

What do we mean when we speak of pseudoscience? The development of a demarcation criterion based on the analysis of twenty-one previous attempts

¿Qué queremos decir cuando hablamos de pseudociencia? El desarrollo de un criterio de demarcación basado en el análisis de veintiún intentos anteriores

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Se lleva a cabo el análisis crítico de veintiún criterios de demarcación, obteniéndose como resultado una herramienta que permite un cribado adecuado entre ciencia y pseudociencia. Luego de una introducción que enfatiza la relevancia científica y social del problema de la demarcación y la necesidad de un enfoque adecuado para hacerle frente, son remarcados los problemas específicos de los intentos demarcativos de tipo multicriterio, como la falta de fundamentos teóricos y la presencia de ítems prescindibles y/o contradictorios. Sobre la base de este primer análisis, es desarrollado un metacriterio: los requisitos filosóficos necesarios para un criterio de demarcación. El análisis de datos indica falta de progreso entre los criterios de demarcación propuestos desde 1964 hasta la fecha, y permite el desarrollo de un criterio basado en los ítems con mayor apoyo, capaz de satisfacer las exigencias del metacriterio planteado.

Pseudociencia · Criterio de demarcación · Multicriterios.

A critical analysis of twenty-one demarcation criteria is carried out, obtaining as a result a demarcating tool that allows appropriate screening between science and pseudoscience. After an introduction that will emphasize the scientific and social relevance of the demarcation problem and the need of an adequate approach to face it, the specific problems of multicriterial attempts will be remarked, such as their lack of theoretical foundations and the presence of dispensable and contradictory items. On the basis of this first analysis, a metacriterion, the necessary general requirements for a demarcation criterion, will be established. The data analysis will show a lack of progress among demarcation criteria from 1964 to date, and will provide a demarcation criterion partially based on the items with greater support.

Pseudoscience · Demarcation criterion · Multicriteria.

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THE PROBLEM OF DEMARCATION is the problem regarding the limits of science; the problem of where to draw the boundaries between science and religion, paranormal thought or humanities, with the distinction between science and pseudoscience having special historical relevance (Nickles, 2013). In this article, a criterion to demarcate between science and pseudoscience will be developed based on the critical analysis of twenty–one demarcation criteria. In the first place, an introduction to the problem will be carried out, in which some of the historical complexities of the demarcation problem and some points of view regarding it will be discussed—for example, the ideas of Popper, Laudan or Pigliucci. After this introduction, an analysis of the specific problems of the multicriteria approach will be carried out, finishing with the establishment of a metacriterion composed of four philosophical requirements, two desirable and two mandatory. Subsequently, I will analyse a data matrix elaborated with twenty–one multicriterial criteria published between 1964 and 2016. As a result of this analysis, a demarcation criterion will be proposed. In the last section, the relationship between this criterion and Hansson (2009) will be discussed.

The definition of pseudoscience, besides being a philosophical problem, is also a scientific issue since without a demarcation criterion the study of the phenomenon can suffer a lack of reliability due to the inability of researchers to define a homogeneous domain. The social implications of pseudoscience are also a reason to develop a demarcation criterion, since it has a high social prevalence, being especially harmful in clinical and educational contexts—although the study of pseudoscience can be a very useful tool to understand

the nature of science (Lilienfeld, Lohr, and Morier, 2004; Afonso and Gilbert, 2009). Nevertheless, in spite of the fact that there have been various attempts, none of them have ever been satisfactory to the fussy community of philosophers of science.

Some of the main problems related to the demarcation of science (Hansson, 2017b; Mahner, 2013), which should serve as a guideline for the development and evaluation of demarcation criteria, are:

1. The problem of demarcation is generalized and not only related to pseudoscience. It is a distinction between science and non-science —a heterogeneous set of practices and ideas that includes religion, the paranormal, conspiracy theories, humanities, art and so on. It is necessary to choose what to demarcate.

2. There is a distinction between good science and bad science (Goldcrane, 2008; Elliot, 2016). This distinction has been stated as ambiguous, as a *continuum* (Pigliucci, 2013), but we must take into account that bad science is still science, so the demarcation criterion between bad science and pseudoscience should be the same as the demarcation criterion between good science and pseudoscience. In any case, this issue has been barely discussed.

3. Another decision for the philosopher is whether his demarcative proposal will be monocriterial or multicriterial. That is, if he will bet on a silver bullet, as is the case of falsificationism, or if, on the contrary, there will be several necessary and/or sufficient conditions to be science and pseudoscience.

4. Another decision of great relevance is the one concerning the units of demarcation: to which aspects of science are we going to pay attention when demarcating. Proposals in this regard are many: we can demarcate propositions (Popper, 1963), fields of knowledge (Bunge, 1982; Thagard, 1988), theories (Kitcher 1982; Lugg, 1987), research programmes (Lakatos, 1978a), we could focus our attention on the logical–methodological level (Wilson, 2000), etc.

5. The fifth problem is whether the criterion will be historical or ahistorical; whether it will consider the demarcating unit or units from a synchronous or diachronic standpoint. Falsifiability is an ahistorical criterion, nevertheless, other authors have considered as relevant theoretical progress over time (Lakatos, 1978a; Thagard, 1978; Grove, 1985; Hansson, 2009; Lilienfeld, Ammirati, and David, 2012).

6. The unity or disunity of science is another theoretical problem to be faced by any demarcative attempt (Cat, 2006). Nowadays, once the physicalist project of neopositivists has been abandoned, the concept of *consilience* is often appealing; the idea that science as a whole offers us a worldview (Reisch 1998; Wilson 1998). In this regard, external congruence can be stated as necessary or merely desirable.

7. Finally, the problem concerning the sense or necessity of a criterion. Is it worth developing a demarcation criterion or can we just get rid of the problem? Although this question is valid, the problem of demarcation plays a key role in other questions such as: Should our public health systems include alternative medicine? Should the funding system of science finance research on homeopathy or on reiki? Should biology teachers teach as alternatives the theory of evolution and intelligent design? Should we hire dowzers, neurolinguistics programmers or biodynamic farmers to improve our management of public resources? Our answers to these questions are momentous since they will directly affect our quality of life.

The most famous demarcation criterion has been falsifiability, developed by Popper as a response to the verificationism of the Vienna Circle—which should not be understood as a criterion between science and pseudoscience, but as a criterion of epistemic meaning which sought to demarcate between physics and metaphysics. According to falsifiability, every proposition is scientific if and only if it can be subjected to a process of falsification (Popper, 1963). This idea has been, and still is, very popular (Ruse, 1982; Lilienfeld, Ammirati, and David, 2012; Lack and Rousseau, 2016), although as a criterion and as an interpretative framework for scientific activity, it has been widely rejected by the community of philosophers of science (Kuhn, 1970; Agassi, 1971; Lakatos, 1974a; Thagard, 1978; 1988; Kitcher, 1982; Laudan, 1983; Siitonen, 1984; Lugg, 1987; Rothbart, 1990; Derksen, 1993; Resnik, 2000; Mahner, 2007).

It has several problems, with three as especially relevant. In the first place, falsificationism denies any importance to the confirmation of theories, an idea that does not correspond to the reality of scientific inquiry (Hansson, 2006). Secondly, it assumes the existence of an instantaneous rationality in falsifications, so that they are understood as a final verdict, something that characterizes as irrational several events of the history of science in which a theory overcame disconfirmations (Lakatos, 1978a). Finally, the biggest problem of falsifiability is simple: falsifiable pseudoscience exists and is usual. “Homeopathy cures the flu” or “repressed memories are a psychological phenomenon” are falsifiable claims (McNally, 2007; Ernst, 2010). This is why as a criterion between science and pseudoscience it turns out to be an imprecise tool.

After Popper, there have been multiple attempts to avoid all these problems. Kuhn proposed a demarcation criterion based on the concept of *puzzle-solving* (Kuhn, 1974), typical of what he called “normal science” as opposed to moments of scientific revolution. Scientific research would consist of solving puzzles rather than testing fundamental theories; puzzles that would be defined within these fundamental theories, which, in turn, would be part of a “paradigm” in which scientists would be immersed. Nevertheless, Kuhn’s criterion is at least partially relativistic, since, although we could demarcate between science and pseudoscience within a paradigm in which, for example, astrology is not carrying out puzzle-solving (Kuhn 1974, p. 804), standards of rationality would be defined only within this particular paradigm. Thus, despite the existence of certain agreed values (Kuhn, 1977), the pseudoscience of one paradigm could be the science of another given that they are “incommensurable” among them. According to the interpretation of Popper and Lakatos (Worrall, 2003), the acceptance of Kuhn’s criterion would mean the “replacement of a rational criterion of science by a sociological one” (Popper 1974, p. 1146).

The sociological approach to demarcation based on consensual values, which we could call “axiological demarcationism” —although Lakatos, who proposed his own criterion of progressivity (Lakatos, 1974b), calls it “elitism” (Lakatos, 1978b)— has had many defenders (Merton, [1942] 1973; Lacey, 2004), being Shermer its most famous backer within circles of skeptical thinkers (Shermer, 2013). According to this approach to the demarcation problem, science is what scientists do based on some consensual values shared by all of them. Nevertheless, the main problem of axiological demarcationism is that it

includes a circular reasoning —(1) scientific values are those in which scientists agree together; (2) scientists are scientists because they make science; (3) science is what meets scientific values; and again (1). Moreover, it leaves the decision on the nature of science in the hands of a community in which values are not homogeneously distributed, something that is observable in problems such as scientific fraud (Fanelli, 2009) and pseudoscience offered by healthcare professionals (Garb and Boyle, 2003; CAMbrella, 2012).

Laudan's announcement of the demise of the demarcation problem, labeling it as a philosophical pseudoproblem (Laudan, 1983), has been especially influential as a reaction to all these failed attempts. In his famous article, Laudan states that "The (*demarcation*) question is both uninteresting and, judging by its checkered past, intractable. If we would stand up and be counted on the side of reason, we ought to drop terms like 'pseudo-science' and 'unscientific' from our vocabulary; they are just hollow phrases which do only emotive work for us. As such, they are more suited to the rhetoric of politicians and Scottish sociologists of knowledge than to that of empirical researchers" (Laudan, 1983, p. 125). Laudan holds a pessimistic point of view about the problem on the basis of his analysis of its history: since no philosopher of science has managed to develop a well-grounded and functional criterion, able to fulfill Laudan's metaphilosophy (Laudan, 1983, p. 122), the problem must lie in the irrational nature of terms like "pseudoscience" and, therefore, its demarcation must be considered as a philosophical blind alley.

His denial of the demarcation problem, nonetheless, is not as radical as one might think: Laudan, in fact, offers a demarcation criterion for what is commonly called "pseudoscience" based on the "empirical and conceptual credentials for claims about the world. The 'scientific' status of those claims is altogether irrelevant" (Laudan, 1983, p. 125). Thus, Laudan considers that the problem of demarcation belongs to general epistemology. This implies that he is not a radical denialist of the demarcation problem; he is, rather, a denialist of pseudoscience and of *a priori* demarcation. But, despite his pessimism, his expectations have not been fulfilled (Mahner, 2013). In the first place, philosophy of science has not been replaced by general epistemology and is still a very lively field. Secondly, during the last decades the development of demarcation criteria has continued to take place, showing that the demarcation problem is still interesting for philosophers of science. And thirdly, the study of the rhetorical, psychological and sociological mechanisms of pseudoscience as a specific and delimited set of epistemologically unwarranted beliefs has been

progressing (Bensley, Lilienfeld, and Powell, 2014; Lobato et al., 2014; Blancke, Boudry, and Pigliucci, 2016; Hansson, 2017a; Fasce, 2017; Fasce and Picó, 2018a; 2018b; 2018c).

Pigliucci (2013) has criticized Laudan's ideas, especially his metaphilosophy. Pigliucci argues against his requirement of necessary and sufficient conditions, accusing him of being out of fashion and he appeal, following Dupré (1993), to the Wittgensteinian concept of *family resemblance* to point out the fuzzy limits of concepts such as *science* and *pseudoscience*. But, despite being an attractive idea based on cluster techniques of classification, Pigliucci's proposal is insufficient since statistical demarcation of pseudoscience has no normative force (for in-depth critical analysis of Pigliucci's ideas and general statistical demarcation see Fasce, 2018; Schindler, 2018) —the key factor here is that pseudoscience is non-science disguised as science. The use of intuitive resemblance is a problematic strategy to develop a demarcation criterion, since intuitive resemblance assumes the existence of a *continuum* between science and pseudoscience —science will be improved pseudoscience—, without taking into account discriminant features between both classes. Pigliucci's proposal makes explicit some basic thoughts that underlie any demarcationist intention —that the entities to be demarcated are in similar—, but the justification of our decision must be beyond intuitive resemblance. Why do we call all these practices and ideas “pseudoscience”? Pigliucci tentatively appeals to the “theoretical understanding” and to the “empirical knowledge”, but this does not offer us a normative and well-founded answer to the question. Furthermore, the problems of statistical demarcation based on family resemblance not only affects the science/pseudoscience demarcation, but also the demarcation between pseudoscience and other forms of non-science, as can be seen in psychometric scales of pseudoscience that do not measure a congruent construct (examples of this scales can be found in Johnson and Pigliucci, 2004; Majima, 2015; Tseng et al., 2013). In fact, correct psychometry of pseudoscience is unusual since, among other problems, its family resemblance can be a double-edged sword (for a technical discussion on these psychometric problems see Fasce and Picó, 2018), something that Laudan (justly) demands.

§ 1. Problems of multicriterial attempts

Multicriterial approach to demarcation, although it has precedents (Langmuir [1953] 1989), has been booming since the 1980s. It consists of the development of lists of features of science and/or pseudoscience —according to which the

criterion is focused —that would allow us to define them. Whether these characteristics are necessary or sufficient conditions depends on each author, since in many cases the transgression of some items is allowed (Park, 2003; Lilienfeld, Ammirati, and David, 2012) and in others it is a completely strict criterion (Bunge, 1982; Mahner 2007; Hansson, 2009). For example, Lack and Rousseau define pseudoscience as “Any claim, hypothesis, or theory that is presented in the language and manner typical of scientific claims, but that fails to conform to accepted standards in science regarding openness to peer review, replicability, transparent methodology, and the potential for falsifiability is highly likely to be a pseudoscientific claim, hypothesis, or theory” (Lack and Rousseau, 2016, p. 39). In this case, we have as first premise that the assertion, hypothesis or theory is presented as science, something that must be mandatory in any definition of pseudoscience (Hansson, 1996), and the following five items try to define when the first one is a fraud —when something is non-science.

Nevertheless, we are not told if these criteria are all necessary or if one of them is enough to be pseudoscience. Given that Lack and Rousseau later offer a list of characteristics that are merely indicative of pseudoscience (Lack and Rousseau, 2016, p. 42) we may think that all these requirements are what they consider to be necessary, but if so, and even if not, the list is problematic. For example, replicability is required, a feature shared with other proposals (Gruenberger, 1964; Hansson, 1983; Beyerstein, 1995) that would leave out much of the social sciences, and even parts of psychology would have serious problems for not being pseudoscience (Open Science Collaboration, 2015). As other authors have argued (Vollmer, 1993; Norton, 2015), replicability should not be considered as part of a demarcation criterion for this reason, being merely a positive value. Another obvious problem of this criterion is the inclusion of Popperian falsifiability which, as argued above, has already been ruled out as a demarcation criterion between science and non-science. Openness to peer review is also problematic. A great deal of scientific research is not open to peer review and does not even make public its data and its results — for example, private or military research, which would thus be characterized as pseudoscience. In spite of it, this item is present in other criteria (Gruenberger, 1964; Tuomela, 1985; Beyerstein, 1995; Park, 2003; Lilienfeld, Ammirati, and David, 2012).

These types of theoretical problems are a constant in multicriterial criteria, even since its origins. The forerunner of multicriterial demarcation was

Gruenberger with his article *A Measure for Crackpots* (1962). In his article, Gruenberger tries to develop a way to measure how loon the assessed pseudoscientific is. It assigns a particular value to each item of his criterion, which would allow us to calculate a final score going from zero to one hundred, zero being very scientific and one hundred very pseudoscientific—it is the only criterion that carries out an explicit and numerical measurement of pseudoscience—and without postulating any characteristic as necessary or sufficient. Gruenberger lists thirteen items, among which are predictability, the use of controlled experiments, parsimony, humility, mental openness or paranoia against the system. But there are two basic problems with this criterion which the multicriterial tradition has not been able to solve. In the first place: “What follows, then, is a check list of some significant items which *we think* are among the main attributes of the scientist” (italics are mine) (p. 6). The selection of items usually has weak foundations. The second problem, which Gruenberger is also aware of: “The scores are personal, arbitrary, and biased. The reader is urged to fill his own values, rather than waste time quibbling over mine” (p. 12). This is the usual problem of hierarchy between items. Why are some of them more important than others? —If some of them are more important than others.

Demarcation criteria have been published in academic articles as well as in books and websites related to skepticism and to the study of pseudoscience. They have also been used by courts. For example, in the famed trial between Tammy Kitzmiller and the Dover Area School District, in which a group of parents filed a lawsuit against the teaching of intelligent design in public schools of Pennsylvania, claiming that, as a type of creationism, its presence in the classrooms violated the first amendment of United States’ Constitution. Judge Jones appealed to multicriterial demarcation (Jones, 2005) in order to decide whether or not intelligent design was a religious pseudoscience—as expected, the sentence ruled that it is a pseudoscientific way of creationism. His criterion included presenting incomplete explanations, without causalities and teleological thinking, but there are scientific studies that do not establish causalities—for example, some interpretations of quantum mechanics or correlational studies—, give incomplete explanations—physics as a whole is incomplete—and functional explanations, despite having detractors (Hempel, [1959] 1994), are often used by scientists (Godfrey-Smith, 1993).

Other judges prior to Judge Jones also adopted these kind of criteria, such as Judge Overton, who headed the litigation between William McLean and the

Arkansas Board of Education. Judge Overton adopted in his decision (Overton, 1982) a criterion provided by Ruse, who later published it reviewed (Ruse, 1982). Ruse's criterion includes as essential characteristics of science that (1) must refer to natural laws; (2) must explain these natural laws; (3) must be empirically testable; (4) its conclusions must be tentative; (5) must be falsifiable—being all these characteristics necessary and sufficient in conjunction. Despite being officially adopted in a court and having passed reviews, Ruse's criterion has been the target of strong criticism, especially by Laudan (1982). Laudan criticizes that (1) and (2) are too strong, while (3), (4) and (5) are too weak, so that Ruse's criterion would leave out scientific theories and fields due to the first two items and would let in pseudosciences for its last three. For example, with regard to (1) it is debatable that all science uses nomological explanations, with several authors against this idea (Cartwright, 1989; van Fraassen, 1989). With regard to (2) there are historical examples that would refute this item, such as the postulation of gravity by Newton, in addition to many correlational studies, purely predictive, that do not formulate explanations; in addition, there are cases of pseudosciences that appeal to supposed laws, such as German new medicine or the law of attraction. On (3), (4) and (5) Laudan claims that creation science is—or at least could be—testable, tentative and falsifiable.

In view of all these problems, and in order to achieve a demarcation criterion to be well-founded and functional, the tool will need to fulfill some metaphilosophical requirements or metacriterion. On the one hand, R1 and R2 are desirable *procedural requirements*—that is, they are general values that should guide the elaboration of the demarcation criterion of pseudoscience, giving rise to general conditions of plausibility. On the other hand, R3 and R4 are mandatory *criterion requirements*. R3 and R4 provide the demarcation criterion with a criterion of relevance, with a valid domain of unities of demarcation and with an appropriate internal structure (for an in-depth discussion of this metacriterion see Fasce, 2018):

Procedural requirements:

- R1** The demarcation criterion of pseudoscience must entail a minimum level of philosophical commitments.
- R2** The demarcation criterion must explain current consensus on pseudosciences and aspire to achieve new ones.

Criterion requirements:

- R3** Pretending to be science is a necessary requirement to be pseudoscience.
- R4** Leaving aside R3, all the items of the demarcation criterion must be discriminant with respect to pseudoscience, being sufficient to be pseudoscience the fulfillment of R3 and of at least one R4-type item. To find R4-type items we must ask about the items “what characteristics does pseudoscience have that science cannot have?”—another version of this question would be “can something with this feature be science?”.

It is necessary to carry out an in-depth analysis of the multicriterial tradition in order to reveal if these four requirements could be satisfied or not. The two general questions that should guide this analysis are: Has there been progress in the development of demarcation criteria? And, is it possible to develop a demarcation criterion able to meet these three requirements?

§ 2. An analysis of twenty-one demarcation criteria

An analysis of the following twenty-one criteria will be carried out (Gruenberger, 1964; Dutch, 1982; Bunge, 1982; Kitcher, 1982; Hansson, 1983; 2009; Grove, 1985; Tuomela, 1985; Thagard, 1988; Glymore and Stalker, 1990; Derksen, 1993; Vollmer, 1993; Beyerstein, 1995; Schick and Vaughn, 1995; Ruse, 1996; Coker, 2001; Park, 2003; Jones, 2005; Skelton, 2011; Lilienfeld, Ammirati, and David, 2012; Lack and Rousseau, 2016). Criteria that have not passed a minimum review, either by peer review or by a publisher, or do not have some official status or do not have been written by a recognized expert in the field (for example, Beyerstein, 1995) have been left out. Some borderline proposals (Thagard, 1978; Giere, 1979; Rothbart, 1990; Reisch, 1998), which are not clearly multicriterial or which are not considered as such in the available bibliography on the topic (Hansson, 2017b), have been left out as well in order to increase consensus regarding the sample. Finally, only demarcation criteria published in English have been selected to avoid misunderstandings when translating terms belonging to a field with many semantic nuances as philosophy of science. For example, the subtle difference between *verifiability*, *testability*, *confirmability*, *disconfirmability* or *falsifiability*, or between *progressiveness*

and *fruitfulness*, in a language that this author does not handle could make the sample bias. At any rate, this author is not aware of any criterion that meets the selection criterion and has not been published in English —considering that Hansson (1983) has been translated by its own author (Hansson, 2017b) and that Vollmer (1993) has been translated in Mahner (2007).

These twenty–one criteria have in total seventy items:

- | | |
|--|---|
| 1 Arguments from ignorance; | 21 Lack of boundary conditions; |
| 2 Non–replicable; | 22 Invention of facts; |
| 3 Appeal to tradition; | 23 Appeal to subjective or exceptional evidence; |
| 4 Different social support than offered to science; | 24 Dependence on cultural facts; |
| 5 Lack of attention to contrary evidence; | 25 Internal incongruity; |
| 6 Lack of explanatory power; | 26 Lack of evidence; |
| 7 Lack of progress; | 27 Use of rhetoric and propaganda; |
| 8 Creation of mysteries; | 28 Authoritarianism; |
| 9 Circular arguments; | 29 Appeal to emotions; |
| 10 Lack of assessment of alternative theories; | 30 False authorities; |
| 11 Non–cumulative knowledge; | 31 Does not appeal to laws; |
| 12 Lack of credentials among its defenders; | 32 Paradoxical relationship with scientific methodology; |
| 13 Misuse of scientific data; | 33 Teleological thinking; |
| 14 Inability to predict; | 34 Incomplete and non–causal explanations; |
| 15 Lack of fruitfulness; | 35 Conspiracy theories; |
| 16 Rejection by the scientific community; | 36 Work in solitude; |
| 17 Publications without peer review; | 37 External incongruity; |
| 18 Cherry Picking; | 38 Pretend to be new and old at the same time; |
| 19 Extraordinary claims; | 39 Magical thinking; |
| 20 Hypertechnic language; | 40 Conflicts of interest; |

Continue...

41 Non–existence of theories;

61 Abuse of statistics;

- 42 Is presented as science;
- 43 Lack of systematicity;
- 44 *Non-falsifiable*;
- 45 Alien to the domain of science;
- 46 Metaphysical ideas;
- 47 Claims to be consistent with facts, but superficially;
- 48 Abuse of *ad hoc* hypotheses;
- 49 Appeal to paranormal abilities;
- 50 Avoid logic and mathematics;
- 51 Appeal to mythology;
- 52 Focuses on practical problems;
- 53 Lack of openness to criticism;
- 54 Is within the domain of science;
- 55 It is not reliable;
- 56 Presence of spurious correlations;
- 57 “Timid” phenomena;
- 58 Lack of parsimony;
- 59 Reluctance to test;
- 60 Lack of humility;
- 62 Ambiguous language;
- 63 Community of believers, not of researchers;
- 64 Poor approach to problems;
- 65 Deficient methodology;
- 66 Excessive pretensions;
- 67 Unnecessarily complex theories;
- 68 Unnecessary use of mathematical language;
- 69 “Many geniuses have been despised”;
- 70 Quote mining.

The elaboration of this list of items has also required some methodological decisions. In the first place, in some cases different criteria call the same item by different names. For example, item 17 —“publications without peer reviews”— is called in various ways: “public scrutiny” (Beyerstein, 1995), “peer review” (Liliefeld et al., 2012) or “the discoverer pitches the claim directly to the media” (Park, 2003); or item 46 —“metaphysical ideas”— that is called “ontology that allows the existence of immaterial entities and processes” (Bunge, 1982) or (*lack of*) “testability” (Schick and Vaughn, 1995). In these cases, the decision has been to group them under the same label, since the idea they intended to express was equivalent. Nevertheless, in case of slight semantic differences it has been preferred to keep those items separate. This is the case of, for example, items 7 and 11 —“lack of progress” / “non-cumulative knowledge”; 23, 26 and 59— “Appeal to subjective or exceptional evidence” / “Lack of evidence” / “Reluctance to test”; or 39 and 49 —“Magical thinking” / “Appeal to paranormal abilities”.

On the other hand, other items have been chopped since they express diverse ideas at the same time. Examples of these items that include several of them are: “Lack of falsifiability and overuse of ad hoc hypotheses” (Lilienfeld, Ammirati, and David, 2012), “Pseudoscientific concepts tend to be shaped by individual egos and personalities, almost always by individuals who are not in contact with mainstream science. They often invoke authority for support” (Skelton, 2011), or “Pseudoscience appeals to false authority, to emotion, sentiment, or distrust of established fact” (Coker, 2001). Another methodological decision related to the classification of items has been to reverse the meaning of some of them, so that they are now always negative and, therefore, point to pseudoscience. Some of these items have been originally expressed pointing to science (e.g. Kitcher, 1982; Vollmer, 1993), others to pseudoscience (e.g. Hansson, 2009; Lack and Rousseau, 2016), and others include the positive and negative expression of the same idea (e.g. Bunge, 1982; Thagard, 1988; Skelton, 2011). The only item that could not be affected by this situation is number 42 —“is presented as science”— since it is exclusive of pseudoscience, being included just by criteria that choose a negative expression of its items.

It is worthwhile to make an additional comment on the presence of dispensable and contradictory items, an evidence of lack of theoretical foundations. The recognition of dispensable items has been carried out based on the question included in R4 in order to find R4-type items. For example,

with regard to item 14 —“inability to predict”— some authors would consider this characteristic to be mandatory of non–science, for example Reichenbach, Popper or Lakatos, but it is debatable to what extent we can or cannot demand predictive capacity to all scientific fields (Rescher, 1998) —for example, history, economics, or sociology have difficulties performing predictions. Another example is item 62 —“ambiguous language”—, since the presence of some linguistic ambiguity is tolerated within science. Although semantic elucidation has been a classic aspiration of philosophy of science (Carnap, 1950), there is still ambiguity in some scientific concepts, for example in such basic ones as “gene” (Dietrich, 2000) or “species” (Hey, 2001). Nevertheless, some other items can be eliminated with no theoretical resistance, such as the lack of humility or the work in solitude —the complete list is: 8, 12, 17, 20, 24, 36, 40, 50, 52, 57, 58, 60, 62, 67, 68. Another problem is the presence of contradictory items. For example, items 45 and 54 tell us that pseudoscience makes statements inside and outside the domain of science. Other cases are 20/62 and 22/47.

	Items	AVI	ASI	MAI	IVAASI	MVI
(A) + (B) + (C)	70	8,76	0.12	0.42	0.37	5; 17; 46; 53; 44; 7; 65; 37
(A) 1964-1985	40	9,14	0.22	0.57	0.37	7; 27; 65; 37
(B) 1988-1996	39	8,42	0.21	0.57	0.33	67; 28; 6; 56; 46; 53; 7; 37
(C) 2001-2016	39	8,71	0.22	0.57	0.35	3; 27; 5; 17; 46; 37; 7; 44; 65
(A) + (C)	61	8,92	0.14	0.5	0.19	46; 5; 17; 53; 44; 7; 65; 37
TOP 8	8	2,9	0.36	0.42	0.62	5; 17; 46; 53; 44; 7; 65; 37

Table 2. Data analysis.

Note: AVI = Average of voted items; ASI= Average support per item; MAI = Maximum agreement per item; IVAASI = Items voted above the ASI; MVI= Most

The first thing to ask about these data is it show some kind of theoretical progress during the last decades. Given that we can hypothesize that the selection of items responds to a continuous reflection based on the study of previous proposals, it would be possible and desirable that these criteria tend toward consensus based on the accumulation of theoretical successes. Looking at the data matrix (**Table 1**), this would be visible if as we go down —towards

the most recent criteria—the items these newer criteria choose are accumulated in the lower-right corner of the table. Nonetheless, at first glance this does not seem to occur. A detailed analysis of the data (**Table 2**) reveals that the average support by item (ASI = the average of the votes divided by the number of authors) including the 21 authors in the calculation is 12% —this means that on average 2.52 authors support each of the items. The item with the most support (MAI) has 42% —no item has majority agreement— and 35% of the items have a support above the ASI (IVAASI). An IVAASI rate of 35% together with a MAI of only 42% tell us that the distribution is quite unequal, with a large part of 65% of the items below the ASI having marginal support of just one or two authors —in fact, 62% of the items do not exceed two votes. These data reveal a great disagreement about the chosen items. However, the total numbers could be hiding a greater consensus in the most recent proposals, something that would constitute evidence of theoretical progress.

To measure whether there has been a greater agreement over the decades, the matrix should be divided into three groups: the seven oldest criteria (1964–1985 = (A)), the seven newer (2001–2016 = (C)) and the seven that are in between (1988–1996 = (B)). The evidence of theoretical progress would be: less total items, a higher ASI, a higher MAI or a higher IVAASI in (C). Nevertheless, what we observe does not denote the slightest progress. The number of items is the same in the three groups —one more in (A), something that is not statistically relevant. The ASI has been maintained over time, standing around 22% within each band, just like the MAI, which remains at 0.57 in all three. If we look at the IVAASI, we can see also a homogeneous distribution with fluctuations of just around 2 percentage points —although the highest IVAASI is (A) it is not a relevant difference. These numbers denote that demarcation criteria are theoretically stagnated, since their total number of items and their support for those items are almost identical throughout its historical evolution, showing no general progress. These numbers are evidence against the theoretical defense of philosophical progress regarding demarcation carried out by authors like Pigliucci (2013), justifying, at least partially, Laudan's historical pessimism.

In order to have a deeper insight of the theoretical development of the multicriterial tradition, it is appropriate to analyse the relationship between (A) and (C); the relationship between the most recent and the oldest criteria, avoiding the possible influence of (B) in the results. What we observe after carrying out this analysis is that the increase of total items between (A) and (C)

is very pronounced —52.5%—, thus (A) and (C) explain 87% of the variability of items —(A) and (B) explain 80%, and (B) and (C) 81%. In fact, 83% of the items supported by (C) are different from those supported by (A), with 27% of them having at least one vote in each generation— a number that is reduced to 9% if we demand at least two votes in each generation. These new items cannot be explained by a greater length in the newer criteria because the criteria of (A) are slightly longer than those of (C). Moreover, taking into account the ASI, these new items have done nothing to reach an agreement. Given that the two generations consider very different items, the ASI is of 14% and together with the IVAASI, which does not have the leveling effect of (B), are reduced by 51% compared to the global data. This is because many items have been introduced by a minimal support. Instead of understanding demarcation as a joint work, these authors have increased their theoretical isolation with the passing of the decades.

Nevertheless, it is possible to recognize some items as the most popular, so that it is possible to define an average criterion composed by 5, 17, 46, 53, 44, 7, 65 and 37 —eight items have been selected since the overall AVI is 8.76. If we analyse this criterion (TOP 8) we find numbers that, even though they are far from achieving consensus, improve those of the complete list of items. We find an AVI of 2.9 and an ASI of 0.36. The item with more agreement reaches 42%, having items 7, 65 and 37 this level of support. In addition, IVAASI rises to 62%, so there are now no items with marginal support. But even in TOP 8 there is still a high level of disagreement about the nature of science, even regarding its most essential features, something that has already been measured among philosophers in a broad sense (Alters, 1997), but never among experts in demarcation. The ASI of TOP 8 triples that of the general data. It is still far from majority but it is the best we can obtain regarding the support of a demarcation criterion.

Since it was established in R4 to achieve normative force, all items must be discriminative. Thus, it is worth asking ourselves if science could fulfill some of these eight features and maintain its status. In this regard, two items are problematic: 17 and 37. 17 has already been argued, noting that, although peer review is a tool of great interest for the maintenance of the reliability of scientific publications, not going through a process like this does not necessarily invalidate the results of an investigation. For this reason, because a considerable part of science does not go through peer review and thus meets the item 17, this item must be removed from the criterion.

On the other hand, the item 37 labels as unscientific heterodoxy and progress based on criticism of well-established theories. To give two classic examples: the theory of relativity violated some of the accepted principles of Newtonian mechanics or the initial rejection of Alfred Wegener's continental drift theory, both conflicting theories regarding the beliefs of the scientific community of their time. To label something as pseudoscientific simply because it is not orthodox is something that should be avoided in the light of the history of science (Toulmin, 1985), since doing so could suffocate the freedom of thought and criticism within science, impeding its progress. Although it is true that the Popperian model of scientific progress, based on increasing explanatory power with a new theory that includes the previous one, would be ideal, scientific progress often takes place defending new ideas that are partially incongruent with current knowledge. After all, the epistemological problem with homeopathy is not that it violates the principles of chemistry, the problem is that it violates them without offering in return a better theory.

The thematic spectrum of the remaining items is: (1) Scientific domain: 46, 44; (2) Method: 65; (3) Evidence: 5, 53, 7. Beyond the specific details of these items, they seem to be the three discriminant R4-type indicators of pseudoscience. They are also inviolable: there can be no science outside the scientific domain, or with a method that is extremely biased, or not based on evidence. No philosopher of science has advocated a science that does not have these characteristics. A scientific theory or hypothesis on the embryology of unicorns is not valid, a scientific theory without a good methodology is not reliable and a scientific theory without confirmatory evidence is no more, at best, than a mere hypothesis. To these three R4-type items we should add, because of R3, the item 42 —“is presented as science”. This is due to the prefix “pseudo-” of “pseudoscience”: its nature is to be non-science presented as science. With this, pseudoscience will be defined as follows:

(Pseudoscience) (1 and/or 2 and/or 3) and 4.

1. Refers to entities and/or processes outside the domain of science.
2. Makes use of a deficient methodology.
3. Is not supported by evidence.
4. Is presented as scientific knowledge.

Being necessary to fulfill any of the first three items and sufficient in

conjunction with (4) to be pseudoscience, and taking into account that pseudoscience is defined based on current knowledge on methodologies and evidence, this demarcation criterion meets the three requirements, demarcating between science and pseudoscience any epistemological product—theories, hypothesis, propositions, etc. Nevertheless, it could be even more explicit. Concepts such as “scientific domain” should be elucidated—which, based on items 46 and 44 would be defined as non–metaphysical and disconfirmable semantic content—, “deficient methodology”, which will require an analysis of the epistemological foundations that unify all methods and methodologies of science as well as an analysis of extreme cases of methodological misconduct, and “evidence”, since here, *scientific* evidence is appealed. The elucidation of these concepts is not the goal of this paper, although it is a necessary continuation for an in–depth foundation of this demarcation criterion.

Nevertheless, at its current level of completion it already allows a fairly satisfactory and functional demarcation. For example, paranormal thinking meets (1) since by definition it appeals to phenomena outside the domain of science (Broad, 1953; Tobacyk, 2004), although it would not be pseudoscience because it does not meet (4). On the contrary, parapsychology can present an optimal methodology and does not necessarily fulfill (3), but it meets (1)—since the existence of the so–called “psi phenomena” has never been demonstrated— and (4), so it is pseudoscience. There are many cases of fulfillment of (1); pseudoscientific ideas that appeal to metaphysical concepts such as acupuncture and its “Qi”, reiki or chiropractic and its “subluxations”. Others fail to avoid (2). A case would be EMDR (Herbert et al., 2000), a technique that avoids (1) and (3) but not (2) since when studies are done using a triple–blind methodology —EMDR without imitation of saccadic movements— results suggest that it works by covert exposure by visualization and not because of the specific technique offered by EMDR (Davidson and Parker, 2001; Cusack, 2016). Conspiracy theories could avoid (1) but not (2), and depending on whether they meet (4) they will or will not be pseudoscience — for example, science denialism would be pseudoscience, given that it fakes scientific controversies using conspirational ideation (Hansson, 2017a; Fasce and Picó, 2018c). It would be a great contribution to the discussion that the reader endeavored to try to find counterexamples to this criterion.

§ 3. A comment on the relationship between this criterion and Hansson's. Revolution or progress?

The result of the analysis carried out, a demarcation criterion which is constituted by four items, has a direct relationship with Hansson (2009). His criterion is the only one of the whole data matrix that did not fulfill any of the items of TOP 8, a surprising fact if we misinterpreted Hansson's proposal. In spite of the fact that in recent years has gained notoriety by being used as a demarcation criterion in a large number of studies, Hansson's proposal is between a metacriterion and a criterion: it is the general structure that any criterion, either between science and pseudoscience, philosophy and pseudophilosophy or good science and bad science, should present. This general structure is as follows (Hansson, 2009, p. 240):

- 1) It pertains to an issue within the domains of science in the broad sense (the criterion of scientific domain).
- 2) It suffers from such a severe lack of reliability that it cannot at all be trusted (the criterion of unreliability).
- 3) It is part of a doctrine whose major proponents try to create the impression that it represents the most reliable knowledge on its subject matter (the criterion of deviant doctrine).

Consequently, a proposal, whether theoretical or practical, will be pseudoscience if and only if it meets the first two items and, moreover, is presented as science. Nevertheless, it presents serious problems if we took it as a demarcation criterion. In the first place, it presents a problem of indefiniteness, something that the author is aware of and that is caused by the theoretical foundations of his work. Hansson defines the fields he considers as scientific based on the German concept of *Wissenschaft*, claiming that "their very *raison d'être* is to provide us with the most epistemically warranted statements that can be made, at the time being, on the subject matter within their respective domains. Together, they form a community of knowledge disciplines characterized by mutual respect for each other's results and methods" (Hansson, 2013, p. 63). He even asserts that "Philosophy, of course, is a science in this broad sense of the word" (Hansson, 2013, p. 63). Hansson aims to conceptualize pseudophilosophy as pseudoscience and this compelled him to

maintain his ideas in the maximum indefiniteness, given that the domain of humanities, as well as its methodology and its standards for acceptable evidence, are so different than those of science that any concreteness would lead him to reintroduce the concept of *pseudohumanities* —“The rationale for choosing a criterion that is not directly applicable to concrete issues of demarcation is that such direct applicability comes at a high price: it is incompatible with the desired exhaustiveness of the definition.” (Hansson, 2013, p. 73). This high indefiniteness turns his ideas into a basic, but empty, structure.

The demarcation criterion presented in this paper is a progress regarding Hansson’s schema. It accepts as valid his general idea but gives more meaning to its key concepts —a meaning that needs later elucidation, but that already gives functionality to this criterion when indicating the non-negotiable characteristics of pseudoscience. Thereby, Hansson’s criterion of scientific domain is now defined in relation to the debate on the nature of metaphysics, with consideration to disconfirmability. His criterion of unreliability is now split into two items, one related to methodological problems and another one related to lack of evidence. And finally, his criterion of deviant doctrine remains as an item of necessary compliance. Nevertheless, and this solves a serious problem of Hansson’s general schema, it is no longer necessary for pseudoscience to have a discourse that is within the scientific domain, since there are several cases of pseudoscientific ideas that are outside this domain —part of reiki, parapsychology or chiropractic have been mentioned. In addition, this is a progress that, as I hope to have shown, has the greatest possible consensus. In this regard, it is desirable that this demarcation criterion, initiated by Hansson, continues progressing in the future.

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