

SPECIAL ISSUE

# Why Science Does Not Know: A Brief History of (the Notion of) Scientific Ignorance in the Twentieth and Early Twenty-First Centuries

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Currently, "scientific ignorance," that is, the blind spots and knowledge gaps of science itself, appears to be an important and legitimate research topic in the sociology, history, and philosophy of science. In this article, it is argued that this unusual and provocative topic could only emerge as an object of research in its own right to the extent that the traditional modernist view of scientific ignorance as a merely ephemeral and ultimately irrelevant phenomenon was challenged, starting about one hundred years ago. The article follows the controversial shaping of the notion of scientific ignorance through the works of influential scholars in the twentieth century. It then traces the concept through the evolution of various research programs in the early twenty-first century, focusing on the reasons for and causes of that ignorance. One should nevertheless be careful not to (mis-)understand this history as a linear and irreversible "success story," given that the familiar (self-)image of science as the eminent modern institution producing knowledge and eliminating ignorance is still highly influential.

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In the first decades of the twenty-first century, "scientific ignorance," that is to say the knowledge gaps, blind spots, and inherent epistemic limitations of science itself, has become a well-established and acceptable research topic in the sociology, history, and philosophy of science.<sup>1</sup> This is both remarkable and surprising, given the fact that considering scientific ignorance (or "scientific non-knowledge") to be an important issue contradicts the familiar picture of science as the eminent modern institution that produces knowledge and, at the same time, *reduces* or even *eliminates* pre-existing ignorance. Zygmunt Bauman has nicely summarized and ironized this traditional modernist perception of ignorance and its relation to science: "Ignorance is a not-yet conquered territory; its very presence is a challenge, and the clinching argument of any pep talk summoning support for the next attack in the indeterminable, yet always confident of the ultimate victory, offensive of reason."<sup>2</sup>

On this view, ignorance, as that which is merely "not-yet" known, figures only in the very first stages of scientific research and, therefore, is usually held to be an ephemeral phenomenon, not worthy of closer inspection. Jerome Ravetz, a pioneer of the study of scientific ignorance in the 1980s, has put this more bluntly and polemically: "The triumphalist, positivist image of science has entailed the systematic suppression of all understanding of scientific ignorance."<sup>3</sup> Thus, as I will argue in this article, scientific ignorance could only emerge as a research topic in its own right to the extent that the view of this ignorance as merely a

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<sup>1</sup> See recently, for instance, Henry, *Ignorance scientifique*; Whooley, *Heels of Ignorance*; Kourany and Carrier, *Production of Ignorance*; Fernández Pinto, "Ignorance, Science, Feminism."

<sup>2</sup> Bauman, *Modernity*, 242.

<sup>3</sup> Ravetz, "Sin of Science," 158.

“not-yet conquered territory,”<sup>4</sup> or as a “primitive and native state,”<sup>5</sup> was challenged and abandoned during the twentieth century. Consequently, and contrary to the traditional view, the emerging new understanding of scientific ignorance as a relevant issue has questioned its “naturalness” and suggested that it must, instead, be conceived of as a phenomenon which is produced, reproduced or sustained, intentionally or not, (also) by social factors and forces.<sup>6</sup> Most notably, science itself might even be among these factors and might thus create its own ignorance.<sup>7</sup> In this case, science, “our foremost producer of knowledge,” would turn out to be “an important producer of ignorance” as well, as Janet Kourany has put it.<sup>8</sup>

How and when did such a remarkable, even provocative shift in the perception of both scientific ignorance and science itself come about, and how did it succeed in breaking down or at least weakening the “linguistic and institutional resistance to studies of scientific ‘ignorance?’”<sup>9</sup> The present article aims to trace the gradual emergence of scientific ignorance as an important subject of study in the sociology, philosophy, and history of science during the twentieth and early twenty-first centuries.<sup>10</sup> To this end, I will follow the shaping of the notion of scientific ignorance through the works of influential scholars (among them Ludwik Fleck, Robert Merton, Jerome Ravetz, Michael Smithson, S. Holly Stocking, and Robert Proctor) up to present-day debates on scientific “cultures of non-knowledge”<sup>11</sup> or even “virtuous scientific ignorance.”<sup>12</sup> The history of (the notion) of scientific ignorance, however, is neither the history of all that has remained unknown to the sciences during the past century nor the history of a clearly defined topic of scientific research. Rather, it is the intricate history of various attempts to explore, and thereby simultaneously “invent” and “construct,” the absent, elusive, and contested object of “scientific ignorance” in quite different ways and under different names such as “science-based ignorance,”<sup>13</sup> “specified ignorance,”<sup>14</sup> or “undone science.”<sup>15</sup>

In the next section, I will follow chronologically the most important contributions to establishing scientific ignorance as a subject of study in its own right. Subsequently, I will present and evaluate three sociological, philosophical, and/or historical research programs on scientific ignorance that have emerged in the early twenty-first century: agnotology, the sociology of undone science, and the analysis of scientific cultures of non-knowledge. The final section emphasizes that while the establishment of scientific ignorance as a legitimate topic of scientific research and public concern is certainly an important achievement, it should not be misinterpreted as an irrevocable success. Not only would it be a mistake to underestimate the persistent power of the familiar image of science as the “foremost producer of knowledge.” In addition, even among those who study scientific ignorance there exists a tension between rather modernist views of ignorance as merely temporary knowledge gaps and more reflexive, non-modernist ones stressing the persistence, inevitability, and occasionally even “virtuousness” of science remaining ignorant.

### The Emergence of a new Object of Research in the Twentieth Century: Knowing as Ignoring—Ludwik Fleck’s Untimely Insights

Notwithstanding some important forerunners, among them Emil du Bois-Reymond with his famous statement “Ignoramus, ignorabimus” in the 1870s, it was not until the twentieth century that a few scholars succeeded in establishing “scientific ignorance” as a distinct and relevant subject of scientific inquiry. As is well-known, du Bois-Reymond saw the source of the sciences’ inability to know solely in the complexity and inaccessibility of specific *objects* of research such as force, matter, and consciousness. By contrast, Ludwik Fleck in the 1920s and 1930s was the first scholar to place the reasons and causes of scientific ignorance inside of the epistemic practices of *science itself*. In his now famous 1935 book *Genesis and Development of a Scientific Fact*, Fleck emphasized the strictly social character of scientific observation and knowledge; he argued that “cognition is the most socially-conditioned activity of man, and knowledge is the paramount

<sup>4</sup> Bauman, *Modernity*, 242.

<sup>5</sup> Proctor, “Agnotology,” 4.

<sup>6</sup> *Ibid.*, 3.

<sup>7</sup> For Fernández Pinto, this is even the key element of her working definition of scientific ignorance “as non-knowledge resulting from processes of scientific knowledge production.” Fernández Pinto, “Scientific Ignorance,” 196.

<sup>8</sup> Kourany, “Science,” 155.

<sup>9</sup> Stocking, “Drawing Attention,” 174.

<sup>10</sup> In the present article, this can of course be no more than a rough sketch that will require further elaboration.

<sup>11</sup> Böschen et al., “Scientific Nonknowledge”; Wehling and Böschen, *Nichtwissenskulturen*.

<sup>12</sup> Kourany, “Might Ignorance Be Virtuous?”

<sup>13</sup> Ravetz, *Merger of Knowledge*.

<sup>14</sup> Merton, “Three Fragments.”

<sup>15</sup> Hess, *Undone Science*.

social creation (*Gebilde*).<sup>16</sup> But precisely this is, at the same time, the precondition and the most important cause of scientific ignorance. In particular, it is the adoption of and training in a specific, collective “thought style” (*Denkstil*) that enables scientists to perceive and “see” a scientific “fact,” but at the same time prevents them from becoming aware of anything that does not accord with this fact and the way they have been trained to see things: “The ability directly to perceive meaning, form, and self-contained unity is acquired only after much experience, perhaps with preliminary training. At the same time, of course, we lose the ability to see something that contradicts the form.”<sup>17</sup> Scientific discovery is thus, as Fleck emphasized, “inextricably interwoven with what is known as error. To recognize a certain relation, many another relation must be misunderstood, denied, or overlooked.”<sup>18</sup>

It is important to note that these implications of scientists’ adherence to a specific thought style are not equivalent to *general* human cognitive limitations and psychological effects such as “confirmation bias,” which has been described by Fernández Pinto as a tendency to seek only evidence that seems to support one’s beliefs while dismissing all evidence that goes against them.<sup>19</sup> Although Fleck himself considered the “tenacity of systems of opinion” (*Beharrungstendenz der Meinungssysteme*) to be an “active approach” of scientists, bearing some overlap with the confirmation bias,<sup>20</sup> the inextricable interwovenness of discovery and error, the simultaneity of seeing and not seeing, of knowing and ignoring, is a basic and specific, if not unique, feature of *scientific* knowledge production. Being trained and experienced in a thought style and being included in a “thought collective” are *indispensable preconditions* of becoming and being a scientist at all.<sup>21</sup> Losing the ability to see what contradicts meaning and form is therefore not an indication of “bad” or “biased” science; it is, by contrast, the inevitable flip-side of having learnt to see and observe as a scientist, to perceive a form and give meaning to heterogeneous and confused sensations. Thus, while science does reduce or eliminate some types of ignorance, it simultaneously and unavoidably produces other types within and through its own epistemic practices. Since this ignorance is produced unintentionally, scientists usually remain unaware of it; and, according to Fleck, it cannot be overcome within a given thought style.

Fleck’s radical perspective on the production of scientific knowledge was unprecedented at that time; but although he had laid important foundations for both the theoretical understanding and empirical analysis of (the production of) scientific ignorance, his insights on this issue were not taken up for several decades. There are a number of likely reasons for this. First of all, Fleck’s bold claim about the inherently social and historical nature of science was almost doomed to be disregarded and remain unknown, given the fact that it was put forward in a book published in Switzerland in 1935 and written in German by a Polish Jew, who was a bacteriologist, not a philosopher or sociologist by training. Second, apart from the disastrous historical circumstances, Fleck himself did not speak of ignorance or non-knowledge but of error, misunderstanding or illusion, thus terminologically and conceptually failing to distinguish the absence of knowledge from the existence of “false” beliefs. Moreover, he conceived of the production of ignorance as an inseparable implication of scientific knowledge production and did not highlight it as a distinct and important phenomenon and research area in its own right. Thirdly, Fleck’s claim about the inseparability of knowing and not knowing originated primarily from theoretical reflection, which was based both on his own experience as a medical researcher and strongly influenced by Niels Bohr’s quantum physics. This mainly theoretical approach to the issue was not supported or exemplified by manifest instances of scientific ignorance, as would later be the case with medical disasters such as the thalidomide scandal or environmental hazards such as the “hole” in the stratospheric ozone layer. Thus, blind spots of scientific knowledge could hardly become a matter of public concern during the 1920s and 1930s, a fact that also seems to have limited scientific attention to this issue.

## The (Re-)Appearance of Scientific Ignorance in the 1980s

After World War II and the horrors of the Nazi regime, scientific and technological optimism was extensively revitalized, not least due to the ambiguous “success” of the Manhattan Project for the construction of the nuclear bomb. Science was famously conceived by Vannevar Bush in 1945 as an “endless frontier,” promising

<sup>16</sup> Fleck, *Genesis*, 42.

<sup>17</sup> *Ibid.*, 92.

<sup>18</sup> *Ibid.*, 30.

<sup>19</sup> Fernández Pinto, “Scientific Ignorance,” 201.

<sup>20</sup> Fleck, *Genesis*, 27.

<sup>21</sup> “Every epistemological theory is trivial that does not take this sociological dependence of all cognition into account in a fundamental and detailed manner. But those who consider social dependence a necessary evil and unfortunate human inadequacy which ought to be overcome fail to realize that without social conditioning no cognition is even possible.” Fleck, *Genesis*, 43.

the discovery of vast and “not-yet conquered” territories of ignorance to be harnessed by scientific research. It was in areas such as energy technology (the “peaceful” use of nuclear power), space technology and aviation, computer science, medicine, agriculture and chemistry that this optimism nourished hopes for almost endless progress and welfare. Even the Cold War that took shape soon after 1945 was not only a “rat race” for the most destructive nuclear weapons but also a competition between the “West” and the “East” for the most promising scientific and technological achievements. In this climate, scientific ignorance could hardly become an issue, and even when it did, it was addressed in the traditional view of a mere knowledge gap, of a temporary vacuum soon to be filled with scientific understanding.<sup>22</sup>

For various reasons, this enthusiasm for science and technology began to fade away during the 1960s, and in the following decades scientific uncertainty or ignorance successively appeared (or re-appeared) on the agenda both as a matter of political and public concern and as an object of research and reflection on science. One important reason for this can be seen in the emergence of a broad range of environmental problems (from air and water pollution to the destruction of the ozone layer) as well as social conflicts over potentially hazardous technologies (such as nuclear energy and pesticides) and contested areas of research such as psychiatry. A second influential factor was the advent of new approaches to the social study of science (and technology), which in the mid-1970s became known as the sociology of scientific knowledge (SSK), science studies or, later on, science and technology studies (STS). All of these intellectual and political developments contributed to new but heterogeneous conceptions of scientific ignorance. In what follows, I will focus on the three most influential ones, introduced almost simultaneously in the mid-1980s by Michael Smithson (a), Jerome Ravetz (b) and Robert Merton (c).

a) The sociology of scientific knowledge, and particularly the so-called “strong programme” in SSK as famously developed by David Bloor, argued anew for a social and historical understanding of science. Influenced by, among others, Ludwig Wittgenstein and Thomas Kuhn, it claimed to develop a sociological analysis of scientific knowledge production itself, a topic that had been “blackboxed” by the dominant Mertonian sociology of scientific institutions and norms. Bloor rejected what he termed the “weak programme,” according to which social factors should only be introduced in order to explain errors and false beliefs, whereas true knowledge had to be explained by purely logical and rational factors that are held to be ahistorical and independent of any social influences. The strong programme countered this common view with its well-known “symmetry principle,” claiming that SSK had to explain both true and false beliefs in terms of *the same type* of causes, meaning natural as well as social ones.<sup>23</sup> Although scientific ignorance did not explicitly figure in SSK, this clearly offered an analytical framework for the “symmetrical” social study of the phenomenon. Indeed, this framework was used by Michael Smithson in a 1985 paper, programmatically titled “Toward a Social Theory of Ignorance,” in order to establish a sociological understanding of (scientific) ignorance and construct ignorance as an object of sociological study: “[I]gnorance, like knowledge, is socially constructed and negotiated. Furthermore, if we are to take the so-called ‘strong programme’ in the sociology of knowledge seriously, the same social influences on the nature of knowledge must also apply to influencing ignorance. Indeed, a complete sociology of knowledge requires a sociology of ignorance.”<sup>24</sup> Although Smithson did not explicitly focus on scientific ignorance in this paper, his reference to the strong programme in SSK made clear that his argument did include scientific ignorance as well. While Smithson’s article did not offer much in the way of understanding how and why *scientific* ignorance is actually socially produced, his general claim that ignorance is not simply given by nature, but socially constructed and negotiated proved to be highly influential in the following years and contributed significantly to the evolution of a small field dedicated to the social study of ignorance in general and scientific ignorance in particular (see below the section on the development of the field in the 1990s).

b) As is well-known, environmental problems and hazards became an important and contested political issue from the 1970s on and were linked by social movements and environmental activists to science and technology in a twofold manner: On the one hand, many of these problems were perceived as effects, often unintended, of science and technology; on the other hand, these negative effects were held to be severely aggravated by the fact that the sciences, in many cases, not only failed to anticipate (and then possibly prevent) such undesirable consequences of their own products, but were not even able to detect them after they had occurred. The most prominent and most detrimental example of both such failures was the “ozone hole” caused by chlorofluorocarbons (CFCs). These chemical substances, which were first synthesized at the

<sup>22</sup> Merton, *Social Theory*.

<sup>23</sup> Bloor, *Knowledge*, 7.

<sup>24</sup> Smithson, “Social Theory of Ignorance,” 151.

end of the 1920s, were praised for their extraordinary stability. Although some risk assessment had been done before industrial mass production and use of CFCs started in the 1930s, the relevant sciences did not consider the possibility that CFCs might rise to the stratosphere and split up there, releasing chlorine and then triggering a chain reaction destroying the ozone layer.

In view of cases like the “ozone hole” and the complex problem of the disposal and storage of nuclear waste, philosopher of science Jerome Ravetz developed a distinct and, in a way, more concrete notion of scientific ignorance than Smithson’s. In addition, he also explicitly addressed the counterintuitive and provocative character of the notion and phenomenon of scientific ignorance. “Scientific ignorance,” he noted, “is paradoxical in itself and directly contradictory to the image and sensibility of our inherited style of science and its associated technology.”<sup>25</sup> For Ravetz, this seemingly self-contradictory issue nevertheless became pressing just because the environmental crises of industrial societies revealed a novel, dynamic interaction of scientific knowledge and ignorance, resulting in the unexpected and uncomfortable situation that the growth of scientific knowledge goes along with an even more rapid increase of ignorance: “Now we face the paradox that while our knowledge continues to increase exponentially, our relevant ignorance does so even more rapidly. And this is ignorance generated by science!”<sup>26</sup> This ignorance springs from the fact that, while the sciences are able to acquire enough knowledge to intervene massively in the natural environment, they are unable to anticipate and control all the effects and consequences of these interventions.

A few years later, Ravetz coined the terms “science-based ignorance” and “man-made ignorance” in order to denote this specific type of scientific non-knowledge.<sup>27</sup> He defined such man-made ignorance as “an absence of necessary knowledge concerning systems and cycles that exist out there in the natural world, but which exist only because of human activities. Were it not for our intervention, those things and events would not exist, and so our lamentable and dangerous ignorance of them is man-made as much as the systems themselves.”<sup>28</sup> The focus here is not on a mistaken or incomplete representation of a static and seemingly independent natural world but on the temporal and performative dimensions of scientific and technological practices themselves, which produce new and unforeseen, possibly even unforeseeable, effects. Consequently, Ravetz abandoned the modernist claim to successively eliminate ignorance and replace it by knowledge; he argued instead for the “management” of uncertainty and ignorance, that is, for strategies of “post-normal science” to render ignorance “usable” for more sustainable ways of intervening in the natural environment.<sup>29</sup>

c) Almost simultaneously, Robert Merton sketched out a third influential conception of scientific ignorance, namely “specified ignorance.” He had already introduced this notion rather incidentally in the 1950s, but it was only in 1987 that he elaborated on it—presumably inspired by the debates on ignorance that had emerged in the 1980s; at least, Merton referred to Smithson’s afore-mentioned paper from 1985.<sup>30</sup> Specified ignorance was defined by Merton as “the express recognition of what is not yet known but needs to be known in order to lay the foundation for still more knowledge.”<sup>31</sup> As Merton added later in his paper that the “specification of ignorance amounts to problem-finding as a prelude to problem-solving,” it becomes clear that his notion of specified ignorance is close to the traditional modernist view questioned by Ravetz, which conceives of the unknown primarily as the “not-yet-known” that will not to be able to resist for long the quest for knowledge.<sup>32</sup> In some respects, however, Merton did go beyond this view, by emphasizing that this allegedly useful kind of ignorance does not immediately meet the eye, but requires informed theoretical reflection and skills on the part of the scientists before it can be detected and specified.<sup>33</sup> An important implication of this is that different theoretical orientations also differ in how they specify their ignorance and in what they consider a worthy and soluble scientific problem. Using Fleck’s term, Merton illustrated this by referring to four different “thought collectives” in the sociological study of deviant behavior.<sup>34</sup> As the

<sup>25</sup> Ravetz, “Usable Knowledge,” 421.

<sup>26</sup> Ibid., 423.

<sup>27</sup> Ravetz, *Merger of Knowledge*, 1.

<sup>28</sup> Ibid., 217.

<sup>29</sup> The concept of “post-normal science” as developed by Ravetz and Silvio Funtowicz ironically echoes Thomas Kuhn’s notion of problem-solving “normal science” and refers to situations where facts are uncertain or even unknown, where values are in dispute and decisions urgent. Funtowicz and Ravetz, “Post-Normal Age,” 744. Such situations require novel procedures for the validation of knowledge and ignorance, for instance “extended peer communities” including non-scientific actors.

<sup>30</sup> Merton, “Three Fragments,” 7.

<sup>31</sup> Ibid.

<sup>32</sup> Ibid., 10.

<sup>33</sup> Ibid., 6.

<sup>34</sup> Ibid., 8–10.

practice of specifying ignorance is inevitably selective, it necessarily results not only in specified ignorance that is considered worthy of investigation but also in ignorance that is left *unspecified*, because it is held to be less important, or not so easily accessible by established methods, or seems to promise less funding or academic prestige. Although the notion of unspecified ignorance might thus have been a quite promising object of research on scientific ignorance, Merton did not elaborate on it.<sup>35</sup> Instead, his analysis largely remained within the limits of a functionalist and modernist view according to which the specification of ignorance is often “a first step toward supplanting that ignorance with knowledge.”<sup>36</sup> It is in this sense that Merton summarized his reflection: “As new contributions to knowledge bring about a new awareness of something else not yet known, the sum of manifest human ignorance increases along with the sum of manifest human knowledge.”<sup>37</sup> This statement only superficially resembles Ravetz’ afore-mentioned paradox suggesting that ignorance might increase even more rapidly than knowledge. While for Ravetz this ignorance entails unforeseen or unforeseeable events in the natural world that expose the limitations of the sciences, Merton focuses on “not-yet-knowns” as stimulating the continuous acquisition of new knowledge.

### The Development of a Small Field in the 1990s

Obviously, these notions of scientific ignorance, as well as some others that were developed during the 1980s, remained heterogeneous and were only marginally related to each other.<sup>38</sup> Although partly complementary, they were also partly opposed to each other. Nevertheless, in the following years, some efforts were made to bring together these different approaches and thus foster the establishment of a new object of study and a new field of research. The symposium “Science and Ignorance” organized by media scientist S. Holly Stocking at the 1993 Annual Meeting of the American Association for the Advancement of Science (AAAS) played an important role. Both Smithson and Ravetz were among the speakers, in addition to Stocking and her colleague Lisa Holstein as well as medical researcher Marlys Witte and philosopher Ann Kerwin.<sup>39</sup> Very soon after, the presentations were published in a thematic issue of the journal *Knowledge: Creation, Diffusion, Utilization* (which was re-named *Science Communication* in 1994).<sup>40</sup>

In a 1998 paper in *Science Communication*, Stocking drew on these presentations and claimed that since the symposium “investigations of scientific ignorance have begun to gain a small foothold in science and science studies.”<sup>41</sup> She not only highlighted three important research projects on the topic but also noted, apparently for the first time, the emergence of a distinct field of research she called the “sociology of scientific ignorance” (SSI). Echoing Smithson’s claim from 1985 cited above, Stocking wrote “that it is tempting to suggest that we are witnessing the emergence of a sociology of scientific ignorance (SSI) to complement and expand the existing sociology of scientific knowledge (SSK).”<sup>42</sup> Unsurprisingly, given her explicit reference to SSK, Stocking saw the basic and, in a way, the “unifying” idea of the new field in the insight that (scientific) ignorance, like knowledge, is socially constructed, that is, it is “not simply a ‘given’ in people or nature, but is (at least in part) a construction embedded in diverse social interests and commitments.”<sup>43</sup>

The research projects on scientific ignorance Stocking considered most significant largely followed this “constructivist” line of argument. They included, first, the analysis of “ignorance claims” in science, the media and the public as suggested by Stocking herself and Lisa Holstein at the AAAS symposium;<sup>44</sup> second, research

<sup>35</sup> It clearly resonates, however, in both Proctor’s later idea of a “history of scientific nonevents” and the concept of “undone science” developed by David Hess and colleagues. Proctor, *Cancer Wars*. Also, see below the subsections on the development of the field and on undone science.

<sup>36</sup> Merton, *Social Theory*, quoted in Merton, “Three Fragments,” 7.

<sup>37</sup> Merton, “Three Fragments,” 7.

<sup>38</sup> Other conceptions included David Collingridge’s reflections on decisions under (scientific) ignorance, which constitute a whole class of challenging decision problems “beyond” the more familiar situations of “risk” and “uncertainty.” Collingridge suggested a Popperian “fallibilist” approach to decisions under ignorance which should always be falsifiable by the discovery of new facts. Collingridge, *Social Control*, 29.

<sup>39</sup> It was Kerwin (and not former US defense secretary Donald Rumsfeld) who, in 1993, was most probably the first to coin the term “unknown unknowns” as distinct from “known unknowns.” Although Rumsfeld’s strategic (mis-)use of the “unknown unknowns” has widely discredited the term, it nevertheless remains an indispensable, if ambivalent, conceptual tool for mapping the terrain of ignorance. Kerwin, “None Too Solid,” 178–82.

<sup>40</sup> Smithson, “Ignorance and Science”; Ravetz, “Sin of Science”; Stocking and Holstein, “Constructing Ignorance”; Kerwin, “None Too Solid.”

<sup>41</sup> Stocking, “Drawing Attention,” 168.

<sup>42</sup> *Ibid.*, 173.

<sup>43</sup> *Ibid.*, 168.

<sup>44</sup> Stocking and Holstein, “Constructing Ignorance.”

into conscious public ignorance of science done by Brian Wynne and Mike Michael at Lancaster University;<sup>45</sup> thirdly, the analysis of the “political construction of knowledge gaps” in Robert Proctor’s book *Cancer Wars: How Politics Shapes What We Know and Don’t Know About Cancer* published in 1995 and critically referring to the “war on cancer” declared by US President Richard Nixon in 1971. As is well known, in 2008, Proctor (together with Londa Schiebinger) launched, under the label of “agnotology,” one of the most prominent contemporary approaches to the study of (scientific) ignorance.<sup>46</sup> It might therefore be illuminating to take a closer look at his 1995 book: Using the example of cancer research in the US, it aimed at gaining a solid understanding of the “politics of science.” Crucial for this politics is, according to Proctor, not only what is studied, but also what is *not* studied in science (for instance the environmental causes of cancer). For Proctor, this means that “[o]ne has to study the social construction of ignorance,”<sup>47</sup> for instance, by “outright censorship (admittedly rare), by failures to fund, by the absence or neglect of interested parties, and by efforts to jam the scientific airwaves with noise.”<sup>48</sup> Proctor framed this analytical approach as a “political philosophy of science,” which he specified in terms of the following three questions: “Why do we know what we know, and why don’t we know what we don’t know?” “Who gains from knowledge (or ignorance!) of a particular sort and who loses?” “How might knowledge be different, and how *should* it be different?”<sup>49</sup> Given the significance of what is not studied, according to Proctor, the history of science can no longer be understood (or celebrated) only as a history of discoveries and inventions, but also as a “history of scientific nonevents,” that is, the exploration of instances “where it is the *absence* of a discovery ... that is the most poignant fact in need of explanation.”<sup>50</sup> The term “agnotology” was also already introduced in Proctor’s 1995 book, though spelled differently, as the idea of a “political agnatology” to complement existing political epistemologies by explaining the absence, not the acquisition of knowledge.<sup>51</sup> Thus, in *Cancer Wars*, agnatology served as an analytical tool within the framework of a political philosophy of science rather than as the overarching term for the study of ignorance that it became in the early twenty-first century.

## Research Programs on Scientific Ignorance in the Early Twenty-First Century

Stocking’s 1998 paper marked a milestone in the history of (the notion of) scientific ignorance: The investigation of this ignorance, its reasons, causes, and possible effects, seems now to have evolved into a respectable, though still marginal, topic of scientific research. Moreover, a small but growing interdisciplinary field has established itself, more or less loosely integrated by the idea of the social construction of scientific ignorance. Yet, although the concept of a sociology of scientific ignorance (SSI) was occasionally taken up in the early twenty-first century, it did not become accepted as the common label (and theoretical core) of the entire field—partly because in the late 1990s its complementary field, the sociology of scientific knowledge (SSK), rapidly lost its leading position in the social study of science and technology, partly due to the interdisciplinary character of the new field: Increasingly, other fields joined sociology in the study of scientific ignorance such as the philosophy and history of science as well as feminist science studies and ethnography.

Building on what has been achieved since the 1980s, the study of ignorance in and of science in the first two decades of the twenty-first century was mainly characterized by the evolution of a number of both complementary and competing research programs that focus from quite different angles on the *reasons for* and *causes of* that ignorance. Of these programs, the three that are currently most visible seem to be: agnotology, the sociology of undone science, and the analysis of scientific (or epistemic) cultures of non-knowledge. In the following sections, I will very briefly describe these programs in order to elucidate their respective core assumptions and to highlight the interrelations, similarities, and differences between them.

## Agnotology

As mentioned in the previous section, the neologism agnotology (or “agnatology”) already appeared in Robert Proctor’s work in the 1990s. However, it became a widely known term and comprehensive name for the study of ignorance in general, and scientific ignorance in particular, only in 2008 with the publication

<sup>45</sup> See Michael, “Ignoring Science.”

<sup>46</sup> Proctor and Schiebinger, *Agnotology*.

<sup>47</sup> Proctor, *Cancer Wars*, 8.

<sup>48</sup> *Ibid.*

<sup>49</sup> *Ibid.*, 8–9 (emphasis in original).

<sup>50</sup> *Ibid.*, 12 (emphasis in original).

<sup>51</sup> *Ibid.*, 8.

of an edited volume presenting the papers of two workshops held in 2003 und 2005.<sup>52</sup> It was primarily Proctor's programmatic introduction to that volume that laid claim to unite the whole new field under the heading of agnotology. But, while agnotology (the study of how and why we do *not* know) was very broadly designed as counterpart and complement to epistemology, when it did develop into a specific research program on the causes of scientific ignorance, it turned out to be remarkably narrow.

In his introductory chapter, Proctor explicitly mentioned three relevant variants of ignorance (apart from the less interesting modernist notion of the "not-yet-known"): first, ignorance as "lost realm, or selective choice (or passive construct)"<sup>53</sup>; second, ignorance "as strategic ploy, or active construct"<sup>54</sup>; thirdly, "virtuous ignorance," that is, not knowing as "resistance or moral caution" against knowledge that could be biased or undesirable.<sup>55</sup> As a distinct research program, however, agnotology has concentrated (at least until recently) almost exclusively on the second type, strategically constructed ignorance. And, still more narrowly, the focus here is mainly on the efforts of powerful commercial players to raise doubts and uncertainties regarding scientific findings and insights. One of the most prominent examples of the agnotological focus on this kind of phenomena is Naomi Oreskes and Erik Conway's book *Merchants of Doubt* from 2010. It refers to a wide range of cases in point, including acid rain, the "ozone hole," passive smoking, and global warming, and shows that the aim of the "merchants" usually has been to prevent political regulation of their products by intentionally raising doubts about the certainty and validity of existing scientific knowledge. One rather obvious reason for agnotology's empirical focus on these forms of actively constructing scientific ignorance has been Proctor's strong interest and extensive research on the tobacco industry's attempts, which were largely successful from the 1950s to the 1990s, to obscure the link between smoking and lung cancer and to discredit the growing body of scientific knowledge of this link as being "uncertain," "unproven" or "flawed."<sup>56</sup> A second, less obvious reason for this narrow framing of the "social construction of scientific ignorance" in agnotology might be that the focus on the strategically motivated raising of uncertainty and doubt ultimately leaves untouched the traditional normative image of science as the social institution that is able to provide true and certain knowledge.<sup>57</sup> Ultimately, in almost all cases investigated from the agnotological perspective it is not science that is ignorant; instead, there are vested interests that aim (albeit most often with the help of collaborating scientists) to make proper scientific knowledge *appear* uncertain, to make science *appear* ignorant (although, in fact, it is not).

Only quite recently have some efforts been made to renew the originally wider scope of agnotology as outlined by Proctor and to pay more attention to the hitherto neglected variants, that is, to the passive, unintended construction of scientific ignorance and to virtuous ignorance.<sup>58</sup> The latter term refers to cases where the absence of scientific research and knowledge (e.g., about ostensible cognitive differences between gender or "racial" groups) appears to be *desirable*.<sup>59</sup> It remains an open question, however, whether such thematic and conceptual extensions can easily be added to the existing agnotological research program without challenging both its coherence and its tacitly normative view of science.

## Undone Science

The concept of "undone science" and the program of a sociology of undone science as developed by US sociologists David Hess, Scott Frickel and others since about 2007 offer a different approach to the issue of scientific ignorance. This approach has emerged at the intersections of STS and social movement studies, with the term "undone science" referring to areas of research (for instance, on the risks of nanotechnology, but also on the possible advantages of "green" technologies) which are "identified by social movements and other civil society organizations as having potentially broad social benefit," but "are left unfunded, incomplete, or generally ignored."<sup>60</sup> Undone science results from a "structured absence"<sup>61</sup>; it springs from "a situation of unequal power ... that involves a conflict between reformers, such as social movement leaders, and industrial and political elites."<sup>62</sup> Given this context, undone science usually indicates a known unknown

<sup>52</sup> Proctor and Schiebinger, *Agnotology*.

<sup>53</sup> Proctor, "Agnotology," 6–8.

<sup>54</sup> *Ibid.*, 8–20.

<sup>55</sup> *Ibid.*, 20–23.

<sup>56</sup> *Ibid.*, 11–18.

<sup>57</sup> See, for instance, Oreskes and Conway, *Merchants*, 205–11, and, critically, Fernández Pinto, "Tensions."

<sup>58</sup> See, for instance, Fernández Pinto, "Scientific Ignorance," and Kourany and Carrier, *Production of Ignorance*.

<sup>59</sup> Kourany, "Might Ignorance Be Virtuous?"

<sup>60</sup> Frickel et al., "Undone Science," 445.

<sup>61</sup> Hess, *Undone Science*, 33.

<sup>62</sup> Hess, "Undone Science and Social Movements," 142.



or a potentially knowable unknown rather than an unknown unknown, understood in the sense of a general and unrecognized absence of (scientific) knowledge.<sup>63</sup> The identification of undone science does not, however, necessarily mean that the required research is actually “doable,” at least not always in a time-frame that would be relevant for political action.<sup>64</sup>

The focus of this research program appears to be rather specific and, in a way, narrow as well. Yet, although there is some thematic overlap between the sociology of undone science and agnotology (as a research program), the former does not understand science in a normative way as an independent and value-free search for truth, as some proponents of agnotology do. Instead, science is conceived of as a social field that is inevitably embedded in and shaped by asymmetrical power relations that heavily influence the priorities of research as well as the resources made available for different research areas and topics. Therefore, the lack of such knowledge that might be useful for less powerful social groups, for instance, knowledge of the long-term risks of genetically modified organisms (GMOs), is structurally and, in a way, politically produced.<sup>65</sup> The sociology of undone science thus adopts a political sociological perspective; nevertheless, and again contrary to most current agnotological research, it is also interested in the epistemic dimensions of the production of ignorance, in particular in the interactions of epistemic practices with institutional and regulatory settings.<sup>66</sup> Recently, June Jeon has significantly added to research on undone science with an ethnographic study on how and why scientific organizations as well as individual scientists often readily abandon their research topics (thus leaving them “undone”) when no further funding is available. Drawing on Pierre Bourdieu's concept of habitus, Jeon argues that scientists both legitimize their own moving to new, better funded topics and invisibilize the political or economic pressures to do so by internalizing the idea of being “a mature scientist” who is expected always to be open to new issues and challenges.<sup>67</sup>

### Scientific Cultures of non-Knowledge

In contrast to both agnotology and the sociology of undone science, the analysis of scientific or epistemic cultures of non-knowledge (or ignorance) concentrates primarily on the production of ignorance by the epistemic practices of the sciences themselves. Without denying that there exist many forms and cases of conscious and strategically motivated “manufacturing” of uncertainty and ignorance, the concept of “cultures of non-knowledge” is more interested in the unintended and unconscious construction of ignorance by science itself, that is in unknown unknowns rather than in known unknowns. The concept as developed around 2005 by a group of sociologists and STS researchers at the University of Augsburg (Germany) “refers to the practices by which different scientific (sub-)disciplines generate, acknowledge, and communicate non-knowledge.”<sup>68</sup> Drawing on Fleck's concept of thought styles as well as on Karin Knorr-Cetina's idea of a plurality of “epistemic cultures” within the sciences,<sup>69</sup> the basic assumption is that the various thought styles or epistemic cultures differ not only in how they produce knowledge but also in how they simultaneously produce ignorance and in how they deal with their unknowns, both known and unknown. This means, first, that cultures of non-knowledge (*Nichtwissenskulturen*) are not the opposite of cultures of knowledge or knowledge cultures (*Wissenskulturen*) but *are* knowledge cultures observed and analyzed from the perspective of how they produce knowledge and, at the same time, ignorance. The second implication is, following Fleck's insights, that it is *the same* epistemic practices (for instance the selection of a methodological approach, or an experimental design, or a specific way of “seeing”) that simultaneously produce both knowledge and, unintendedly, ignorance—ignorance of which the scientists mostly are unaware.<sup>70</sup> This means, thirdly, and contrary to a normative view of science, that it is not only and simply “bad” research that produces ignorance. “Good,” even “excellent” science also inevitably does so.<sup>71</sup>

The concept of cultures of non-knowledge can be used for comparative analysis either by comparing different scientific fields in terms of how they generate knowledge/ignorance or by identifying diverging and competing cultures of non-knowledge in interdisciplinary conflicts over contested technologies such

<sup>63</sup> Ibid.

<sup>64</sup> Hess, *Undone Science*, 34.

<sup>65</sup> Ironically, the sociology of undone science appears to be much closer to Proctor's idea of a “political philosophy of science” from 1995 than is most of the research currently done under the label of agnotology.

<sup>66</sup> See, for instance, Kleinman and Suryanarayanan, “Dying Bees”; Henry, *Ignorance scientifique*.

<sup>67</sup> Jeon, “Invisibilizing Politics,” 852.

<sup>68</sup> Böschen et al., “Cultures of Non-Knowledge,” 295; see also Böschen et al., “Scientific Nonknowledge.”

<sup>69</sup> Knorr-Cetina, *Epistemic Cultures*.

<sup>70</sup> See in more detail Wehling, “Nichtwissenskulturen.”

<sup>71</sup> See also Fernández Pinto, “Scientific Ignorance,” 199–201.

as GMOs.<sup>72</sup> A more general aim of the research program consists in fostering a reflexive understanding of science as an epistemic practice that produces both valuable knowledge and ignorance (in the form of knowledge gaps, blind spots, unknown unknowns and the like) that at least in some instances might be hazardous. Arguing that knowledge and ignorance are inevitably co-produced does not at all mean, however, that their interrelation is necessarily a kind of automatic mutual increase. To the contrary, the concept of cultures of non-knowledge claims that while it is unavoidable *that* epistemic practices produce both knowledge and ignorance, *how* this happens in specific instances is neither entirely inaccessible to self-reflection nor unchangeable. Thus, the sciences are requested to observe and, at least to a certain degree, self-critically evaluate how they generate ignorance in order to develop self-reflexive strategies to deal with this paradox—without falling back into the modernist illusion that they could ever be able to produce all-encompassing knowledge and to completely eliminate ignorance.

Saying that these three research programs currently seem to be the most visible ones does not at all mean that they are the only ones or that they actually cover all issues relevant for the study of scientific ignorance.<sup>73</sup> Quite to the contrary, it has become clear that their respective research foci are rather specific. Therefore, additional research programs are likely to emerge in the future and to both advance and diversify the study of scientific ignorance.

## Conclusion

Tracing the conceptual history of “scientific ignorance,” one can observe how this unfamiliar and counterintuitive notion has developed, perhaps surprisingly, into an acceptable and important, if heterogeneous, topic of research throughout the twentieth century and the first decades of the twenty-first century. It has become clear, however, that this history is not a linear and continuous one, given the fact that essential theoretical foundations had been laid as early as the 1920s and 1930s by Ludwik Fleck but were subsequently ignored or forgotten and taken up again only at the end of the century. Likewise, Robert Merton introduced his concept of “specified ignorance” in the 1950s, but did not elaborate on it until the 1980s, when there was growing attention to the ignorance of science.

The history of the study of scientific ignorance should also not be misinterpreted as an irreversible “success story.” In retrospect, it seems that theoretical reflections and new conceptual perspectives alone would not have been strong enough to overcome resistance to the study of scientific ignorance and to establish it as a legitimate, politically important, and theoretically interesting object of self-reflective scientific investigation. A favorable condition seems to have been the experiences of environmental disasters and health hazards that, from the 1960s onwards, exposed a “lamentable and dangerous ignorance” of the sciences, as Ravetz put it.<sup>74</sup> Likewise, the purposeful efforts of powerful commercial actors to raise doubts about scientific findings in fields such as cancer research and climate research unintentionally promoted the development of agnotology in the 1990s and early 2000s. Doubtlessly, the growing concern with the ignorance and uncertainties of science fostered by these historical contexts appears to be more than a mere short-term “hype.” But if Ravetz is right in stressing that what he had termed the “sin of science,” that is to say, science’s ignorance of its own ignorance, is deeply entrenched in the institutional culture and self-understanding of modern science,<sup>75</sup> one must always reckon with repeated attempts to re-establish the hegemonic and self-congratulatory image of science as the pre-eminent producer of knowledge.

This is all the more relevant, because even among those scholars who work on scientific ignorance there is a persistent tension between, on the one hand, those who understand this issue in a way that ultimately leaves untouched the modernist view of science as the master institution predestined to reduce or even eliminate ignorance and, on the other hand, those who argue that this view should be abandoned or at least qualified, precisely because of the “discovery” of scientific ignorance. The former camp includes those scholars who conceive of scientific ignorance mainly in terms of Merton’s “specified ignorance” as a prelude to new knowledge as well as many of those who work under the label of agnotology and, in a

<sup>72</sup> Kastenhofer, “Rekonstruktion.”

<sup>73</sup> Current research programs on (scientific) ignorance include feminist epistemologies of ignorance (for an overview, see Fernández-Pinto, “Ignorance, Science, Feminism”); ethnographic work on the “anthropology of ignorance” (High et al., *Anthropology of Ignorance* and Dilley and Kirsch, *Regimes of Ignorance*); the analysis of “real-world experiments” as a way of dealing with ignorance in processes of technology implementation (Gross et al., *Realexperimente*; Gross, *Ignorance and Surprise*); the sociological study of the “politics of not knowing” in individual disciplines such as psychiatry (see Whooley, *Heels of Ignorance*). For a general overview of the growing field of “ignorance studies,” see Gross and McGoey, *Ignorance Studies*.

<sup>74</sup> Ravetz, *Merger of Knowledge*, 217.

<sup>75</sup> Ravetz, “Sin of Science.”

way, “externalize” the sources of ignorance to the “merchants of doubt,” to deviant scientists and interested parties consciously undermining scientific truth.<sup>76</sup> The latter camp, by contrast, is formed by those scholars who claim that the epistemic practices of science itself inevitably co-produce knowledge and ignorance as well as those who emphasize that the sciences will never be able to fully anticipate and control the effects of their interventions in the natural and social world. In addition, this camp also includes those who take into account the possibility that scientific ignorance, the conscious omission of certain research, might even be a virtue—a view that obviously opposes the modernist belief that searching for knowledge is always “better” than remaining ignorant.

Given these tensions, scientific ignorance will hardly ever become a “normal” object of “value-free” scientific investigation, since what is at stake here, at least implicitly, are not merely isolated findings of the sociology or history of science, but, more fundamentally, the (self-)image and role of science in our present societies. Strikingly, in their statements quoted at the outset of this article, both Bauman and Proctor use colonial metaphors to describe the modernist understanding of ignorance as “a not-yet conquered territory” and “a primitive and native state.” As long as science continues to pursue the goals of “conquering” the territory of ignorance and eliminating the supposedly “primitive” and “native” state of being ignorant it remains indeed part of a colonial and colonizing project “conquering the world, defining what really matters and what are mere illusory beliefs,” as philosopher of science Isabelle Stengers has put it.<sup>77</sup> Contrary to this attitude, science and knowledge must learn to “live” and coexist with ignorance as their “Other” that not only cannot be eradicated, but is constantly produced and reproduced by science itself.

## Competing Interests

The author has no competing interests to declare.

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<sup>76</sup> See Fernández Pinto, “Tensions.”

<sup>77</sup> Stengers, *Another Science*, 143.

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