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## Styles of Reasoning, Human Forms of Life, and Relativism

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### ABSTRACT

The question as to whether Ian Hacking's project of scientific styles of thinking entails epistemic relativism has received considerable attention. However, scholars have never discussed it vis-à-vis Wittgenstein. This is unfortunate: not only is Wittgenstein the philosopher who, together with Foucault, has influenced Hacking the most, but he has also faced the same accusation of 'relativism'. I shall explore the conceptual similarities and differences between Hacking's notion of style of thinking and Wittgenstein's conception of form of life. It is a fact that whether or not the latter entails epistemic relativism is still a controversial question. From my comparative analysis, it will emerge that there are stronger reasons to conclude that Hacking's notion of style leads to epistemic relativism than there are to reach the same conclusion in the case of Wittgenstein's conception of form of life. This point will be at odds with the anti-relativistic stance that Hacking has taken in his more recent writings.

### 1. Introduction

In 1978, the philosopher Ian Hacking was invited to a conference in Pisa in which the historian Alistair C. Crombie lectured on what he called 'styles of scientific thinking in the European tradition' (Crombie 1981, 1994). As Hacking revealed later (Hacking 2012, 599), that lecture suggested to him the 'idea of a small manifold of styles' (Hacking 2009, 6), broad frameworks that govern a certain way of investigating the world and involve new types of evidence, questions, and methods of inquiry. Later on, in the 1980s, Hacking put forward what he subsequently called 'the styles project' (Hacking 2012), a set of suggestions that characterise the notion of 'style of reasoning' and are scattered in different writings (Hacking 1982, 1992c, 2009). According to Hacking, styles emerge at a specific time in history and determine what counts as rational or irrational. In particular, they bring about new sentences as candidates for being true-or-false: whether or not a proposition possesses a truth-value depends on whether we have ways to reason about it. For instance, in Renaissance medical textbooks such as those of Paracelsus (1493–1541), we may find statements that are unclear to us: indeed, what settles their truth-value is the style of reasoning of the Renaissance thinkers.

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Hacking's account of styles left an issue unsolved: it is unclear whether there exists an atemporal and independent criterion for justifying those sentences whose sense hinges on a given style. A claim could be justified only by using the standards of evidence, methods, and the way of thinking and doing of its own style. In other words, it is unclear whether Hacking's project entails epistemic relativism. No univocal answer has emerged from the discussions on this issue in the literature. For example, Newton-Smith (1982) claimed that Hacking's point that a proposition can be determined as true by a style for which there is no external justification entailed a form of relativism. Likewise, Baghramian (2004) noted that Hacking's account was an example of relativism because for him what counts as evidence is internal to a given style. Kusch (2010) pointed out that epistemic relativism is the claim that the properties picked out by the predicates 'rational' and 'justified' are relative to different epistemic systems. Then he argued that this definition fits the case of styles: a style-dependent sentence can be justified in its own style but has no truth-value, that is, no meaning, outside it; therefore, its justification is relative to its style. Other scholars disagreed with Kusch by claiming that Hacking has resources to avoid relativism (Bueno 2012).

However, scholars have never discussed this issue vis-à-vis Ludwig Wittgenstein, a philosopher who has influenced Hacking profoundly. In this article, I shall take on this task. By comparing and contrasting the styles project with Wittgenstein's later works such as *Philosophical Investigations* (Wittgenstein [1953] 1997; henceforth *PI*) and *On Certainty* (Wittgenstein [1969] 1995; *OC*), I want both (1) to shed light on the styles project and (2) to argue that the styles project is relativistic in nature.

In his quest to describe the workings of human language, Wittgenstein adopts different notions, of which those of 'language game' and 'form of life' will be the most interesting for my aims. As he says, 'the term "language-game" is meant to bring into prominence the fact that the *speaking* of a language is part of an activity or a form of life' (*PI* 23). For him, language is composed by different games with their own rules, for example, giving orders and obeying them; making up stories; and guessing riddles. What enables all these games to work is a form of life, our biological, behavioural, and sociological matrix. The interpretation of 'form of life' has been widely debated. Wittgenstein says that 'what has to be accepted, the given, is—one could say—*forms of life*' (*PI* 226), suggesting that a form of life is the 'given' in which a language has meaning. The plural 'forms of life' has grounded relativistic readings of Wittgenstein, which have insisted on the idea that forms of life are to be understood as contingent, historical, dependent on culture. On the other hand, non-relativistic readings of Wittgenstein are suggested by other passages, such as those in which a form of life seems to be what is common to humankind and makes the language possible, for example, 'the common behaviour of mankind is the system of reference by mean of which we interpret the unknown language' (*PI* 205).

In the next section, I shall summarise the main ideas of the styles project by considering two examples of styles of reasoning: the algorithmic style and the postulational style. In section 3, I shall explain that, despite Hacking's insistence on anti-relativism, whether or not the styles project entails epistemic relativism is an unresolved issue. In section 4, I shall point out that the conceptions of meaning of both the early and the later Wittgenstein can be recognised in the styles project and I shall discuss the philosophical consequences. In section 5, by relying on some analogies between the notion of 'form of life'

and the notion of style, I shall argue that the styles project entails anti-foundationalism, that is, the idea that each style is ungrounded, not epistemically justified. In the last sections, I shall conclude that, although in the case of Wittgenstein whether or not anti-foundationalism leads to epistemic relativism is at issue, in the case of Hacking this inference is *inevitable*.

## 2. Hacking's Styles Project

Crombie suggested that in the history of the sciences, it is possible to distinguish six styles of scientific thinking: (1) the postulational style (or style of geometry); (2) the experimental style; (3) the style of hypothetical modelling; (4) the statistical style; (5) the taxonomic style; and (6) the historico-genetic style. Hacking hinted at the possibility of other styles (Hacking 1982; Lakoff 2012): for example, he introduced the laboratory style, a sort of combination of styles 2 and 3, he spoke of the now extinct hermetic style of Paracelsus (Hacking 1982, 1983b, 1992c), and he mentioned the algorithmic style, distinct from the style of geometry (Hacking 1993).

More importantly, he made philosophical claims about the features of styles: for instance, he claimed that each style of reasoning is also a way of doing, that each style is self-authenticating and introduces new types of objects, evidence, laws, and new true-or-false sentences, that is, sentences whose truth-value hinges on the style itself (for this reason they are called *style-dependent sentences*; Hacking 1982, 1983a, 1992b, 1992c, 2009). Hacking's account of the postulational style endorses Reviel Netz's thesis that proof emerged in ancient Greece and was not a Babylonian or Egyptian practice (Netz 2000). For Netz, the deployment of lettered diagrams is what makes Greek mathematics a recognisable genre. On a logical plane, lettered diagrams and words combine in necessity-preserving ways to form deductive chains and to yield knowledge of general validity: knowledge not of a particular triangle but of all the triangles (Netz 2000, chapters 5 and 7). On a cognitive plane, Greek demonstrations are the result of interplay between visual resources and *indices* (letters that signify a point by standing next to it; Netz 1999, 47).

The Greek postulational style introduced abstract 'objects' unknown to previous civilisations, such as diagrams, points and lines, the 'objects' of geometry, and style-dependent sentences: 'those very sentences used to express the geometrical *a priori* propositions could not have that sense unless they were embedded in the practice of geometrical demonstration' (Hacking 1983a, 457). That is, for Hacking the sense of Euclid's propositions such as the following:

Any prism which has a triangular base is divided into three pyramids equal to one another with triangular bases. (*Elements* XII, 7; Heath 1908, 394)

is determined by the way in which we can reason for their truth or falsehood. For a Babylonian, the sentence would not have been a candidate for truth or falsehood for the presence of the quantifier 'any', which gives generality to the proposition. Indeed, 'Babylonian mathematics is limited, compared to Greek mathematics, by being tied to the particular operation upon the particular case' (Netz 1999, 154): generality was a 'historical novelty' (Høyrup 2005, 143). Hacking's claim implicitly relies on a verificationist thesis: a sentence is not meaningful for a community that has no methods to assess its truth.

In recent papers, Hacking has put emphasis on the idea that styles have *clear beginnings* and are not only ways of thinking but also ways of *doing*, that is, ways of intervening in the world in order to know (Hacking 2012). For example, proof involves not only a way of thinking but also a way of doing. Indeed, the diagram is a *necessary* element in producing and reading a proof. Consider the sentence, ‘Let  $AB$  be the given finite straight line’, that can be read in a Greek diagram. This is not an assertion but a sentence that invites an *action* in the course of a proof: to individuate the letters and the line in the diagram. It might be necessary to examine the line  $AB$  within its context: is it the radius of a circle? Does it intersect another line? Is it also the radius of another circle? *Thinking and doing*, mental and visual resources, interact in the course of a proof based on a diagram.

Finally, for Hacking styles of reasoning are ‘self-authenticating’ (Hacking 1982, 1983a, 1988, 1991, 1992a, 1992c, 2009, 2012), a term that refers to the circularity induced by the following double claim: the truth of certain sentences is what we find by using a style; in turn, a style is a standard of objectivity because it gets at the truth. For example, for him ‘there is no standard of what is correct proof, than proof itself. Proofs are self-authenticating’ (Hacking 2009, 40).

As another example, consider the algorithmic style. Hacking regarded it as a mathematical style that, together with the postulational one, forms the ‘style of mathematics’ (Hacking 2002–2003, 53). To adopt this style means to follow methods of calculation, that is, step-by-step lists of rules that might be represented by a formula. Applying an algorithm to solve an algebraic equation is different from thinking in order to demonstrate that an angle inscribed in a semicircle is a right angle. Whereas the steps to be taken in order to solve an algebraic equation are fixed, within a line of reasoning from hypotheses to thesis every statement must be *deduced* from the previous one.

The first known algorithms in history go back to civilisations more ancient than Greece. Egyptians were able to use different algorithms for solving the same problem; therefore, one of these algorithms could serve as a means for checking the result obtained. Examples are: the already mentioned method of successive doubling and the ‘Russian farmer’s method’ for performing multiplications; the ‘method of false positions’ and the ‘method of factorisation’ for solving linear algebraic equations (Boyer 1968, 17). In other words, the algorithmic style does not answer to any criterion except its own: the criterion for proving whether or not what has been found out is correct still relies on another algorithm. In this sense, the algorithmic style possesses what Hacking would call a technique of self-vindication: ‘the solution of the riddle is  $x$ ’ is what we conclude by using the algorithm  $A$ ; and how do we know that we are correct? We know that because by using another algorithm, the algorithm  $B$ , we find  $x$ . That is: the algorithmic style of reasoning is self-authenticating.

### 3. The Relativism Issue

#### 3.1. Projectibility

Imagine two different communities that adopt different styles. When a member of one community comes to see the presuppositions (that is, the standards of evidence, methods of inquiry, ways of reasoning and doing) of another community that has a *different* style, she can comprehend why a certain sentence is a candidate for truth or falsehood

in that style. However, those presuppositions are not shared by her community, are not *her* presuppositions. In this sense, a style-dependent sentence is a candidate for truth or falsehood only for the community who adopts its appropriate style. To make this clearer, notice how in *Representing and Intervening*, Hacking referred to the sentences of the Renaissance style used by Paracelsus: ‘There is no way to match what Paracelsus wanted to say against anything we want to say ... we cannot assert or deny what is being said’ (Hacking 1983b, 71). What Hacking means can be interpreted in the light of my discussion so far: Paracelsus’s sentences ‘live’ only in his community, that is, only when there exist presuppositions by which they can be validated. By virtue of a hermeneutic attitude, Paracelsus’s sentences do become intelligible in our community but if we want to use them in order to argue, think, and do, we need to give up our own styles, that is, our presuppositions: either we become members of Paracelsus’s community or we cannot say what we want to say by using Paracelsus’s sentences. By the same token, it is not possible, for example, to defend a style-dependent sentence of the postulational style without relying on its presuppositions, for example, the new type of evidence based on the deployment of lettered diagrams. In other words, if Euclid’s proposition above has to be used to express knowledge claims, it cannot be separated from the presuppositions of the postulational style by which it can be validated. Following Hacking, these presuppositions were not those of civilisations prior to Greece.

Ultimately, Hacking’s styles project entails the impossibility of ‘projecting’ style-dependent sentences into another style. For example, according to Hacking, certain sentences of Paracelsus are not projectable into our styles: there is no way of justifying them according to our standards; there is no possibility of *doing* things as he does because that would be to hold Paracelsus’s criteria of evidence. It would mean, so to speak, dropping out of our community. The styles project offers concrete examples of communities of people that have not shared the same style. For instance, Hacking drew from Steven Shapin and Simon Schaffer’s *Leviathan and the Air-pump* (Shapin and Schaffer [1985] 1989), which he considers a book about the origin of the laboratory style, the idea that the dispute of Thomas Hobbes (1588–1679) against Robert Boyle (1627–1691) was a quarrel between two men who had two different styles (respectively, the postulational style and the emergent laboratory style):

[Hobbes] foresaw that laboratory apparatus for generating phenomena was radically new. He was dead against it. This was not a quarrel about the relative weight of empirical evidence as against deductive proof. The question was more profound and more consequential. What shall be evidence? Is it to be what we find among us, bring home from abroad, chart in the skies—or is to be what we make with laboratory apparatus? (Hacking 2009, 114)

In other words, Hobbes did not accept the new kind of evidence of the laboratory style (the phenomena elicited by man-made machines) and answered in the negative the question: are Boyle and his community trustworthy informants?

The styles project implies that similar questions might have been asked, *mutatis mutandis*, when other styles (such as the postulational or statistical) emerged. Furthermore, similar questions might also be emerging today or might emerge in the future. For instance, one could argue that mathematical modelling and simulation *on computers* constitute a new style of reasoning. After all, the articulation by computers of existing mathematical models is a historical novelty, a new kind of experimental activity that enjoys a

distinct status compared to ordinary experiments (Hacking 2002, 186, makes a similar point speaking of ‘computer-generated concepts and proofs’ in mathematics). Although the list of sciences that make extensive use of simulations is enormous, whether and under which circumstances we should accept simulations on computers as a new form of evidence is still under debate.

To sum up, the style project poses these questions: which *presuppositions* (standards of evidence, methods, ways of reasoning, and ways of doing) should we single out in order to be *justified* in choosing a certain informant? Are there independent presuppositions to provide an answer to this question? This is not an abstract dilemma (posed by the styles project) that vanishes when we come to concrete examples. It is a kind of incommensurability issue different in nature from that discussed by previous philosophers of science, such as Paul K. Feyerabend and Thomas S. Kuhn. Nothing in the styles project leads to *semantic* incommensurability. Hacking’s point is that there are sentences that are meaningful in certain styles (e.g. because there are methods to assess their truth) and meaningless in other styles—but the meaning of sentences does not change from one style to another. If anything, the point is that, although style-dependent sentences are intelligible, that is, their presuppositions can be identified and understood, they cannot be projected into a different style. Nor it is *always* possible to switch from a style to another as when, as Kuhn imagines, one switches from the Ptolemaic system to the Keplerian. For Hacking, a Renaissance natural philosopher could well learn how Boyle justified his sentences, but in order to use all his sentences she would have to reject the presuppositions of her community and espouse Boyle’s. *Intelligibility is not enough*. The Renaissance natural philosopher would have to think, do, and justify her conjectures as Boyle did—and she would not be able to perform these mental and physical actions *while preserving the presuppositions of her community*. Of course it is true that, for example, today it is possible to switch from the probabilistic style to the postulational style: the reason is that their presuppositions are *our* presuppositions. So, the suspicion of epistemic incommensurability of styles comes from the fact that there seems to be no common measure, that is, no universal set of presuppositions, valid for all the theoretical sentences expressed by communities that have different styles.

### 3.2. Hacking’s Defence

In his first papers on styles, Hacking seemed to be aware of the existence of the incommensurability issue (‘I wish to pose a relativist question from within the heartland of rationality’, Hacking 1982, 48). Commenting on contingency in the history of science, he explicitly spoke of the possibility of an alternative physics successful and progressive like ours but incommensurable with ours: ‘Such imaginary stable sciences would not even be comparable, because they would be true to different and quite literally incommensurable classes of phenomena and instrumentation’ (Hacking 1992a, 31).

However, in the following 30 years, his thought has evolved taking an anti-relativistic turn, but he has not offered any conclusive argument that helps to solve the epistemic incommensurability issue. Let us examine the passages relevant to the evolution of his thought. In his first paper on styles, he wrote:



Consider Hamlet's maxim, that nothing's either good or bad but thinking makes it so. If we transfer this to truth and falsehood, this is ambiguous between: (a) Nothing, which is true, is true, and nothing, which is false, is false, but thinking makes it so: (b) Nothing's either true-or-false but thinking makes it so. It is (b) that preoccupies me. My relativist worry is ... that the sense of a proposition  $p$ , the way in which it points to truth or falsehood, hinges on the style of reasoning appropriate to  $p$ . (Hacking 1982, 49)

In this passage, Hacking highlights that the key distinction to bear in mind is the difference between truth-and-falsehood and truth: point (b) would imply alethic relativism; point (a) states only that the truth-or-falsehood of style-dependent sentences is relative to styles. Hacking manages to dissociate himself only from *alethic* relativism—point (b) is still compatible with epistemic relativism. The question about *epistemic* incommensurability remains unanswered.

In a more recent piece, Hacking wrote:

the answer to a clear question about some aspects of the world is determined by how the world is. ... when the question is a live one, and there is a context in which there are ways of addressing the question, or even methods of verification for possible answers, then aspects of the world determine what the answer is. (Hacking 2000, S69)

In the terminology of the styles project, 'live questions' are the questions that a community that adopts certain styles asks in a certain historical period: for example, questions about human evolution became relevant within the historico-genetic style. We may say that certain questions are relative to styles: they become lively when a style emerges; they are condemned to oblivion when the style withers away. Hacking's point is that, although questions may be relative to styles, the correct answers to them are not relative to anything: 'the answers to live questions about the natural world have nothing to do with us' (Hacking 2000, S70).

By putting forward these ideas Hacking also wanted to distance himself from those social constructionists such as Shapin and Schaffer who spoke of the social construction of the actual answers to well-asked questions (Hacking 2000). However, his anti-relativist turn is all the more evident in writings unrelated to science studies, for example, in his re-reading of the concept of style inspired by the philosopher Bernard Williams. In his review of *Truth and Truthfulness* (Williams 2002), Hacking described the emergence of a style as 'a change in conceptions of what is to tell the truth about  $X$ ' (Hacking 2004, 142) but insisted that the key premise of the styles project is that truth is external to history: the truths discovered by reasoning in a certain way are independent of how we have found them. In other words, although only if we reason in a particular style can we attribute a truth-value to certain sentences, their being true or false has nothing to do with the fact that we reason in a particular style.

I want to highlight two of Hacking's central claims: (1) there are correct answers to live questions 'determined by how the world is', and (2) these correct answers are found when there are ways of addressing the question. Now, think of an answer expressed in terms of style-dependent sentences found by a community that adopts a certain style. The problem is that we might not be able to establish that this answer is correct until we find an atemporal and universal criterion to justify style-dependent sentences. If the ways of addressing the questions and the methods of verification are changeable, how could one ever know whether the answers provided by a certain style are to be trusted? Hacking's arguments can oppose only alethic relativism but are a blunt spear against *epistemic* relativism.



In his latest paper on styles, Hacking implicitly disagreed with those who drew relativistic implications from his styles project but he postponed his reply to another occasion: 'Relativism, or *reductio ad absurdum* of the styles project, take your pick. This is a sufficiently focused question to which the project can reply. For reasons of space, it will have to do that elsewhere' (Hacking 2012, 10).

My argument in the following sections will support the thesis that the styles project, as conceived by Hacking, does have relativistic implications despite his recent anti-relativistic remarks. This assessment of Hacking as not successfully avoiding epistemic relativism is important for the following philosophical reasons. First, the style project falls within the field of historical epistemology (Sciortino 2016). Consequently, the importance of the epistemic incommensurability issue arises from the fact that whether or not the styles project invites relativism can be considered a sub-problem of a wider issue hotly debated: is relativism a philosophical consequence of the historicisation of epistemology? The relationship between historicism and relativism represented a problem for discussion already a century ago (Kusch 2010, 168) and Ludwig Fleck, who introduced the notion of 'thought style' and enormously influenced Kuhn and Hacking, explicitly spoke of incommensurability of concepts and ideas (Fleck [1935] 1979, 100). The issue continues to be relevant today: in *Objectivity*, Daston and Galison (2007, 377) took care to remark that relativism has nothing to do with their account of objectivity. I interpret this *excusatio non petita* as the symptom of the general worry, among historical epistemologists, about the relativistic implications of the historicisation of scientific reason.

It is also this worry, and not only a mere attempt to distance himself from social constructionism, that forces Hacking to allay any suspicion of relativism in his more recent writings. More importantly, his *Representing and Intervening* (Hacking 1983b) makes it impossible to sidestep more abstract epistemological debates concerning the relativistic implications of the styles project. Indeed, in that book, where the notion of style is explicitly mentioned three times (Hacking 1983b, 56, 71, 127), he makes the *epistemic* claim that the best kind of evidence for the existence of a theoretical entity is that we can manipulate it in the laboratory. By making this claim Hacking raised the doubt that, if his characterisation of styles is correct, his justification strategy based on experimental realism would be no viable option for a member of a community that did not adopt the laboratory style. Indeed, in that case, one might argue that the existence of a theoretical entity would be justified for an advocate of the laboratory style and unjustified for someone, like Hobbes, who refused to think and *do* in that style. Ultimately, to ask whether or not the styles project has relativistic implications is crucial for assessing the internal coherence of Hacking's philosophy of science.

Recently, J. Adam Carter and Emma C. Gordon presented a strategy for what they claimed to be Hacking's line of argument for a 'radical denial of the possibility of objective epistemic reasons for belief' (Carter and Gordon 2014, 1683). In fact, they ignored the evolution of Hacking's thinking on styles over the last 30 years and took it for granted that he self-identified as a relativist. The most serious thing, however, is that for them 'differences in objectual understanding' (Carter and Gordon 2014, 1691) suffice to explain the epistemic incommensurability between different styles. By 'objectual understanding', they mean understanding achieved when informational items are pieced together. Essentially, for them, the epistemic incommensurability between the style of Paracelsus, *P*, and another style, *S*, can be explained by a difference in objectual

understanding: an advocate of *S* fails to appreciate how the propositions taken as true in *P* are interrelated and the reasons taken in *S* for believing a certain proposition cannot have force for her. By relying on these points, Carter and Gordon argue that the relativistic implications of the notion of style can be blocked.

Their diagnosis of epistemic incommensurability between styles is misconceived, as my analysis above shows. Differences in objectual understanding are not the reason for epistemic incommensurability. Hacking has been clear that they can be overcome: he remarked that, although the way Paracelsus proposed and defended propositions is alien to us, we can reconstruct Paracelsus's way of thinking and even talk as Paracelsus talked (Hacking 1982, 60). On the contrary, as I have explained in sections 3.1 and 3.2, the problem is that, even if we came to see the presuppositions of Paracelsus's style (its criteria of evidence, methods, questions, ways of thinking and doing, including the way these things were interrelated), they would not be *our* presuppositions. *Understanding would not be enough*. We would not be able to 'project' Paracelsus's style-dependent sentences into our styles of reasoning. We could not think, *act*, and justify our conjectures as Paracelsus did—*while preserving the presuppositions of our community*. The epistemic incommensurability issue amounts to the following doubt: are the presuppositions of a style that is alien to us right or wrong? Are there independent presuppositions to provide an answer to this question?

## 4. Meaning, Language Games, and Styles of Reasoning

### 4.1. Wittgenstein and Hacking on Meaning and Context

When in *Leviathan and the Air-pump* Shapin and Schaffer wrote that Boyle's 'experimental programme' was a 'language game' and a 'form of life' (Shapin and Schaffer [1985] 1989, 22), Hacking reacted thus: 'I am too cautious a reader of Wittgenstein to follow our two authors in using his words, but it is a valuable direction to contemplate' (Hacking 2009, 105). Although he did not want to leave room for relativistic implications of the styles project by using Wittgenstein's terminology, he seemed to suggest that to investigate the important similarities between the notion of style and the notion of form of life is a valuable direction to contemplate.

The early Wittgenstein regarded the meaning of a proposition as what must be the case in the world for the proposition to be true. In *PI*, Wittgenstein developed an alternative view in which it is our *use* of words, and not the relation between them and the objects of the world, which provides meaning to what we say. He stressed that language has to do not only with identifying and representing, but also with *activities* such as requesting (*PI* 2), naming colours (*PI* 48), and inferring the intentions of an interlocutor from given expressions (*PI* 632). Each of these activities is a language-game, that is, a 'language and the actions into which it is woven' (*PI* 7). Ultimately, 'the meaning of a word is its use in the language' (*PI* 43). If we 'look and see' (*PI* 66), we realise that there is nothing common to the different uses of the same word. It is for this reason that the philosopher ought to look at the different conditions governing the employment of a concept in different circumstances.

Hacking seems to follow these precepts when he considers that concepts are situated. For Hacking, a concept should be understood not by reflection on the human

understanding but ‘in terms of the words that we use to express the concept, and the contexts in which we *use* those words’ (Hacking 2002, 35). Hacking also describes his way of doing philosophy by echoing Wittgenstein’s ‘looking and seeing’ (Hacking 2002, 221): ‘nearly all my work has turned to real life, real knowledge, real expertise. I have come to call that *taking a look*’ (Hacking 2007, 36).

However, there is an important difference between Hacking and Wittgenstein. The former considers necessary to examine concepts in relation to contexts that are determined by *history*: the structure of concepts changes and develops *over time*. For example, for Hacking, the concept of objectivity has a history: as new styles emerge, novel forms of objectivity come about. Furthermore, styles represent different contexts that provide meaning to words and sentences—only within a style does a style-dependent sentence acquire meaning. On the other hand, Wittgenstein generally contrasts ordinary language with metaphysical language. His main worry is to prevent us from going astray in our arguments when we use a word in ordinary language, out of its context. For him concepts are situated because, to be properly understood, their philosophical context or, in general, their language-game, must be studied. A concept is a nonsense when it is outside any language-games that *we* use in everyday language. The language-games Wittgenstein considers are the language games that are *ours*, *present*, in use *today*. For Wittgenstein, even scientific language is simply a branch of the language we speak as human beings, whereas for Hacking, it is that particular language that receives meaning from the presuppositions of a set of different styles that have accumulated throughout history.

In conclusion, both Wittgenstein and Hacking urge philosophers to pay attention to the ‘contexts’ that give meaning to words and sentences. However, Wittgenstein’s emphasis is on those ‘contexts’ that are represented by the countless activities and practices of our everyday language; Hacking’s emphasis is on those contexts that result from *historical* contingences such as styles.

#### **4.2. Wittgenstein and Hacking on Meaning and Understanding**

As I have mentioned, in the early works of Wittgenstein, it is possible to find another conception of meaning, which he rejected later. He considered as a constitutive principle of meaning the memorable statement of logical positivism, ‘the meaning of a sentence is its method of verification’, which he discussed with Moritz Schlick in 1929. At that time, Wittgenstein’s conception of meaning pointed to something external to the proposition, which provided a truth-value to it. Later on, when he abandoned the representationalist view and defined the meaning of a word as its use in the language (*PI* 143), he rejected the view that the meaning of a word is ‘contained’ within a sign or mental accompaniment of it.

The two conceptions of meaning, ‘meaning as method of verification’, as conceived by the early Wittgenstein, and ‘meaning as use’, as conceived by the later Wittgenstein, coexist in the styles project. Ever since ‘Language, Truth, and Reason’, Hacking has often used Schlick’s motto to convey a central point of the styles project: ‘we assert that until there are methods of reasoning that bear on the truth or falsehood of a scientific statement, the question of its truth and falsehood does not arise’ (Hacking 2009, 21). The passage expresses the claim that certain (style-dependent) sentences acquire a

truth-value only when there is a style that makes them up for grabs as true or false. Consider Euclid's proposition cited above:

Any prism which has a triangular base is divided into three pyramids equal to one another which have triangular bases.

Hacking would say that this sentence became up for grabs as true or false when the pre-suppositions (methods of reasoning, criteria of evidence, etc.) of the postulational style came into play. Its meaning points to something external, although this 'something' is not a state of affairs in the real world, rather a state of affairs in the universe of discourse supplied by the lettered diagram. For someone who adopts the postulational style to *understand* Euclid's proposition, the situation can well be expressed by proposition 4.024 in the *Tractatus*: 'to understand a proposition means to know what is the case if it is true' (Wittgenstein [1921] 1974, 4.024). The representationalist view held by Wittgenstein in the *Tractatus* is more evident in Hacking's insistence that there exist purely observational sentences, which acquire their meanings from a correlation between words and states of affairs in the external world. In particular, for Hacking the truth of certain (style-independent), sentences can be assessed by relying on the evidence of our senses, which is basic and outside history (Hacking 1992b, 134).

The conception of meaning of a proposition as its use within a language-game is also present in the styles project. Consider the sentence in Euclid's *Elements* XIII, 4: 'Let there be a straight line, *AB*' (Netz 1999, 43). This sentence does not assert a relation between a symbol and an object. It asserts an action, which is the following: take for granted a certain line, then proceed to localise it in the diagram on the basis of the letters *A* and *B*. As Netz points out, 'the identity of "the *AB*" as a certain line in the diagram is assumed by Euclid, rather than asserted by him' (Netz 1999, 44). To paraphrase Wittgenstein, the action to be performed, that is, assuming that there is a certain line in the diagram and localising it so-and-so, is not 'forced upon us' by the sentence written. It is only by virtue of its *use* that Euclid's proposition receives its meaning—to think its sense means to think the written sentence *and* its 'normal response'.

In the light of Wittgenstein's observations, it is possible to re-read Hacking's point that certain sentences are style-dependent, that is, they have no truth-value for someone who adopts a different style. Consider the example of Euclid's sentence, 'let there be a straight line, *AB*': the 'normal response' necessary to give meaning to it is a pattern of use that emerged in ancient Greece, part of the way of doing of the postulational style. An imaginary Babylonian who had had to understand the meaning of that sentence would have been in the same position of that child who 'came into a strange country and did not understand the language', to echo Wittgenstein. Neither the signs that express the sentences nor pointing to someone who responds to the sentence in a certain way could have revealed the meaning of Euclid's proposition to a Babylonian. Like the imaginary child mentioned by Wittgenstein, the Babylonian would have had to possess a 'background capacity', be prepared to respond to Euclid's proposition as the ancient Greeks *standardly* responded when they assumed the existence of a certain line and looked for it in the lettered diagram, a Greek 'invention'. According to Hacking, Euclid's proposition would not have been a candidate for truth or falsehood for a Babylonian. Indeed, the latter would have needed to learn to *respond* to Euclid's proposition as an ancient Greek did. But to act and rely on the evidence of the postulational style would have meant, so to speak,

dropping out of her community. After all, returning to Wittgenstein, when a child learns the meaning of the words by *using* them as the members of her community do, she becomes a member of her community.

Ultimately, notwithstanding the differences in terminology, Hacking makes a point very similar to Wittgenstein's: for both of them, the meaning of a sentence is determined by a pattern of usage that has emerged over a long period of time. In the case of Wittgenstein, this pattern of usage is rooted on the 'background capacity' of a child; in the case of Hacking on the 'presuppositions' of a given style, that is its standards of evidence, methods of inquiry, and ways of reasoning and doing.

For my purposes, it is important to note once more that Wittgenstein discusses meaning in the context of language-games that inhabit our *everyday* language: in order to exemplify the case of someone that is 'outside a language-game', he gives *imaginary* examples, for example, that of a child who has to learn the language. On the other hand, Hacking discusses meaning in *historical* contexts that emerge at different points in time. In this sense, it is possible to say that Hacking brings history into Wittgenstein's picture of meaning. It is true that Wittgenstein seems to allow that criteria for concepts can change over time (e.g. 'When language-games change, then there is a change in concepts, and with the concepts the meaning of words change', *OC* 65; 'I distinguish between the movement of the waters on the river-bed and the shift of the bed itself', *OC* 97). Be that as it may, Hacking presents *concrete* and *historical* examples of different communities that do not share the same presuppositions.

Wittgenstein noted that 'what we are supplying are really remarks on the natural history of human beings' (*PI* 415). His remark 'concerns the importance of recognising the ways in which the language we speak is contingent on the circumstances of our lives' (Hertzberg 2011, 351). For Hacking, the styles project should be seen 'as part of "the natural history of human beings"' (Hacking 2009, 48): it is a study of the ways in which some of the sentences uttered by a community that adopts a given style, that is, the candidates for truth and falsehood of that style, are contingent on certain historical circumstances. Indeed, he conceived styles as ways of tapping cognitive and environmental resources which emerge at particular historical moments in certain parts of the world and are cultivated into ways of finding out (Hacking 2009).

## 5. Ungroundedness, Self-authentication, and Epistemic relativism

### 5.1. Forms of Life and Styles of Reasoning

The expression of form of life is mentioned for example in *PI* where Wittgenstein says that 'to imagine a language means to imagine a form of life' (*PI* 19). He means not that languages are shaped by cultures, but rather that *human* language, including the use we all associate to words, is associated with certain common features of human life. Indeed, as Hill (1997, 565) suggests, *PI* 19 can be compared to this passage:

One can imagine an animal angry, frightened, unhappy, happy, startled. But hopeful? And why not? ... Can only those hope who can talk? Only those who have mastered the use of a language. That is to say, the phenomena of hope are modes of this complicated form of life. (*PI* 174)

In this passage, Wittgenstein speaks of a form of life to which the phenomenon of hope is peculiar. Therefore, the expression refers not to a specific human culture but to all human beings, those beings who speak a language (and therefore can hope).

Another well-known passage helps to understand better what a form of life is:

‘So you are saying that human agreement decides what is true and what is false?’—It is what human beings *say* that is true and false; and they agree in the *language* they use. That is not agreement in opinions but in form of life. (PI 241)

Wittgenstein’s point is that there is a sort of ‘human agreement’ that allows the working of the language itself; within the framework of this ‘human agreement’ human beings express sentences that can be true or false. And what does ‘human agreement’ consist in? It is an agreement in form of life, an expression by which, as it will appear soon, Wittgenstein points to a common way of *acting*; to *human* reasoning procedures such as deduction and induction; to our taking for granted of certain propositions such as ‘The earth has existed since long before my birth’, ‘The earth is round’, or ‘Every human being has two parents’; and, in general, to what is part of our natural history such as walking, eating, drinking, and playing.

The relation hypothesised by Wittgenstein between a form of life and meaningful sentences is comparable to the relation between a style and its style-dependent sentences. Indeed, a form of life is the *sine qua non* of the existence of meaning, of a common ‘response’—and, all the more so, of any true-or-false sentence; similarly, a style is what makes sentences true-or-false, meaningful, and objective. Compare, for example, the following two passages:

[My picture of the world] is the inherited background against which I distinguish between true or false. (OC 94)

Propositions of the sort that necessarily require reasoning to be substantiated have a positivity, a being true-or-false, only in consequence of the styles of reasoning in which they occur. (Hacking 1982, 64)

Often, Wittgenstein refers to our form of life as a way of *acting* that is part of our nature. In OC 109, Wittgenstein asks whether an empirical proposition can be tested and continues:

What counts as its test?—But is this an adequate test? And if so, must it not be recognizable as such in logic?—As if giving grounds did not come to an end sometime. But the end is not an ungrounded presupposition: it is an ungrounded way of acting. (OC 110)

What we take for granted is closely related to a way of acting: giving justifications for the truth of a proposition comes to an end—and the end is a way of acting not a proposition. To understand the sense of this thought, one has to bear in mind that a way of acting is ascribable to a way of judging, as Wittgenstein himself says *en passant* about ‘our manner of judging and *therefore* of acting’ (OC 232, my italics). In other terms, the human system of beliefs, the human procedures of reasoning, what *we* consider as irrefutable evidence, determine our way of judging and therefore the way of acting in order to prove, argue, experiment, measure, etc. Therefore, the passage above expresses the idea that there is no further justification for the human way of judging, for example, our procedures of reasoning and our systems of evidence. Indeed, they determine our way of acting, which the passage defines as the end of our giving grounds.



In Hacking, the concept of ‘way of doing’ plays the same role: the styles project puts emphasis on the idea that a style is a way of thinking *and* a way of *doing* (Hacking 2012). For example, as I have explained in section 4.2, in the case of the postulational style thinking *and doing*, mental and visual resources, are a *necessary* element in assessing and proving propositions. We implicitly appeal to this way of acting, the ‘end of our giving grounds’, when we assess the truth of a sentence expressed in the postulational style.

## 5.2. Ungroundedness

In the case of style-dependent propositions, one can ask the same question posed by Wittgenstein regarding empirical propositions: does giving ground come to an end? The end is not a proposition—the end, according to Hacking, is represented by the presuppositions of the style itself, for example, the way of thinking and doing of that very style. Indeed, compare the following two passages:

There is no higher standard to which they [styles] directly answer. (Hacking 1992c, 13)

At the foundation of well-founded belief lies belief that is not founded. (OC 253)

From the former passage, there follows that there is no further justification outside the presuppositions (e.g. standards of evidence, ways of reasoning and doing) of the style in which a belief is held. In the light of the latter passage, the presuppositions of the styles represent, so to speak, the belief that lies at the foundation of all our beliefs in that style—and there is no foundation for the presuppositions.

Note that when Hacking says that we never call into question the presuppositions of a given style, he seems to echo Wittgenstein. Compare the following passages:

We do not check to see whether mathematical proof or laboratory investigation or statistical ‘studies’ are the right way to reason. (Hacking 1992c, 10)

We can’t just investigate everything, and for that reason we are forced to rest content with assumption. If we want the door to turn, the hinges must stay put. (OC 343)

Given the striking analogies between the notion of style and the notion of form of life that I have highlighted, styles can be viewed as concrete historical instances of Wittgenstein’s notion of form of life. Hacking discusses meaning within the perspective of different structures that emerge and evolve *over time*. In some sense, Wittgenstein’s form of life is prior to the notion of style in that all the styles themselves presuppose the existence of human language, and in particular style-independent propositions that can be assessed by virtue of a universal and atemporal evidence of senses. When styles emerge and evolve, they introduce new criteria of evidence and candidates for truth of falsehood leaving intact the basic structure of human language with its rules and languages games. For Hacking, these rules include a way of judging that relies on the evidence of senses.

Wittgenstein’s investigation reaches, in this sense, deeper levels: it is an investigation on what makes possible meaning at all. No wonder that, while Hacking simply assumes that empirical propositions are assessed by the evidence of senses, Wittgenstein asks what makes us certain of their truth. In the context of his argument against two papers of G. E. Moore, ‘A Defence of Common Sense’ and ‘Proof of an External World’ (Moore 1959), Wittgenstein argues that common-sense certainties (expressed by sentences such



as ‘Every human being has two parents’ or ‘The earth has existed since long before my birth’) cannot be treated as the most certain *knowledge*. Common-sense certainties are ungrounded propositions of our language-games. They are neither true nor false, neither justified nor unjustified, or neither empirical nor normative.

Common-sense certainties and the presuppositions of styles have the same epistemological status. The former lie at the bottom of all human languages games, are constitutive of our form of life, represent ‘the axis around which a body rotates’ (OC 152): if we did not believe in their truth, we could not assert that we know all we know. The presuppositions of a style stand exactly in the same relation with all is known by using that very style. In this respect, in doing philosophy Hacking has pursued similar aims as Wittgenstein in that he has identified the ungrounded presuppositions of the different ways of knowing. Compare the following two passages:

We don’t, for example, arrive at any of them [Moore’s propositions] as a result of investigations. (OC 137)

the propositions that are objectively found to be true are determined as true by styles of reasoning for which in principle there can be no external justification. (Hacking 1982, 65)

In Wittgenstein’s passage, it is said that our belief that common-sense certainties are true is not justified by an investigation. Similarly, in Hacking’s passage, it is said that the presuppositions of a style have no external justification.

To sum up, for Wittgenstein whether we consider the *human* way of acting or *our* procedures of reasoning or *our* common-sense certainties, which are all constitutive of *our* form of life, we have to conclude that they are ungrounded—in short, our form of life is ungrounded. The parallels I have drawn between Wittgenstein’s and Hacking’s claims have brought to the fore that styles are ungrounded too. In particular, whether we consider our ways of thinking or doing, or our systems of evidence, or our types of explanations, which emerge over history and are part of the presuppositions of our styles, they are all ungrounded.

### 5.3. Ungroundedness and Self-authentication

The comparisons I have drawn also shed light on the concept of self-authentication. Indeed, one can express this concept by saying: a style becomes a standard of objectivity *because* it gets at the truth and we believe that it gets at the truth *because* we rely on its presuppositions. Now we can say that the *circulus in probando* emerges from the fact that we cannot give any ground for the presuppositions of a style: they are neither justified nor unjustified. It is ungroundedness that lies at the root of the ‘phenomenon of self-authentication’, as the following parallels between Wittgenstein and Hacking show.

Consider for example the algorithmic style. As it is described by Hacking, it does not answer to any criteria except its own (see section 2): what has been found by using an algorithm is assessed by using another algorithm. For example, in ancient Egypt, the ‘method of false positions’, an algorithmic method used to solve linear algebraic equations, was checked by the means of proportions. Let us compare this chain of reasoning concerning the self-authentication of the algorithmic style with the following chain of reasoning that we find in OC. Wittgenstein says:

In certain circumstances, for example, we regard a calculation as sufficiently checked. What gives us a right to do so? Experience? May that not have deceived us? Somewhere we must be finished with justification, and then there remains the proposition that *this* is how we calculate. (OC 212)

In conclusion: ‘When does someone say, I know that  $\dots \times \dots = \dots$ ? When one has checked the calculation’ (OC 50). From the perspective of the styles project, this conclusion amounts to stating that the algorithmic style is self-authenticating. Indeed, to check  $\dots \times \dots = \dots$  by another (or the same) method of calculation is for Wittgenstein the only way to assess the truth of  $\dots \times \dots = \dots$ . Notice, however, this difference between Wittgenstein and Hacking: for the former we cannot think outside the algorithmic style and for this reason it does not require grounds; for the latter we can think in other different styles of which he has provided concrete examples. For instance, we can prove Pythagoras’s theorem in the postulational style, as Euclid did, or in the algorithmic way by rearrangement (a kind of demonstration well known before the emergence of the postulational style).

#### 5.4. Ungroundedness and Epistemic Relativism

Notice the use of the verb ‘know’ in the last passage above. Imagine a very ancient society who adopted a style different from, say, the algorithmic one. One *cannot* say that a member of that society was able to ‘know’ that  $\dots \times \dots = \dots$  in that the only way to assess the truth of  $\dots \times \dots = \dots$  is to use the algorithmic style itself, which was alien to her. In the case of Hacking, this circumstance leads to epistemic relativism:  $\dots \times \dots = \dots$  is justified within the algorithmic style and unjustified outside it.

Now, observe that the example of a hypothetical ancient society I have made is not so far from Wittgenstein’s mind. He considered a *hypothetical* situation in which someone does not want to rely on any method of calculation:

If someone supposed that *all* our calculations were uncertain and that we could rely on none of them (justifying himself by saying that mistakes are always possible) perhaps we would say he was crazy. But can we say he is in error? Does he not just react differently? We rely on calculations, he doesn’t; we are sure, he isn’t. (OC 217)

Wittgenstein is pointing to a situation in which a calculation would be justified for us and unjustified for someone else. However, we cannot conclude that Wittgenstein’s passage implies epistemic relativism since he is illustrating a *hypothetical* case for the argument’s sake. Conversely, Hacking does *not* give hypothetical examples—as a matter of fact the styles project posits the existence of societies that have not thought according to certain styles. Consequently, whereas for Wittgenstein ungroundedness just implies the possibility of *hypothetical* cases of epistemic relativism for Hacking it does imply *actual* cases of epistemic relativism.

Let me illustrate this point in more general terms. Wittgenstein wrote that ‘if a lion could talk we could not understand him’ (PI 223) meaning that human beings could not understand a talking lion because there would be no ‘agreement in judgements’ between the lion and us. Only through the connection with the form of the life of the individuals of its species could we learn to understand the lion. But since talking lions do not share our form of life, we cannot project ‘the lion’s sentences’. In other terms, the lion’s claims of knowledge would be justified in its form of life and unjustified in ours. Now,

just as for Wittgenstein agreement in judgements among human beings is constitutive of our form of life, so for Hacking agreement in a standard of evidence, way of thinking and doing is constitutive of a given style. So for similar reasons to those expressed by Wittgenstein by his example of the lion, a claim of knowledge made in a certain style could not be projected. Importantly, whereas the case of a talking lion is a mere fictitious example, the emergence of different styles is for Hacking a *real* historical event. Therefore, while for Wittgenstein the consequences of the groundlessness of our form of life concern hypothetical cases, for Hacking they imply that as a matter of fact a certain claim can be justified within a given style and unjustified outside it. Therefore, the style project entails epistemic relativism.

The conclusion is strengthened by a further consideration. Whether the later Wittgenstein should be considered an epistemic relativist has been a question fiercely debated. A recent article by Coliva (2010) is sufficiently representative of that line of argumentation that aims to show that Wittgenstein is not an epistemic relativist:

Wittgenstein was merely an anti-foundationalist: he believed that our world-picture is ungrounded and that it is not a mere reflection of a totally mind-independent reality. But anti-foundationalism is a long way short from relativism, let it be *factual*—the view according to which there actually are different incompatible epistemic systems that are all equally valid—or merely *virtual*—that is, equally valid, and incompatible epistemic systems, all in fact conceivable from our own standpoint. For simply to say that our world-picture is ungrounded does not entail either that there are actually different ones, or—more contentiously—that there could *intelligibly* be other ones, at least in principle. (Coliva 2010, 13)

However, whether or not Coliva is right in the case of Wittgenstein, her argument cannot be applied to Hacking's case. Indeed, as I have shown, both the elements, anti-foundationalism and the claim that there are different epistemic systems (i.e. styles of reasoning), are present in Hacking. A point that is evident in these two quotations:

it never occurred to me that all knowledge needed foundations. (Hacking 2007, 35)

[there are] manifold styles of scientific reasoning about which he [Wittgenstein] was silent. (Hacking 2002, 226)

In conclusion, nothing prevents us from stating that the styles project entails epistemic relativism.

## 6. Conclusions

No univocal answer has emerged so far from the discussions on whether or not Hacking's characterisation of styles entails epistemic relativism. For all his influence on Hacking, Wittgenstein's work has never been systematically and critically used to address this question. In this article, I have compared and contrasted Hacking's theses with Wittgenstein's later writings such as *Philosophical Investigations* and *On Certainty*. My comparative analysis helps to highlight the philosophical assumptions which underlie the styles project and to pinpoint the reasons that make it relativistic in nature: the justification of certain (style-dependent) sentences is relative to a given style.

The corollary of this conclusion is that Hacking does not really manage to distance himself from relativism. Indeed, he claims that, although the questions change over history, the correct answers are fixed, that is, the truths discovered by science are

independent of our styles of reasoning (section 3). The problem is that if the ways of addressing the questions and the methods of verification are changeable how could we ever know whether the answers provided by a certain style are to be trusted? We might not be able to establish that an answer is correct until we find an atemporal and universal criterion to justify style-dependent sentences.

To reach these conclusions the following steps were taken. First of all, I showed that Hacking's notion of style of reasoning and Wittgenstein's notion of form of life share fundamental features. In particular, they are both conditions for objectivity: for Hacking the sense of certain sentences, the way they point to truth or falsehood, hinges on their style of reasoning; for ok, a form of life is the *sine qua non* of the existence of meaning and, all the more so, of any true-or-false sentence. Second, I made it evident how both the notions of style and form of life entail anti-foundationalism: there is no higher standard to which they answer. In particular, for Hacking a style does not answer to anything external to it. Finally, I explained that when one asks whether anti-foundationalism entails epistemic relativism, the answer is different in the two cases. In the case of Wittgenstein whether anti-foundationalism entails relativism is in dispute because, as I argued in section 4, he does not discuss meaning in different *historical* contexts as Hacking does, that is, to use Coliva's words, he does not posit the *actual* existence of different epistemic systems. In the case of Hacking, nothing prevents us from stating that his anti-foundationalism leads to epistemic relativism: the justification of a certain sentence might be relative to one of the different epistemic systems of which he claims the *actual* existence.

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## References

- Baghramian, M. 2004. *Relativism*. New York: Routledge.
- Boyer, C. B. 1968. *A History of Mathematics*. New York: Wiley.
- Bueno, O. 2012. "Styles of Reasoning: A Pluralist View." *Studies in History and Philosophy of Science* 43: 657–665.
- Carter, J. A., and E. C. Gordon. 2014. "A New Maneuver Against the Epistemic Relativist." *Synthese* 191: 1683–1695.
- Coliva, A. 2010. "Was Wittgenstein an Epistemic Relativist?" *Philosophical Investigations* 33: 1–23.
- Crombie, A. C. 1981. "Philosophical Perspectives and Shifting Interpretations of Galileo." In *Theory Change, Ancient Axiomatics and Galileo's Methodology: Proceedings of the 1978 Pisa Conference on the History and Philosophy of Science*, edited by J. Hintikka, D. Gruender, and E. Agazzi, 271–286. Dordrecht: D. Reidel.
- Crombie, A. C. 1994. *Styles of Scientific Thinking in the European Tradition: The History of Argument and Explanation Especially in the Mathematical and Biomedical Sciences and Arts*. London: Duckworth.
- Daston, L., and P. Galison. 2007. *Objectivity*. New York: Zone Books.
- Fleck, L. [1935] 1979. *Genesis and Development of a Scientific Fact*. Translated by F. Bradley and T. J. Trenn. Chicago, IL: University of Chicago Press.
- Hacking, I. 1982. "Language, Truth and Reason." In *Rationality and Relativism*, edited by M. Hollis and S. Lukes, 48–66. Oxford: Blackwell.

- Hacking, I. 1983a. "The Accumulation of Styles of Reasoning." In *Kant ODER Hegel? Über Formen der Begründung in der Philosophie*, edited by D. Heinrich, 453–465. Stuttgart: Klen-Cotta.
- Hacking, I. 1983b. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.
- Hacking, I. 1988. "On the Stability of the Laboratory Sciences." *Journal of Philosophy* 85: 507–514.
- Hacking, I. 1991. "Artificial Phenomena." *British Journal for the History of Science* 24: 235–241.
- Hacking, I. 1992a. "The Self-vindication of the Laboratory Sciences." In *Science as Practice and Culture*, edited by A. Pickering, 29–64. Chicago, IL: University of Chicago Press.
- Hacking, I. 1992b. "Statistical Language, Statistical Truth and Statistical Reason: The Self-authentication of a Style of Scientific Reason." In *The Social Dimensions of Science*, edited by E. McMullin, 130–157. Notre Dame, IN: University of Notre Dame Press.
- Hacking, I. 1992c. "'Style' for Historians and Philosophers." *Studies in History and Philosophy of Science* 23: 1–20.
- Hacking, I. 1993. "Do Thought Experiments Have a Life of Their Own? Comments on James Brown, Nancy Nersessian and David Gooding." In *PSA 1992: Proceedings of the 1992 Biennial Meeting of the Philosophy of Science Association*, edited by D. Hull, M. Forbes, and K. Okruhlik, vol. 2, 302–308. East Lansing, MI: Philosophy of Science Association.
- Hacking, I. 2000. "How Inevitable Are the Results of Successful Science?" *Philosophy of Science* 67 (Proceedings): S58–S71.
- Hacking, I. 2002. *Historical Ontology*. Cambridge, MA: Harvard University Press.
- Hacking, I. 2002–2003. *Des styles de raisonnement scientifiques. Résumé du cours*. Paris: Collège de France. <http://www.college-de-france.fr/site/ian-hacking/course-2002-2003.htm>. Accessed 5 May 2016.
- Hacking, I. 2004. Critical Notice: Bernard Williams, *Truth and Truthfulness*. *Canadian Journal of Philosophy* 34: 137–148.
- Hacking, I. 2007. "On Not Being a Pragmatist: Eight Reasons and a Cause." In *New Pragmatists*, edited by C. Misak, 33–49. Oxford: Clarendon Press.
- Hacking, I. 2009. *Scientific Reason*. Taipei: National Taiwan University Press.
- Hacking, I. 2012. "'Language, Truth and Reason' 30 Years Later." *Studies in History and Philosophy of Science* 43: 599–609.
- Heath, T. L. 1908. *The Thirteen Books of Euclid's Elements*. Cambridge: Cambridge University Press.
- Hertzberg, L. 2011. "Very General Facts of Nature." In *The Oxford Handbook of Wittgenstein*, edited by O. Kuusela and M. McGinn, 351–374. Oxford: Oxford University Press.
- Hill, G. 1997. "Solidarity, Objectivity, and the Human Form of Life: Wittgenstein vs. Rorty." *Critical Review* 11: 555–577.
- Høyrup, J. 2005. "The Shaping of Deduction in Greek Mathematics: A Study in Cognitive History." *Studia Logica* 80: 143–147.
- Kusch, M. 2010. "Hacking's Historical Epistemology: A Critique of Styles of Reasoning." *Studies in History and Philosophy of Science* 41: 158–173.
- Lakoff, A. 2012. "Ian Hacking Interviewed by Andrew Lakoff." *Public Culture* 24: 217–232.
- Moore, G. E. 1959. *Philosophical Papers*. London: George Allen and Unwin.
- Netz, R. 1999. *The Shaping of Deduction in Greek Mathematics: A Study in Cognitive History*. Cambridge: Cambridge University Press.
- Netz, R. 2000. "The Origins of Mathematical Physics: New Light on an Old Question." *Physics Today* 53 (6): 32–37.
- Newton-Smith, W. H. 1982. "Relativism and the Possibility of Interpretation." In *Rationality and Relativism*, edited by M. Hollis and S. Lukes, 106–122. Oxford: Blackwell.
- Sciortino, L. 2016. "On Ian Hacking's Notion of Style of Reasoning." *Erkenntnis*. doi:10.1007/s10670-016-9815-9.
- Shapin, S., and S. Schaffer. [1985] 1989. *Leviathan and the Air-pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.
- Williams, B. 2002. *Truth and Truthfulness: An Essay in Genealogy*. Princeton, NJ: Princeton University Press.

Wittgenstein, L. [1921] 1974. *The Tractatus Logico-Philosophicus*. London: Routledge.

Wittgenstein, L. [1953] 1997. *Philosophical Investigations*, edited by G. E. M. Anscombe. 2nd ed. Oxford: Blackwell.

Wittgenstein, L. [1969] 1995. *On Certainty*, edited by G. E. M. Anscombe and G. H. von Wright. Oxford: Blackwell.