the demarcation problem, to then examine some of the main steps that have recently been taken towards a solution in the philosophy of science, comparing these with historical and contemporary instances challenging their success. I will argue that the reason for being of the category of pseudoscience in epistemology is precisely the absence of such a final dogmatic set of criteria—in other words, the absence of a clearcut identity within science is the cornerstone of pseudoscience.

Kant's problem, Popper's problem

> *Whenever you get two people interpreting the same data in different ways, that's metaphysics.*
>
> Thomas Kuhn (in Horgan, 2012)

Some of the problems concerning the use and the status of the pseudoscience label date back to the first employment of this very category in philosophy. An unsolved confusion over the boundaries between science and its values, and between logics and ethics, gave rise to the several nuances of the demarcation problem within the philosophy of science.

When he first launched the demarcation problem, Sir Karl Popper was not thinking of (or at least, not writing about) pseudoscience. The project he initially embarked on concerned the search for a tool theoretically capable of discerning empirical sciences from mathematics, logics, and metaphysics:

> The problem of finding a criterion which would enable us to distinguish between the empirical sciences on the one hand, and mathematics and logic as well as 'metaphysical' systems on the other, I call *the problem of demarcation*. This problem was known to Hume who attempted to solve it. With Kant it became the central problem of the theory of knowledge. If, following Kant, we call the problem of induction 'Hume's problem,' we might call the problem of demarcation 'Kant's problem.' (Popper, 1959 [1934], p. 11)

His concern was directed against positivist empiricists and the application of inductive logic as a demarcation criterion, which, in his view, introduced metaphysics straight into empirical sciences. The issue was strictly related with the Humean problem of how to justify "reasonable belief" without entering a logical infinite regress, for in order to rationally justify inductive inferences, a principle of induction is needed. However, a principle of induction must be a universal statement and if one wants it to be known by experience, she or he would need to justify that statement too by an inductive inference, to justify which new (higher) induction principle is required, and so on.

In challenging inductionism, Popper sought a solution to Kant's problem of the limits of scientific knowledge without involving an a priori universal causation. To do that, he needed to trace the differences between those statements belonging to the empirical sciences and other statements he describes as "metaphysical,"

"meaningless," or "pseudo-statements." The main setting, and the greatest challenge, of this venture was the set of rules, limits, and possibilities of the connections between a logical-linguistic model and nature, enabling the former to represent, reflect, describe, or correspond to the latter by means of observation. In other words, how to reduce the laws of nature to observational statements and thus rule out metaphysical utterances for good:

> My business, as I see it, is [...] to define the concepts 'empirical science' and 'metaphysics' in such a way that we shall be able to say of a given system of statements whether or not its closer study is the concern of empirical science. (Popper, 1959 [1934], p. 15)

To deal with this issue, Popper thus developed a "deductive method of testing" theories against nature. To test a theory, one should deduce its consequences, logically fostering conclusions until a risky prediction is reached. This prediction statement has to be tested against nature. The statement would then be verified or falsified, and since a scientific theory is for Popper a system of statements, the whole architecture could be either verified or falsified. Popper proposed to reverse the testing method towards deduction. Therefore, to test a theory, one should not follow the course of induction (1) but the deduction process (2):

(1) Observation > Pattern > Hypothesis > Theory

(2) Theory > Hypothesis > Observation > Confirmation / Confutation

Distrusting verificationism due to its confirmation bias, he suggested that the only way to prove whether or not a sentence belonged to empirical science, instead of "meaningless metaphysics," was *falsificationism:*

> According to this criterion, statements, or systems of statements, convey information about the empirical world only if they are capable of clashing with experience; or more precisely, only if they can be systematically tested, that is to say, if they can be subjected (in accordance with a 'methodological decision') to tests which might result in their refutation. (Popper, 1959 [1934], p. 315)

By choosing a method that attributed the hallmark of "empirical" only to those statements and theories capable of advancing the conditions for their confutation, Popper thought he had revolutionized epistemology. In fact, in his ambitions, falsificationism would have solved both Hume's and Kant's issues at once, *id est*, both the induction and the demarcation problem:

> the recognition of unilaterally decidable statements allows us to solve not only the problem of induction [...], but also the more fundamental problem of demarcation, a problem which has given rise to almost all the other problems of epistemology. (Popper, 1959 [1934], p. 315)

Still, along *The Logic of Scientific Discovery*, the word 'pseudoscience' does not show up, not even once. It is in *Conjectures and Refutations* (1962) that Popper modulates his former demarcation proposal by establishing new terms for framing the dispute—the new lexicon for the demarcation venture proposed the separation of science and pseudoscience: "I wished to distinguish between science and pseudo-science; knowing very well that science often errs, and that pseudo-science may happen to stumble on the truth" (Popper, 1962, pp. 32–33). Here, Popper also declared his interest towards Einstein's theory of relativity, Marx's theory of history, Freud's psychoanalysis, and Adler's individual psychology. While having no doubt about the scientific status of Einstein's relativity, he was sincerely worried about the blind faith demonstrated by his friends and colleagues towards the theories of Marx, Freud, and Adler:

> I found that those of my friends who were admirers of Marx, Freud, and Adler, were impressed by a number of points common to these theories, and especially by their apparent explanatory power. These theories appeared to be able to explain practically everything that happened within the fields to which they referred. The study of any of them seemed to have the effect of an intellectual conversion or revelation, opening your eyes to a new truth hidden from those not yet initiated. Once your eyes were thus opened you saw confirming instances everywhere: the world was full of verifications of the theory. (Popper, 1962, pp. 34–35)

The theory of relativity, by contrast, appeared to be safe from this verification bias precisely because it was vividly incompatible with certain possible results of observation. For the above reasons, the theory of general relativity had to be considered scientific, while Marxism, individual psychology, and psychoanalysis were pseudoscientific, thus to be grouped together with alchemy and astrology.

Yet, although logically seductive, falsificationism provided no final solution to the problem. In fact, besides having led Popper to describe Darwinism as a metaphysical research program (a 1976 claim he later withdrew), several critics pointed out that the disciplines he recognizes as pseudosciences do actually contain falsifiable claims. Furthermore, philosophers of science have

often underlined that both psychoanalysis and astrology have indeed been falsified, therefore being falsifiable (Laudan, 1989; Mahner, 2013; Pigliucci, 2013).

Moreover, as Kuhn, Feyerabend, and also Lakatos later showed, the history of science provides plenty of instances that contradict the notion that scientists discard their theories when observational data falsify them.

Scientists would rather regard those contradictions as exceptions, waiting for a better theory or explanation to come along. In *Science and Pseudoscience*, Lakatos asked a more interesting question:

> Newton's theory of gravitation, Einstein's relativity theory, quantum mechanics, Marxism, Freudianism, are all research programmes, each with a characteristic hard core stubbornly defended, each with its more flexible protective belt and each with its elaborate problem-solving machinery. Each of them, at any stage of its development, has unsolved problems and undigested anomalies. All theories, in this sense, are born refuted and die refuted. But are they equally good? (Lakatos, 1974, pp. 4–5)

Lakatos says they are not. Resuming an early perspective outlined by Popper (1962, p. 240), he claimed that a research program was progressive when theories had the power to make surprising, unexpected predictions, then confirmed by observation; otherwise, they were degenerating ones:

> all the research programmes I admire have one characteristic in common. They all predict novel facts, facts which had been either undreamt of, or have indeed been contradicted by previous or rival programmes [...] In degenerating programmes, however, theories are fabricated only in order to accommodate known facts. Has, for instance, Marxism ever predicted a stunning novel fact successfully? Never! It has some famous unsuccessful predictions. (Lakatos, 1974, pp. 3, 4)

However, the problem posed against Lakatos' proposal was the implication that such demarcation would lead to considering a research program as degenerating simply because it fails to make progress or offer novel predictions. Additionally, one might find that various established sciences and theories could actually stand on both sides of such criteria. As Laudan argued:

> Some scientific theories are well tested; some are not. Some branches of science are presently showing high rates of growth; others are not. Some

> scientific theories have made a host of successful predictions of surprising phenomena; some have made few if any such predictions. (Laudan, 1983, p. 124)

And still, they have not been marked off for not having delivered confirmed, surprising predictions. The logico-mathematical, linguistic assessment of the issue stands in contradiction with the history of science: should we consider the way science should work or rather the way it actually works? Popper was so focused on a logical interpretation of scientific theories as systems of statements that his model ended up identifying philosophical truth and scientific truth. But we cannot forget that science adopts logics *also*, not logics *only*. Thus, logics cannot be the arbiter in that trial, and specifically considering the challenges represented by paradoxes.

However, despite leaving Kant's problem unsolved, falsificationism does point to a crucial feature science is always expected to satisfy, and that scientists promote as its key characteristic. Namely, the receptiveness towards error, the ongoing acceptance to the revision of truths, models, and results, the possibility to abandon a set of mind and enter a new dimension in light of new evidence. As Philip Kitcher (1982, p. 33) once put it, the idea that "[f]allibility is the hallmark of science."

However, if nothing in science is an unquestionable truth, such a criterion seems to be more embedded in ethics than in logic. With falsificationism, Popper actually tried to provide a logical tool to test a scientific value—namely, open-mindedness. Yet, that is not a purely logical property, for "logic is silent about whether one should reject the hypothesis in the face of a failed prediction P or search for a problematic auxiliary assumption(s)" (Cleland & Brindell, 2013, p. 188). Against falsificationism, scientific progress has historically been achieved also despite contrary evidence. It was by continuing to use Newtonian mechanics, despite its failure in describing Uranus' orbit, that natural philosophers discovered Neptune (Kitcher, 1982, p. 45). History of science suggests that no logical principle alone can justify the decision-making about whether or not a theory has to be abandoned, a statement has to be considered correct or wrong, true or false, valuable or negligible.

Fair enough, while philosophers were trying to determine the logical limits of science, it took a scientist, particularly a physicist, to reintroduce human beings and their troubling ethics into the picture. In *The Function of Dogma in Scientific Research*, Thomas Kuhn (1961) strongly questioned scientists' open-mindedness,

showing that the reasons for a theory to be rejected or included into standard science were all but technical:

> Though the scientific enterprise may be open-minded, whatever this application of that phrase may mean, the individual scientist is very often not. [...] From Galileo's reception of Kepler's research to Nägeli's reception of Mendel's, from Dalton's rejection of Gay Lussac's results to Kelvin's rejection of Maxwell's, unexpected novelties of fact and theory have characteristically been resisted and have often been rejected by many of the most creative members of the professional scientific community. (Kuhn, 1961, pp. 347–348)

Considering the historical evidence of such oppositions, we can infer that pseudoscience charges, together with a potential engine for scientific progress, have been precisely a mode of this resistance, as falsificationism in itself provided no solution to Kant's problem.

Demarcations and their nemesis

> *Once anything like a cultural divide gets established, all the social forces operate to make it not less rigid, but more so.*
>
> C. P. Snow (1959, p. 18)

Ever since Popper, the vastness of the philosophical debate around the distinction between science and pseudoscience has only been matched by its insolvability. Beyond falsificationism, several propositions have been advanced over time. Most of these, however, have focused more on territorial concerns and boundaries between disciplines than on the genuine solution of Kant's problem about knowledge. Those include Popper's second view and motivate the idea that we should consider it an entirely different problem. As recently pointed out by Maarten Boudry (2022; 2013) there may actually be two different demarcation projects in progress:

> The demarcation project, [...] has traditionally been the banner of two distinct [...] intellectual projects, only one of which is pressing and worth pushing. The genuine demarcation problem [...] deals with distinguishing bona fide science from pseudoscience. The second [...] concerns the territorial boundaries separating science from such epistemic endeavors as philosophy,

> history, metaphysics, and even everyday reasoning. [...] I argue that the territorial problem has little epistemic import. (Boudry, 2013, p. 79)

Among the elements suggesting the infertility of such a territorial demarcation between fields, Boudry (2013, p. 81) highlights that "there is often no way to disentangle philosophical elements from scientific theories and arguments." Indeed, no scientist would drop Occam's razor principle, Leibniz's integral rule, or Mill's method of agreement solely because they belong to philosophy. Philosophical ideas have always been intertwined with scientific activity in a structural manner, just like scientific discoveries influence philosophical reasoning. The principles of classical mechanics are based on Newton's work, emblematically titled *Philosophiæ Naturalis Principia Mathematica*. On the same page, Konrad Lorenz once observed that, owing to his philosophical culture, Max Planck could treat causation not as a necessary a priori, but as a human-made hypothesis, to be rejected when it no longer conformed to experimentally deduced facts, and then replaced by the calculation of probabilities:

> Max Planck was one of the first to attempt a breakthrough from physics, the most fundamental of the natural sciences, to epistemology, the most fundamental of philosophical disciplines. [...] Without his profound knowledge of Kant, Max Planck would hardly have succeeded in making this breakthrough, which is as revolutionary for the theory of knowledge as it is for physics. (Lorenz, 1973, pp. 17, 18)

It is true, though, that the separation between philosophical truth and scientific truth historically happened, fostering the growth of some specific sets of mind, premises for knowledge, and methodologies of research. The division also created meaningful difference between scientific questions and philosophical ones. Take these two sentences:

– *How does phytoremediation restore contaminated soil, water, and air?*
– *Was the 9/11 New York attack one single event or two different ones?*

Intuitively we all feel the former is a scientific question and the latter a philosophical one, despite both having concrete, real, material impact, especially if you are the leaseholder asking an insurance company a refund which can be double or half according to the relative definition of the 9/11 "event."[4] Some sort of division in the theory of knowledge has been present since ancient philosophy, as Seneca wrote:

[4] The question has been answered in court, see Hirschkorn & Wald, 2004.

> The philosopher investigates and gains knowledge of natural phenomena, while the geometer collects figures and measurements and does calculations based on them [...]. The rationale behind celestial phenomena, their efficacy and their nature: these are knowledge for the philosopher; [...] The philosopher will prove that the sun is large, the astronomer will proceed by empirical methods to find out just how large it is. (Seneca, *Letter 89*, § 26–27)

But a radical split occurred in the 16th century. According to Hannah Arendt, the moment of this split corresponds with the first use of the telescope, an act which separated how things appeared to the human eye from how they really were in the world. The telescope showed that the truth does not manifest, that it is something external to mankind, non-rational, obscure to our mind until revelation:

> Since then, scientific and philosophic truth have parted company; scientific truth not only need not be eternal, it need not even be comprehensible or adequate to human reason. [...] After Descartes based his own philosophy upon the discoveries of Galileo, philosophy has seemed condemned to be always one step behind the scientists and their ever more amazing discoveries [...] Philosophers became either epistemologists, worrying about an over-all theory of science which the scientists did not need. (Arendt, 1958, pp. 290–294)

Warranted knowledge started to depend on the findings of an external instrument, more reliable and efficient than the human cognitive apparatus. Human senses can intuitively inform us about the passing of time, but in no way do they allow us to know that the lower the gravitational potential, the slower the passing of time. Ever since Galileo, Arendt argues, modern philosophy mainly restricted its fields to the theory of knowledge, history, and psychology, affected by the ultimate reversal of contemplation and action. That may well have been the beginning of the territorial demarcation. Lorenz also agrees with Arendt, tracing the distinction between humanities and sciences:

> Modern science came into existence with Galileo, without any real help on the part of philosophy [...] It paid no heed to the discoveries of the philosophers, who in turn studiously ignored the new natural scientists. Thus the seal was set on the division between 'Art' (meaning the humanities) and 'Science.' (Lorenz, 1973, p. 17)

However, such a bold distinction widely disregards the interconnections between philosophy and the scientific method, making it hard, if not impossible, to ultimately separate the fields:

> Scientific theories invariabily rest upon certain philosophical underpinnings, and science without abstract reasoning and logical inference is just stamp-collecting. As Daniel Dennett succinctly put it, "there is no such thing as a philosophy-free science; there is only science whose philosophical baggage is taken on board without examination." (Boudry, 2013, p. 81)

The clear distinction, for instance, provided by the 2001 STEM umbrella (a straightforward territorial model) seems to neglect precisely those interconnections, while emphasizing others to generate an idea of homogeneity among specific disciplines and extraneity among others. However, such territorial divisions have often been crossed in the past and are always subject, at least theoretically, to further transgresses. Indeed, Newton's law of gravitation united astronomy and physics in one single science, "where the same equation will cover the movements of heavenly bodies in the sky and the motion of terrestrial bodies on earth" (Arendt, 1958, p. 265); in a similar manner, the once separated researches of physics and chemistry are today "closely knit together not least by integrative subdisciplines such as physical chemistry, quantum chemistry, and surface science" (Hansson, 2013, p. 63). Especially as new areas and mixed disciplines keep on flourishing, the boundaries remain fluid. As Georg Reisch once observed, though with much imagination:

> If, for example, an astronomer convincingly demonstrated that zodiacal signs or observed conjunctions of planets were useful for pursuing substantive astronomical questions, the network unificationist could expand the boundary to include these parts of astrology that were previously considered unscientific. (Reisch, 1998, p. 335)

To overcome territorialism, a partial set of such interconnections has also been proposed as a demarcation criterion, observing that scientific disciplines are integrated, sharing theoretical models and methods, while pseudoscientific explanations fail to produce tools that can be successfully adopted by scientific disciplines. Astronomists do not use statements and theories from astrology to describe the world, while astronomy represents a crucial source for astrologists' work.

Still, if interconnections and compatibility of methodology and models frequently occur in disciplines, we cannot rely on such a demarcation proposal as a definitive criterion either. Not every model and theory is well integrated, smoothly compatible, and shared within different scientific domains. This is something particularly striking about physics, where partial theories are successfully used to describe the world without being adequately integrated. As Stephen Hawking (1988, p. 35) once noticed on general relativity and quantum mechanics: "Unfortunately, these two theories are known to be inconsistent with each other—they cannot be both correct," an evidence that alone may lead to ultimately dropping the curtain on this demarcation proposal. Here is, in fact, another key feature of science: these partial theories keep on being used as long as they serve their purpose, whether or not followed by an all-embracing coherent theoretical structure. As long as Newtonian mechanics gives us the tools to practically act on Earth, it will be used despite its limits.

It is indeed very interesting that, although most of scientists and philosophers of science do agree on specific cases of demarcation, this agreement has yet to find a common, sufficient, and necessary general criterion to rest upon. Equally fascinating is that nearly all singular ideal characteristics of scientific inquiry have been broken in the history of science to produce scientific knowledge (Feyerabend, 1975). The horizon gets even wider if we consider viewpoints such as those of Anthony Derksen (1993) as well as of Kitcher (1993), according to whom pseudoscience is essentially what pseudoscientists do. Complementarily, Michael Shermer (2013, p. 207) claimed that "from a pragmatic perspective, science is what scientists do," with the idea of shifting the focus towards the researchers' activity. Within a scientific discipline, in fact, it is possible that a single scientist may veer onto a misguided path, or that any sort of bias may taint the outcome of a research. However, the question emerges again:

> When exactly is an alternative theory a piece of pseudoscience and when is just a heterodox view? This distinction is important because heterodoxy should be welcomed as a stimulating critical debate and research, whereas pseudoscience is just a waste of time. (Mahner 2013, p. 31)

The case of Dr Wakefield's unfounded claims about the connection between autism and the MMR vaccine is known worldwide for being a scientific fraud of this kind (see White, 2014). The lack of evidence for the conclusions of his paper, and its nefarious impact on the public opinion, led to the withdrawal of both his article and his license by the British General Medical Council. Nevertheless, some argue that the distinction tool is also not straightforward, as scientific fraud

is not (yet) pseudoscience (Mahner, 2013, p. 31), nor is pseudoscience simply non-science.

This approach leaves us with the unresolved task of demarcating when a researcher has to be considered an unappreciated visionary, a bad scientist, or a pseudoscientist. While the Wakefield case is a clear case of fraud, more subtle stories complicate the appraisal. Consider the case of Luc Montagnier, accused by some colleagues of promoting dangerous pseudoscience. Does it not sound uncanny that a virologist, trained in science and awarded the Nobel Prize for the discovery of HIV, can become a pseudoscientist simply for holding an unpopular theory? Under what conditions does a researcher deserve that label? And who is susceptible to being described as a pseudoscientist? On this matter, Shermer points out a relevant quote:

> Historian of science Michael D. Gordin observes in his book *The Pseudoscience Wars*: "No one in history of the world has ever self-identified as a pseudoscientist. There is no person who wakes up in the morning and thinks to himself, "I'll just head into my pseudolaboratory and perform some pseudoexperiments to try to confirm my pseudotheories with pseudofacts." (Shermer, 2013, p. 221)

Is a scientist's sincere belief in a borderline research program enough for her/him to deserve the label of pseudoscientist? Once more, the idea that we can solve the problem by focusing on the activity of a single researcher, while free from territorial constraints, does not represent a definitive solution to the demarcation problem.

Other demarcation propositions have been put forth, trying to address epistemic qualities, methods, and communities combined in nuanced multicriteria approaches. However, no conclusive set of technical, value-free elements has thus far been able to satisfy the necessary and sufficient requirements of epistemic invariants. Even the basic requirement of tests and experiments as a key feature of science has been questioned, since it is an aspect of scientific enquiry but did not historically characterize its entire process of discovery. Lorenz (1973, p. 19) once observed that "Kepler and Newton discovered the laws that govern the movements of the heavenly bodies solely on the basis of observation and description, without making a single experiment." Would that mean that those laws were metaphysical (pseudoscientific) until a test was performed? How can one set such a requirement as a demarcation criterion, since they do not describe the history of science?

If we had anything like a clearly defined set of epistemic criteria, there would be no uncertaintly around specific cases and theories. Also, there would be no resistance against the advance of new models. The historical evidence indicating that science itself is changing over time and does incorporate values, makes it unlikely to succeed in identifying so-called pseudosciences on the ontological level. The pursuit of demarcation thus seems more political than epistemological, especially if we accept that scientific paradigms are incommensurable with each other (Kuhn, 1962, p. 103).

Popper's first formulation of the demarcation problem did not involve pseudoscience. By changing the terms that way, the statements of mathematics, logics, and metaphysics suddenly become pseudoscientific, despite the central role they may play within scientific theories. Moreover, the greatest topic is still left unaddressed—what concept of pseudoscience is such a change based on? In order to account for that, it may prove fruitful to analyze some aspects of the debate.

Charges of pseudoscience

Wherever the relevance of speech is at stake,
matters become political by definition,
for speech is what makes man a political being.
Hannah Arendt (1958, p. 4)

Sir Karl Popper did not pick the word pseudoscience out of a hat. Just like science, the term pseudoscience is a modern product, running side by side with the progressive definition of every novel scientific endeavour.

Some researchers have traced an early reference to the word 'pseudoscience' back to 1824, when Sir William Hamilton used it to refer to phrenology (Thurs & Numbers, 2013). Other reports indicate older uses of the Latin term *pseudoscientia* in the first half of the 17th century (Guldentops, 2020) and according to the OED, a 1796 entry was used by James Pettit Andrew to describe alchemy. Indeed, the first uses of the category were intended to dismiss entire research programmes or disciplines, in compliance with the territorial purpose. By reintroducting the word 'pseudoscience,' Popper replaced the Humean and Kantian problem of 'reasonable belief' with the problem of the reasons for accepting or rejecting scientific theories and statements. In this sense, one might question whether we should call the demarcation problem Kant's problem or rather Popper's problem.

Some of the reasons why the second version of Popper's demarcation problem remains unsolvable seem closely connected with the concept of pseudoscience itself. This term, in fact, though simple enough, does not stand on its own legs, leading only a relative existence. Pseudoscience relies only on its relation to an external other, to something else—namely, the concept of science. As the defining standards of science change, so does pseudoscience:

> Pseudoscience is necessarily defined by its relation to science and typically involves subjects that are either on the margins or borderlands of science and are not yet proven, or have been disproven, or make that sound scientific but in fact have no relationship to science. (Shermer, 2013, p. 203)

The problem with Popper's late formulation is a double-sided one: on the one hand, we are invited to identify a challenging logical object, a false-science, or false-knowledge; suggesting that pseudoscience is somehow telling the false, it is sort of lying, pretending to adopt the scientific method or belong to a scientific field. The etymological argument is in itself a relevant one, since 'pseudo' means false, and 'science' means knowledge. This makes pseudoscience an accusation, a charge more than a thing or a set of disciplines. A pseudoscience charge is an allegation of error, of deviance from the norm represented by normal science at a certain stage. Therefore, it is a temporary, time-relative, and value-relative judgment. On the other hand, the term 'science' itself, which should serve as the basis to define its nemesis, is constantly changing together with its standards, paradigms, disciplines, and theories, making such dynamism no less a value and a reason of being.

Contrary to the history of scientific truth, it has been observed that a clear distinction of science and non-science would require the existence of epistemic invariants, meaning a set of stable and absolute elements serving as the basis for such differentiation, while plenty of evidence proves that no such tools have been found nor produced yet (Laudan, 1983, p. 124). The history of science reveals that what was true yesterday might be false today, and what is false today might become true tomorrow, as our understanding of reality is one with the models we adopt to define it. Given that this peculiar dynamism makes it unrealistic to establish such boundaries between science and non-science once and for all, pseudoscience has been described as an extra category that epistemology may not need. Even within the realm of science, individual scientists have different views on whether or not a theory should be considered scientific, correct, or worthy. Let alone their founders, who surely have specific interests in promoting one vision over another. Consequently, since epistemic heterogeneity makes sciences

themselves elusive as ever-changing and subject to interpretation, why should we not simply follow Larry Laudan when he acknowledges that it is not possible to successfully define pseudosciences on the epistemic level?

> Without conditions which are both necessary and sufficient, we are never in a position to say "this is scientific: but that is unscientific." A demarcation criterion which fails to provide both sorts of conditions simply will not perform the tasks expected of it. (Laudan, 1983, p. 119)

There is a reason for this failure. First, we have to acknowledge that pseudoscience is better defined not as a thing, or a bundle of disciplines, a tradition, or a fuzzy methodology, but pragmatically as a discrediting judgement, an accusation, a normative prescription, or just a petition of principle. Perhaps, "a demarcation criterion will typically assert the epistemic superiority of science over non-science" (Laudan, 1983, p. 119). When we thus approach pseudoscience charges on the discursive level, certain regularities emerge. Those regularities are political in nature.

The many ways and situations in which pseudoscience charges have been used are diverse enough to shed light on both its arbitrariness and its function as an exclusion device. As noted by Resnik, "a given discipline can transform from pseudoscience to science over time" (2000, p. 254). In the 1950s, economics has been described as a pseudoscience (Thurs & Numbers, 2013, p. 133) and is now proudly included in the STEM disciplines; on the opposite side, the barbarian practice of lobotomy has been celebrated for decades due to its "therapeutic value" and granted its discoverers a Nobel Prize. Back in 1925, a high school teacher John Scopes was arrested and prosecuted in Dayton, Tennessee, for teaching Darwinism. Funnily enough, the accusation of teaching a pseudoscience came from Christian creationists who believed they were somehow entitled to discern science from pseudoscience based on religious grounds. In 1949, the Soviet Communist Party declared Mendelian genetics a pseudoscience and had its supporters arrested, including Nicolai Vavilov, who would later die in a concentration camp. Both theories form the foundation of today's scientific view of the world. Similar cases are frequent in the history of science. When adopted by scientists, the rationale behind such claims may well stem from the need to preserve a boundary, which is created and maintained precisely within the act of demarcation, in an attempt to prevent the abuse of scientific authority:

> Maintaining scientific boundaries has required struggle. Rather than relying on a timeless set of essential attributes, its precise meanings have been able

> to vary with the identity of the enemy, the interests of those who have invoked it, and the stakes involved, whether material, social, or intellectual. The essence of pseudoscience, in short, is how it has been used. (Thurs & Numbers, 2013, p. 122)

Above, we inquired as to why Popper had decided to change the terms of his research. Probably, discredit is a reason. While 'empirical sciences' and 'logics and mathematics' represented the existing, established, and respected fields of knowledge, the new distinction between 'science' and 'pseudoscience' was not an impartial, unbiased one, but proposed a discriminating, value-charged judgement. A good argument for that was presented by Laudan:

> demarcation criteria are typically used as *machines de guerre* in a polemical battle between rival camps. Indeed, many of those most closely associated with the demarcation issue have evidently had hidden (and sometimes not so hidden) agendas of various sorts. It is well known, for instance, that Aristotle was concerned to embarrass the practitioners of Hippocratic medicine; and it is notorious that the logical positivists wanted to repudiate metaphysics and that Popper was out to 'get' Marx and Freud. In every case, they used a demarcation criterion of their own devising as the discrediting device. (Laudan, 1983, p. 119)

The reason for this shift in categories was probably Popper's personal concern around the enthusiasm among many of his colleagues towards the theories of Marx, Freud, and Adler. Pseudoscience represents exactly a mode of this *machine de guerre*, devised for specific purposes by specific authors over time:

> Pseudoscience appeared at precisely the same time during the early part of the 1800s that science was assuming its modern meaning in English-speaking cultures to designate knowledge of the natural world. The more the category of science eclipsed and usurped significant parts of those activities formerly called natural philosophy and natural history, the more rhetorical punch "pseudoscience" packed as a weapon against one's enemies. (Thurs & Numbers, 2013, p. 124)

To take the best out of the science versus pseudoscience debate, it would probably be more fruitful to proceed beyond ontology. Rather than what is pseudoscience, we should ask who has been using this category overtime, in what context, and for what purposes. If we focus on the use of the pseudoscience charges by scientists, we could then deduce that within the stunning epistemic heterogeneity adopted

by scientific inquiry, the function of pseudoscience charges is precisely the one of defending and creating the idea of stable boundaries. As observed by Thurs and Numbers (2013, p. 124), "[p]seudoscience did not simply run afoul of scientific orthodoxy—it helped create such orthodoxy."

Given that all demarcation attempts have failed to deliver a final set of criteria to not only distinguish science from pseudoscience, but also science from non-science, and considering, as exposed by Laudan, there is no possibility to succeed in the quest due to the absence of any possible epistemic invariants, pseudoscience charges continue to appear both in the public and in the scientific debate. In order to understand the meaning of this category we need to consider pseudoscience under a different light, namely under the discursive, political, and pragmatic take describing it as a charge, an accusation, a discrediting practice whose function is strictly connected with one of the most relevant values of scientific endeavors—epistemic heterogeneity. Since science has no boundaries, pseudoscience charges are used to create them, according to the issuer's goals.

Conclusions

> *The philosophy of each science originates independently of general philosophy, from the data of its own branch of knowledge.*
>
> Arthur Schopenhauer (1966, p. 128)

As this article is written, UK's first three-parent baby was born, following an IVF procedure (James, 2023); a ULX pulsar, breaking laws of physics by radiating hundreds of times above Eddington limits has been observed (Bachetti *et al.*, 2022); OpenAI's GPT-4 model is writing online contents (Chow & Perrigo, 2023); and China's artificial Sun has just broken its own 2017 record for the longest sustained nuclear fusion on Earth (Chen, 2023).

This special game, with new rules and fact-finding practices, that we call science confirms its striking power over time. It is obvious that such power comes with a proportional prestige associated with scientific endeavors, and that this goes even beyond the ability to provide us with the most warranted knowledge about the world. It is also obvious that more and more people will try to exploit some of that prestige without doing all the necessary work, by claiming scientific authority in order to support the weirdest claims, policies, and practices. That is when the political discourse of pseudoscience steps in as a tool to protect science from abusive claims:

> Historically, then, demarcation has typically been a conservative exercise in exclusion, an attempt to preserve the purity of modern science as the primary engine of social progress (Nickles, 2013, p. 105).

Epistemologically, that may well be the function of the category of pseudoscience. The progressive extension of the scientific method to the analysis of the world led to an incredible advance in knowledge and to unbelievable progress in technology, reshaping human vision of the world, though limiting its interests to the range of values of an industrial, consumerist, capitalist, and military society. The activities merged under the name of science have rightfully earned it a status and an authority which are inconceivable in any other branch of knowledge. However, the will to protect this system of knowledge production stands side by side with the fact that science is still a human activity, with several people holding various interpretations of its data, contents, methods, facts. Furthermore, science is an activity reshaping the premises of our knowledge. If logics itself is silent about what premises one should choose, science precisely works at this level.

What is pseudoscience then? In short, we can consider it a side effect of science's absolute knowledge ambitions, dynamic paradigms, and epistemic heterogeneity. Some theories which have been labeled as pseudoscience have later been included into the realm of normal sciences; many programs, born and raised into science, have later fallen out of favor. The demarcation project in the form of an ontological differentiation does not account for the actual use of the category of pseudoscience in our society. While long-standing attempts to define specific fields or a set of criteria could not yet deliver a conclusive answer to the topic, the pragmatic interpretation of pseudoscience as a *machine de guerre* does account for the various contexts and situations in which that category has been used.

Pseudoscience charges are a political tool to help an epistemic community define and maintain the uncertain, unclear, shifting, everchanging borders of scientific domain. It is a word running through lips, tribunals, schools, literature, laboratories, philosophers, scientists, Christians, atheists—all with the common aim of defending a specific idea of what is true and what is false. Pseudoscience is a Kafkaesque gatekeeper at the doors of the law. This seems to have been (and continues to be) the function of pseudoscience. The reason for that may be connected to the responsibilities related to the ability to provide exact knowledge, as suggested by Pigliucci:

> In the form of creationism and its challenges to the study of evolution, pseudoscience has done great damage to public education in the United

> States and elsewhere; it has swindled people of billions of dollars in the form of "alternative" medicine like homeopathy; it has caused a lot of emotional distress, for example, to people who are told by mystics and assorted charlatans that they can talk with their dead loved ones. Conspiracy theories about AIDS, which are widespread in many African countries and even in the United States, have literally killed countless human beings throughout the world. (Pigliucci, 2013, p. 3)

I believe we all share such concerns, precisely because we want to trust science and scientists. But we can also consider that those activities, doctrines, and movements are equally dangerous under the name of "unjustified beliefs," "wrong ideas," and "disproven theories." Their qualification as pseudoscience makes no real difference in regard to their potential for harm. The core of the claim is still an accusation of promoting a wrong idea about the world. We have to be careful with the spread of flat-earthers not because that is pseudoscience, but because it represents the spread of a form of ignorance with the right to vote.

At the same time, Fentanyl and pharmaceutical opioids, the worldwide widespread production of single-use plastics, the weapons industry as well as all refinery pollutants are inflicting significant damage both on the planet and humankind, despite their unquestionable affiliation to the realm of exact sciences. In fact, we have to admit they are making much more damage than astrology has ever done. If the purpose were to identify where the perils are, we would probably have to acknowledge that the threats are more closely connected to the realm of normal science and its policies than to that of pseudosciences. For such purposes, a pragmatic distinction between science and non-science has already been developed:

> We distinguish between science and non-science in various practical settings. The reason we need to make these distinctions is that they often have important consequences for health, safety, education, policy and justice. [...] Rudner argued that standards of scientific proof should depend on the consequences of making a mistake: the worse the consequences, the higher the standards should be. (Resnik, 2000, pp. 261–262)

Theoretically, science has no boundaries. Scientific heterogeneity is so wide that not even scientists have control over its boundaries and limits. Nevertheless, some individuals behave as though they can. These are the proponents who use the term pseudoscience to protect a boundary that may have been crossed, or not yet reached. Instead of presuming that there is such a thing as pseudoscience,

a better understanding about this category might be obtained by examining authors who have paid attention to the historical contexts of the way that word has been used. Such reading may well account for its meaning. Employing a method that is less innovative than reasonable, I would second Pierre Menard, according to whom history is the mother of truth, pragmatically drawing the meaning of this word from its history (Borges, 1961, p. 94).

To conclude with some etymological concerns, philosophy is defined as the love for knowledge, or wisdom (Greek φιλο-σοφία), and science is knowledge itself (Latin *scientia*) further defined as the ability to separate things (*sek-* being a Proto-Indo-European root meaning "to cut").

Are we certain that trying to impose boundaries on knowledge, to restrict its procedures (and thus its future achievements) is the best form to express that love?

> Enforcing any such criterion would likely harm future science more than help it. To adopt a criterion that legislates for all future science falls into the trap of thinking that we are today in the privileged position of having finally escaped from history. (Nickles, 2013, p. 114)

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