Rescher and Gadamer: Two Complementary Views of the Limits of Sciences

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Abstract

The question concerning the limits of science leads us to think about the very metaphor of the limit. We found that there exist different kind of limits and different possible actions in relation to them. In sum, there are limits that configure science and others that constrain it. The first ones must be respected, the latter overcome. We explore these limits following the suggestions of Rescher and Gadamer. These authors present complementary views. The first one approaches the question from inside the science, while the second one sees the limits of science from an exterior cultural point of view.

Key words

Limits of science; Nicholas Rescher; Hans-Georg Gadamer

1. Introduction

The question regarding the limits of science requires us to think about the metaphor of limit itself (**Section 2**) and suggests that we then try to think about science from that metaphor (**Section 3**). In order to do this, I suggest that we dialogue with Nicholas Rescher (1928-) and Hans-Georg Gadamer (1900-2002), both of whom have written lucidly on the limits of science. Both were born in Germany, but Rescher's career has been in Pittsburgh and he may be considered an "Anglo-Saxon" philosopher of science, while Gadamer is a "continental", influenced by Heidegger and focused on hermeneutics. Their perspectives are complementary. The former contemplates the limits of science from within, from the point of view of someone primarily interested in science, while the latter looks at science from without, from a standpoint of a more general interest in civilization as a whole. I finish with a conclusive summary, recapitulating the main ideas acquired during my research (**Section 4**).

2. Thinking about the Limit

The word *limit* comes from the Latin *limes-limitis*, meaning the boundary path between two plots of land, an origin offering semantic characteristics worth considering. The boundary shapes and constitutes the plot – without it there would be no real plot. A plot's boundary distinguishes it from other plots, separating it from them while joining it to them. As a path, it has some physical or geographical width; it is not just a geometric line. Its width allows us to think of it as having grey areas, or

no man's lands, likely to be a place for collaboration or conflict. The boundary is not just something "in sight", there for our contemplation. It is also something "to hand", which invites us to walk, explore, to go beyond it... More than that, it is an entity arising from our action. As Antonio Machado's well-known line goes, "The road is made by walking" (*Se hace el camino al andar*)[1].

In principle, a boundary is not an abstract line, but a concrete entity immersed in a context of action, relative to an agent. The agent contributes a space of possibilities, of possible actions, of attitudes, of aims and duties, of feelings and values that depend on a certain ontology. One can feel comfortable within certain boundaries or limits that do justice to the nature of things. Or, on the other hand, we can feel limits as constraints, something wrong, perhaps unjustly imposed. In this second case, our attitude leads us to step beyond the limits. A limit is seen either as something positive, valuable, that contributes to constituting an entity, or as something negative, unjustly constraining the entity.

As we can see, together with the concept of limit, there comes to us a universe of attitudes, of feelings and values linked to ontological presuppositions. For this reason, some limits are experienced by the agent as self-realization or perfection – "Become who you are", wrote Pindar (518-438 BC) – and by others as a constraint or frustration. Later we shall see the importance of these considerations when we talk about the limits of science.

The limit was originally a spatial entity, but the word has undergone many metaphorical displacements, among others into the ambit of time. Thus the *Oxford English Dictionary*, in second place, lists the definition: "One of the fixed points between which the possible or permitted extent, amount, *duration*[2], range of action or variation of anything is confined." Like "end" or "bounds", the word "limit" soon began to play in the fourth dimension. It also underwent a similar displacement into the world of abstractions. There, paths lose their geographical width, their "usability", to become mere geometrical lines, not thoroughfares, or, in mathematical parlance, limits that are by definition unreachable. Finally, let us take note of the displacement of the concept of limit into the sphere of capabilities. Again, the above definition includes "...range of *action*[3] or variation of anything is confined..."

If our journey along the Latin *limes* has enriched us, we may expect something similar from the Greek *horion*, which normal dictionaries translate as "limit" or "border". Now the time metaphor is obvious: our *hours*, as we count them, are boundaries in time. The Hours (*Horai*) in Greek mythology were the goddesses who ordered and governed nature, who controlled the beneficial changing of the seasons. From this standpoint, they are precisely the boundaries cutting us off from chaos and confusion.

Not far from *horion* are the Greek words *horama* and *horasis* (sight, vision), and *horizo* (to limit), where we can glimpse our own word "horizon". The horizon is a fleeting visual boundary, impossible to reach, but which affects our actions as an objective. Our sight marks the direction in which we walk, that is, forwards – towards

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[1] Machado (2001, p. 186).
[2] My italics.
[3] My italics.

the front. Therefore the notion of horizon is not only visual but also "agential", in the same way as the notion of frontier, linked with front.

To cite only two significant and mutually contradictory examples, Vannevar Bush, then director of the Office of Scientific Research and Development, in July 1945 sent a report to the President of the United States with the significant title *Science, the Endless Frontier*, while in 1970 Bentley Glass, once president of the American Association for the Advancement of Science (AAAS), gave a speech to his association called *Science: Endless Horizons or Golden Age?*, which concluded with the statement that the horizons of science were no longer infinite.

After their passage through Latin, Greek words like *horion* have served to name other forms of limitation, such as banks and shores. When we look towards the limits of science, perhaps we should remember Newton's famous words: "...I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."[4] Or St Augustine's famous story, from which this image could easily have been taken.

But before concentrating on science, let us explore once more the sources of our notion of limit, this time looking at the Greek word *peras*. This term, probably linked with "period" (time) and "perimeter" (space), calls to mind the concept of *apeiron* (the unlimited), surrounded in turn with connotations of all kinds – negative for their indeterminateness and difficulty of understanding and positive for their fertility and potency.

We now see that to think in terms of the limits of science is not the same as wondering whether science has limits. Perhaps, in a certain meaning of the metaphor, it does and in another it does not. Furthermore, it will be necessary to posit the question of the value of limits. And the answer to this last question will inexorably beg new questions about our actions. We shall try to tackle all this in the dialogue with Rescher and Gadamer.

3. Thinking Science from the Metaphor of the Limit

3.1. The limits of science: a look from the inside

Nicholas Rescher dedicated a book to the question of the limits of science[5]. In it he maintains, in the first place, that science is not everything, that outside science there are forms of knowledge and praxis that are perfectly valid and rational. There are areas in which we have cognitive and practical interests and which are completely outside the province of science. The author speaks here of "the limited province of natural science"[6]. In his own words, "there is no question that natural science is subject to domain-external incapacities. We must recognize that various important

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[4] Brewster (1855, col. 2, p. 407) The etymological works that I have consulted do not relate the English word "shore" with the Greek *horion*. Their evident similarity may be due to a mere coincidence – poetic justice, perhaps.
[5] Rescher (1984). A revised edition appeared in 1999, which I will quote from now on.
[6] Rescher (1999, ch. 15).

evaluative and cognitive issues lie altogether outside the province of science as we know it"[7]. To think the opposite would be tantamount to subscribing the ideology called scientism.

As we see, Rescher thinks in terms of territories, with their limits or borders. Science takes up one of these domains, but beyond it there is still life. Limits of this type, which make up the profile of science against the background of the lifeworld, or *Lebenswelt*, could be called *constitutive limits*[8]. In my opinion, these are blurred limits, more "geographic" than "geometric", for there will always be cognitive contents and actions of doubtful assignation. The constitutive limit is open to passage, for there must be passage between science and life and vice-versa, and positive, for, rather than constraining, it configures science.

As for communication between science and the rest of the lifeworld, Rescher's position is only partially satisfactory. He admits that there must be outlets from science into life. Indeed, he states on several occasions that science's evaluation criterion can only be its practical usefulness. But he does not accept that there is traffic the other way, from the lifeworld into science. Science, he states in a curious *in crescendo*, is autonomous, self-sufficient, sovereign[9]. But if the *limes* delimits as much as it joins, if it is going to be permeable and passable, it must be so in both directions. Science will have to accept requests, supports and also – why not – restrictions arising in other spheres.

Let us finally observe that science has to be viewed as an integral part of the lifeworld, science is inside it, and not in juxtaposition to it. Science is a part of human action. This integration and connection with the rest of the lifeworld will be dealt with below in the dialogue with Gadamer. But the step that Rescher allows us to take is a major one, as he recognizes the existence of the constitutive limits of science and the legitimacy of some areas of knowledge and practices situated beyond them.

Let us now examine the second type of limit. For this, we shall consider only problems concerning science, leaving aside those that do not fall within its sphere. Well, one might think that theoretical reasons exist to state that science will never offer a perfect solution to all the problems in its domain. These theoretical reasons would form a second type of limit, the *theoretical limits* of science. Outside them would remain those scientific problems that science, for theoretical reasons, will never be able to tackle, much less solve. Within them we should have the problems that science, at least in theory, would be able to tackle successfully. It would be the terrain of *science that is possible in theory*. Now, Rescher argues at length that such theoretical limits do not exist.[10] For Rescher, science that is possible in theory would simply be science.

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[7] Rescher (1999, p. 250).

[8] From now on I shall allow myself to alter Rescher's terminology. He speaks of *disabilities, limits, incapacities* and *deficiencies* of science (1999, p. 3). In fact, all these terms refer to different types of limits. It would therefore be interesting for the term itself to indicate what kind of limit we are dealing with. The change in terminology that I have adopted seeks to carry out this function.

[9] Rescher (1999, pp. 249-250)

[10] Rescher (1999, chs. 6 & 7)

Nevertheless, this thesis has been widely debated. Let us see an example to show the kind of objections that may be raised to it. Chaitin has shown, inspired by the works of Gödel and Turing, that the random character of a mathematical sequence cannot be proven, that it is undecidable. This has consequences for natural sciences, as was recently demonstrated by the Complutense University physicist Fernando Sols.[11] From Chaitin's demonstration, it could be inferred that the question of the presence or absence of purpose in nature is also undecidable, for we shall never know whether a sequence of natural phenomena occurs at random or is directed towards an end. What can we say then? That the problem of randomness and teleology has nothing to do with the natural sciences, or that it does belong to their domain but for purely theoretical reasons cannot be tackled? If we choose the first option, Rescher's position is upheld, but not if we choose the second.

In any event, what we are interested in here is not so much whether theoretical limits exist or not, but the very concept of the theoretical limit. These limits, if they exist, would have a somewhat more restrictive nature than the constitutive limits, and probably more "geometric" than "geographic" profiles. Rescher contributes to clearing this up by distinguishing between theoretical limits and *practical limits*. These are the third type of limits to science. Science does not reach many of the problems within its domain for reasons of a practical nature. For example, the capabilities of the Large Hadron Collider of the CERN mark a practical limit. It is the largest and most powerful particle accelerator in the world. If it were necessary for an experiment to go beyond its capabilities, then for the moment it quite simply could not be done.

Frequently these limits, as Rescher suggests, may be reduced to economic terms. But practical limits cannot always be translated into money. For example, there are historical moments when the mathematics that a part of natural science would have required was not available. For natural science, this means a practical limit that does not only depend on financial investment. Practical limits may also be linguistic, moral, social, political, ecological and of many other types. In some cases, these limits must be overcome, and in others respected.

In short, science that is possible in theory is limited by practical factors, which determine what is *science that is possible in practice*. We know that part of the science that is possible in theory will never be possible in practice. But we cannot know which part. According to Rescher, there is no way of determining which definite problems will remain outside scientific development. Problems that today lie beyond the practical limits may not tomorrow. We have before us a horizon-type limit: it is always there but it moves as we advance. This type of limit, in its movement, responds to what Rescher calls the Kantian principle of propagation of questions: "Science emerges as a project of self-transcendence. It embodies an inner drive that always presses beyond the capacity limits of the historical present".[12] These are blurred, changing limits. They function as a challenge and a frontier. They invite us to transgression, but this never actually happens. Practical limits take up an intermediate position regarding their positive (constitutive) or negative (constrictive)

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[11] Sols (2011).
[12] Rescher (1999, p. 18).

nature. They are between constitutive and theoretical limits on the one hand, and fallibility limits on the other.

Fallibility limits include our personal inoperativeness, organizational and institutional faults, our lack of attention, work or honesty, errors which we inevitably commit given our human nature (all too human!). There are the limits that separate science that is possible in practice from *effective science*, which comprises effective achievements. These fallibility limits also appear as a horizon. They cannot all be overcome, although each of them may be individually. That is, science will always be fallible and incomplete, but none of its definite errors is dictated by fatality. The attempt to overcome limits of this kind is necessary, as they are limits of a purely negative nature: they are constraints on the development of science that generate deficiencies.

We have now seen constitutive limits, theoretical limits, practical limits and fallibility limits. The right moment has now come to remember Pindar's maxim: "Become who you are". If science *is* what its constitutive limits mark out, but *has* only *become* what the fallibility limits allow, the difference between them could be called *Pindar's gap*. To bridge this gap is the ultimate, irrenunciable and unattainable task of scientific undertaking.

All the limits that we have so far found have a common origin. They derive from science itself, that is from its constitution, and from the subject producing it: mankind and his special circumstances, his lifeworld, his environment, or *Unwelt*. But science has an intentional character; it refers to something outside itself, to something outside even the lifeworld, and produces knowledge of that something. That something that science seeks to refer to is the world itself, or *Welt*. And this objective pole of science also imposes limitations on science. Let us call them *objective limits*. These cannot be broken and have a positive character. They cannot be considered as defects of science. That is, our science can be neither more precise nor more complex than nature itself, its depth and breadth cannot go beyond the dimensions of nature itself. If there is indeterminacy in nature, in our science there will be uncertainty. We shall never predict what nature itself has not determined.

Objective limits cannot be broken. Moreover, they cannot be reached, either. This is due to the other limitations that we have identified. For example, science is constitutively conceptual, and what is real, as Rescher states, can never be conceptually exhausted.[13] Or, to put in in Shakespeare's classic terms: "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy"[14].

It is true that a creative and metaphorical use of language can shorten the distance between *physis* and *logos*, but can never bring them to the point of identity. We can only aspire to increasing the similarity between being and thinking.[15] The identity between our conceptual system and reality is one of those limits, unattainable and fleeting.

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[13] Rescher (1999, p. 75).
[14] *Hamlet*, act I, scene V.
[15] This topic is treated more in depth in Marcos (2012, chap. 6).

Let us add a final remark concerning objective limits that has implications for the relationship between the natural sciences and the human sciences. The attempt to subsume in the natural sciences *all* knowledge about the human being may lead to an inconvenient overstepping of bounds. According to Rescher, "Inflating the claims of science to the point where it is held to have all the answers about the condition of man, the meaning of life, or the objects of social polity is a dangerous move [...] Such an inflated view of capacities invites skepticism and hostility in the wake of the disappointment of expectations that is its inevitable consequence".[16] This disappointment stems from the attempt to overcome limits which may be of an objective character, for "Man is a member not just of the *natural* but of the specifically *human* order of things".[17]

3.2. The limits of science: looking from the outside

"My whole philosophy is nothing but phronesis"[18]

Technoscience has constitutive limits, as we have seen.[19] And beyond them there exists intelligent life. Beyond technoscience we come across the remaining fields of the sphere of knowledge, such as art and morals. And the sphere of knowledge appears, in turn, against a background of the lifeworld, to which it doubtlessly belongs, and in which it has to coexist with other respectable human realities, as committed as technoscience may be to true knowledge and rational action. Cultural traditions, emotions, philosophy, religion, politics, education, communication and many areas of human life, ranging from daily experience and common sense to, for example, sport, make up the lifeworld, just as technoscience does.

According to scientism, the limits of science coincide with those of rationality. As Gadamer sums up, "one sees rationality in the context of science and confined within its limits".[20] This is what the neopositivists of the Vienna Circle, in their manifesto, called "the scientific conception of the world" (*Wissenschftliche Weltauffassung*).[21]

But if what we seek is thought more in line with truth and in line with the relationships between technoscience and the other areas of human life, we must look for it a long way from scientism, in some philosophical tradition that shows more respect for those areas other than technoscience.

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[16] Rescher (1999, p. 247)

[17] Rescher (1999, p. 248). For a more extensive treatment of this point, see Marcos (2010).

[18] Gadamer (2003, p. 54).

[19] Science and technology are distinguishable realities both historically and conceptually. Nevertheless, today, their level of symbiosis is such that we can speak correctly of technoscience. For a philosopher of science like Rescher, the conceptual difference between science and technology is very important, which is why we kept to it thus far. On the other hand, for Gadamer, whose interest lies more in hermeneutics than in the philosophy of science, the relevant entity is rather the amalgam of science and technology, which justifies our talking henceforth of technoscience (Cf. Gadamer, 1985-1999, vol. 4, p. 247 and Gadamer, 1996, p. 6).

[20] Gadamer (1979, p. 8-9).

[21] Carnap, Hahn and Neurath (1929).

We have to overcome the modern idea of an absolutely autonomous science. We must reintegrate the sphere of knowledge, and technoscience in particular, into the lifeworld. Technoscience must interact with its environment. Therefore, it needs a healthy environment, made up of entities worthy of respect. It is only one facet of our life, which borders many others. In other words, one of the functional limits of technoscience is that it is not sufficient by itself to give a basis for an entire civilization, to a whole way of life.

To a great extent, this is the message of Gadamer's philosophy. This limit implies no deficiency of technoscience; it is not at all negative, except for those who, with a scientist mind-set, would base everything on technoscience. Gadamer's philosophy is not antiscientific. It is, however, anti-scientist. This is the main reason for choosing Gadamer as an interlocutor in the present text. But there are more reasons. Gadamer's arguments are very near to those of many other contemporary philosophers, whose echoes we shall hear together with Gadamer's voice. I mean other contemporary thinkers, in both the Anglo-Saxon and continental traditions and especially Heidegger, Arendt, Husserl, Dewey, Wittgenstein, Popper, Kuhn, Polanyi, Toulmin, MacIntyre, Putnam, Habermas and Ricoeur. A dialogue with Gadamer would be then, in some ways, like a dialogue with many of these writers' ideas. Like most of them, Gadamer identifies the limits of technoscience, points out it insufficiency as a single basis for a civilization, denounces the excesses of the scientism, and all this he does without defecting to the ranks of the antiscientific mind-set, without falling guilty of relativism or irrationalism, without going into what he himself calls "the shadow of nihilism".[22]

Gadamer's hermeneutics may be read as a theory of the limits of science, as Stefano Marino states.[23] Science does not use up all the territory of truth, of knowledge or of experience, nor everything can be achieved by its means.[24] His thought supposes a critique of the scientist *hybris* that would take science beyond its constitutive limits. As a complement of this *pars destruens*, there appears in his work a *pars construens*, which seeks the reassessment of other areas of "human experience of the world in general", which, according to Gadamer, "goes beyond the limits of the concept of method as set by modern science".[25] "One cannot ignore such 'knowledge', in whatever form it expresses itself: in religious or proverbial wisdom, in works of art or philosophical thought".[26] One has "to understand the variety of experiences – whether of aesthetic, historical, religious or political consciousness".[27] These experiences are beyond the limits of science, and science must not attempt to colonize them. They must be respected and pondered for themselves, for they are by nature irreducible to the methods of science.

We may wonder now what concept of science this drawing of limits that Gadamer proposes depends on. Well, to characterize modern science, Gadamer turns to a few concepts with their roots clearly in Descartes and Bacon. The first of them is the concept of method. Modern science is primordially method. It is a method with a

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[22] Misgeld and Nicholson (1992, p. 114); Gadamer (1985-1999, vol. 9, p. 367).
[23] Marino (2011, p. 33, n. 37).
[24] Gadamer (1993, pp. 127-128).
[25] Gadamer (2004, p. xx).
[26] Gadamer (2004, pp. 565-566).
[27] Gadamer (2004, pp. 84-85)

vocation for universality, for automatism and certainty. This notion takes on so much importance in Gadamer that it forms part of the title of his flagship book, *Truth and Method*. Around the 17th century, a new form of civilization arose, a new *way* or *form of life* (*Lebendsform*), defined almost univocally by the emergence of a new notion of science.[28] The essence of that notion is summed up in a single word: method. The effect of method is objectivation, that is the configuration or delimitation of the object, the transformation of (part of) reality into an object.

The method is, then, an objectifying one. It objectifies by delimitation. Therefore, science does not only have limits, but, at a deeper level, it *is* a limit, it is born of a process of delimitation. Our aim in the first place is to draw a limit between subject and object, along the lines of Descartes' separation of *res cogitans* and *res extensa*. We thus cut reality into two parts, which we set up against each other. One of them is the object for the other, and also inevitably an obstacle. It is what is not the subject, and what resists the subject. Immediately there arises from this arrangement of things the attitude of control, of dominion and planning as procedures for reintroducing the subject in objective reality. It is in this that the new way of life of the modern subject consists. The subject that has been separated from the object returns to it as the dominator. " '*Objekt*' or '*Gegenstand*' is defined through a 'method' that prescribes how reality is to be turned into an object. The aim of methodologically researching the object in this way is then essentially to break down the resistance of 'objects' and to dominate the processes of it".[29] Thus become imbricated science, which supposedly knows with Cartesian objectivity, and technology, which will contribute the Baconian control of the object. Thus is opened up the path to today's technoscience.

The possibility of technoscience overstepping, or *hybris*, is now clearly intuited. This will happen when we seek to impose the objectifying method and the attitude of dominion on all reality. We overstep our limits, we take technoscience beyond its constitutive limits, when we accept, in Gadamer's words, that "nothing can be scientifically investigated or truly understood, unless it conforms to procedure of method. Henceforth, objectivity in this sense specifies the very limits of our knowledge – what we cannot objectify we also cannot know".[30] This movement can be seen indifferently as an unjustified extension of technoscience or as an unjustified reduction of reality. Scientificism and reductionism go hand in hand. However we look at it, the result is the same: the identification of the limits of human knowledge with those of the scientific method, and the consequent attempt to base all our actions, all our relations with reality, on the application of scientific knowledge.

We know the consequences. In the epistemic, objective truth is replaced by subjective certainty.[31] In the practical realm, this is an attempt at the artificializing of all things natural. What starts as an objectifying movement turns into an immense subjectivizing of reality. Thus are laid the foundations for the uneasiness of our culture. But before entering the chapter of unease of modernity in depth, allow me to be yet more precise concerning the idea of objectifying by limitation. And the fact is that the methodical splitting of the real into subject and object was concreted also in

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[28] Gadamer (1983, p. 6).
[29] Gadamer (1998, p. 127).
[30] Gadamer (1987, p. 41).
[31] Gadamer (1996, p. 148).

other splits. We separate primary qualities from secondary ones, we carefully delimit the quantitative from the qualitative. We leave apart, of course, all emotional evocation, any aesthetic quality. We observe "facts" away from values. The scientific method seems to require it. We leave in parentheses, away from reality, everything aesthetic, emotional, qualitative, axiological, never to come back to it, to negate it or simply exclude it. Or to try to reduce it forcibly to the parameters of the objectifying method.

Let us now go on to the question of our western civilization's uneasiness in its modern version, which manifests itself through multiple symptoms, which became especially visible during the last century. I shall name some of them, identified explicitly by Gadamer himself, although surely each reader will be able to add a few more. As the main symptom of the modern pathologies we could identify what Gadamer calls the *shadow of nihilism*.[32] Under this poetic formula we could include the atmosphere of anxiety that dominates modern life, together with the lack of hope and meaning of life that technoscience is unable to alleviate. We must also include the vacuum left by the dissolution of religion, effected by the scientist mentality, a vacuum that technoscience is incapable of filling.[33] According to Gadamer, "the contribution of the scientific Enlightenment reaches an insuperable limit in the mystery of life and of death".[34] In the same way, Gadamer identifies modern voluntarism and relativism as pathological symptoms,[35] which lead to moral subjectivism[36] and aesthetic irrationalism.[37] Together with them we have fragmentarism and specialism,[38] individualism, lack of solidarity, the break-up of community sense[39] and others like consumerism[40] or historicism.[41]

We have sought to base our way of life on technoscience, but this means clearly going beyond its constitutive limits. Technoscience does not go that far, it cannot sustain a way of life. As a result, the modern West has been beset with a number of ailments. If we want to cure our civilization, if we want our way of life – including technoscience – to survive in its postmodern version, we must find other bases for it. For this, Gadamer proposes the rehabilitation, together with technoscience, of other areas of knowledge, of experience and human action, and a dialogue between them all.

But more especially the German philosopher concentrates on the rehabilitation and autonomy of practical knowledge, *irreducible* to episteme or science. The role of the expert is always important, but the final decision in all our actions, even in those making up technoscientific research, corresponds rather to practical wisdom.[42] It is from this that our non-delegable responsibility derives. Practical wisdom is formed from the practices themselves. For example, to participate in a given tradition is

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[32] Gadamer (1985-1999, vol. 9, pp. 367-382; vol. 3, p. 407); Misgeld and Nicholson (1992, p. 114).

[33] Gadamer (1993, p. 197); (1996, p. 159).

[34] Gadamer (1996, p. 67); (1985-1999, vol. 4, p. 293).

[35] Gadamer (1985-1999, vol. 10, pp. 236, 263).

[36] Gadamer (1985-1999, vol. 7, pp. 398-399).

[37] Gadamer (1986).

[38] Gadamer (1985-1999, vol. 10, p. 263).

[39] Gadamer (1985-1999, vol. 10, pp. 235-6); (1989, p. 157).

[40] Gadamer (1985-1999, vol. 4, p. 256); (1996, p. 18).

[41] Gadamer (1985-1999, vol. 10, p. 263).

[42] This idea is examined in depth in Marcos (2010a).

essential for its formation: "We produce ourselves inasmuch as we understand [and] participate in the evolution of tradition".[43]

In a way that might seem provocative to the modern mentality, Gadamer argues for the rehabilitation of the authority of tradition. To avoid any ambiguity, let us remember that tradition, for Gadamer, is an ongoing event, not a static entity. Therefore, there is no kind of defence here of the *status quo*. What is true is that continuity of a given long-lived tradition clearly benefits the rationality of technoscience. Scientific paradigms, as Thomas Kuhn has shown, arise in a seemingly discontinuous, revolutionary and somewhat disconnected way. One may question the commensurability and possibility of comparison between them, and therefore the possibility of justifying the rationality of scientific decisions and the very progress of science. However, the different scientific paradigms are, in fact, comparable in a rational way, as Kuhn himself maintains,[44] thanks to the persistence underlying the changes of a communitary current of values, practices and wisdom that we might well call tradition and which goes far beyond the limits of science.

All this suggests an inversion: it is not only that technoscience is incapable alone of upholding our way of life but that, on the contrary, technoscience itself maintains its aspiration to rationality because it is based on certain practices, values and traditional kinds of wisdom characteristic of a certain way of life. There is a way of life that makes the appeal to reason possible. Gadamer proposes, in this regard, an inversion of the modern position, especially the Kantian position, which sought to base *ethos* on reason. In exchange, he recovers the Aristotelian perspective: it is a certain human *ethos* that allows for the development of rationality, including scientific rationality.[45] "The rationality of practical reason receives its normative power not so much from arguments as from what Aristotle called '*ethos*', that means from the determination of one's emotional life that shows practical wisdom at work in education and moral training".[46]

The practical wisdom that Gadamer refers to is therefore situated in the Aristotelian tradition, and it would not be at all unfair to identify it with the intellectual virtue of *phronesis*. Indeed, in clear agreement with the *Nicomachean Ethics* (1106b 36 ff., 1144a 35-6), Gadamer states that "there is no *phronesis* without *ethos* and no *ethos* without *phronesis*".[47]

4. Concluding Summary

We have tried to think about science from the metaphor of the limit. For this, in the first place, we had to delve into the metaphor itself. We have seen the different levels of its metaphoricalness, from the most conventional, recalling boundaries in space and time, to the most metaphoric, referring to functional limits. The connotations inherent in the different versions of the metaphor are in turn very

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[43] Gadamer (2004, p. 293); (1985-1999, vol. 1, p. 298);
[44] Kuhn (1977, cap. XIII).
[45] Gadamer (1985-1999, vol. 4, pp. 187-188); (1999, pp. 29, 34-35).
[46] Gadamer (2000, pp. 48-49); (1985-1999, vol. 8, p. 437).
[47] Gadamer (1999, p. 155); (1985-1999, vol. 7, p. 390); cf. Marcos (2012, cap. 2). As Gadamer suggests, if we had to look for a Kantian correlate for this type of practical wisdom we should have to look back to the *Critique of Judgement* rather than either of the other two great critical works (Gadamer, 1985-1999, vol. 10, p. 278).

diverse. The limit is in some ways a positive concept, for it constitutes entities, while also being negative, insofar as it constrains them; it may be clear or blurred, static or dynamic, permeable or impermeable.

The metaphor of the limit is very useful for thinking about science. But we have seen that in fact it is insufficient for this task by itself. It is a metaphor that contributes clarity especially when inscribed in a web of metaphors. Ideas like border, exploration, path, bank, hour, horizon, link, nexus or pore are near to the idea of limit, they belong to the same metaphor web. But we have found all the metaphors of an *agential* nature especially interesting. The idea of limit takes us immediately to the idea of a subject that does things with that limit: it respects it, it travels along it, it reaches it, it crosses it, it chases it, it constructs it and explores beyond it.

Once we have gone deeper into the metaphor of limit and into its connections with nearby ones, we are then able to apply it to the task of thinking science. For this, we have used a dialogue with Rescher and Gadamer, as complementary authors.

With Rescher, we have identified the limits of science looking at it from the inside. Thus we have distinguished, in this order, constitutive, theoretical, practical and fallibility limits. Within the constitutive limits lies science as a reality and a possibility, that is, all science. Within the theoretical limits we would find science that is possible in theory. Within the practical limits we have science that is possible in practice and within the fallibility limits, effective science. Scientific undertaking as a whole is guided by the aspiration to reduce the difference between effective science and just plain science. It is a question of bridging what we have called *Pindar's gap*, so that science *becomes* what it *is*. It is an irrenunciable and impossible task, tragic though that may sound. Science, moreover, also has objective limits, marked by the very nature of things and especially by human nature.

The constitutive limits of science, as Rescher sets them out, leave room for other equally respectable human realities. In other words, science is a part of the lifeworld, which is much larger than science itself. We are interested, therefore, in thinking about science's relationships with its surroundings, with other aspects of human life. We are interested in looking from the outside to the limits of technoscience. We have journeyed this stretch of the path in a dialogue with Gadamer.

According to him, technoscience is not enough to base a civilization on, to sustain a way of life. That is one of its limitations. However, western civilization, in its modern version, tried to seek a basis mainly in technoscience, on both the epistemic and practical planes. From the failure of that attempt there derives the unease of the modern West. That unease displays itself in a multitude of symptoms that we all know and which Gadamer poetically summed up in the expression "shadow of nihilism". We have examined some of those symptoms and have addressed the question of how to cure them, or at least how to alleviate them.

The most promising of the strategies consists in the rehabilitation of other areas of knowledge, of human action and experience and more especially the reassessment of practical wisdom, or *phronesis*. This is wisdom that gives support to an *ethos*, to a way of life, where value is given to appealing to reason and experience, and in which

there is room for technoscience. But it should be remembered that this practical wisdom is based in turn on the *ethos* that the wisdom itself contributed to found. Nobody should be shocked by a (hermeneutic?) circle of this sort, a reciprocal support between practical wisdom and sensible practice. Technoscience, for its part, far from founding a way of life, which is beyond its limits, is given a basis by it through practical wisdom.

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