Science, Practice, and Justification: the A Priori Revisited

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Signature: ………………………………………………………………………
Abstract

History is descriptive. Epistemology is conceived as normative. It appears, then, that a historical approach to epistemology, like historical epistemology, might not be epistemically normative. In our context here, epistemology is not a systematic theory of knowledge, truth, or justification. In this thesis I approach epistemic justification through the vantage point of practice of science.

Practice is about reasoning. Reasoning, conceived as the human propensity to order perceptions, beliefs, memories, etc., in ways that permit us to have understanding, is not only about thinking. Reasoning has to do with our actions, too: In the ordering of reasoning we take into account the desires of ourselves and others. Reasoning has to do with tinkering with stuff, physical or abstract.

Practice is primarily about skills. Practices are not mere groping. They have a form. Performing according to a practice is an activity with a lot of plasticity. The skilled performer retains the form of the practice in many different situations.

Finally, practices are not static in time. Practices develop. People try new things, some of which may work out, others not. The technology involved in how to go about doing things in a particular practice changes, and the concepts concerning understanding what one is doing also may change. This is the point where history enters the picture.

In this thesis I explore the interactions between history, reasoning, and skills from the viewpoint of a particular type of epistemic justification: a priori justification. An a priori justified proposition is a proposition which is evident independent of experience. Such propositions are self-evident.
We will make sense of a priori justification in a context of regarding science as practice, so that we will be able to demonstrate that the latter accommodates the normative character of science.
Table of Contents

Introduction: Science as Practice......page 9

1. From Historical Epistemology to Practice: the Question of Normativity......page 33
   1.1 The starting point is normativity......page 33
   1.2 Three historical epistemologies......page 35
      1.2.1 Jurgen Renn’s historical epistemology......page 35
      1.2.2 Lorraine Daston’s historical epistemology......page 36
      1.2.3 The third historical epistemology is Rheinberger’s......page 40
   1.3 Rheinberger’s historical epistemology......page 40
      1.3.1 Experimental systems and epistemic things......page 40
      1.3.2 Epistemic things emerge unexpectedly in experimental systems, reorienting the latter......page 44
   1.4 The experiment in the history and philosophy of science......page 46
   1.5 Epistemology, historicized......page 52
   1.6 Towards embodiment......page 63

2. What is a priori justification? ......page 65
   2.1 The outline of the present chapter......page 65
   2.2 Concepts related to justification......page 66
      2.2.1 Knowledge and justification......page 66
      2.2.2 Belief, judgement, reasons......page 68
      2.2.3 Propositions......page 71
   2.3 A priori......page 72
      2.3.1 A priori justification and knowledge......page 72
2.3.2 Kantian origins......page 73

2.3.3 Contemporary apriority......page 76

2.4 Realisms and anti-realisms......page 80

2.4.1 Scientific realism and its contrasts......page 80

2.4.2 Truth......page 81

2.5 Transcendental arguments......page 85

2.5.1 Kant revisited......page 85

2.5.2 The scope of transcendental arguments......page 93

2.6 Verificationism......page 95

2.7 Summary......page 98

3. A Priori Justification in the Philosophy of Hans Reichenbach......page 100

3.1 Context of discovery and context of justification......page 100

3.1.1 One single science......page 101

3.2 Scientific philosophy......page 104

3.3 Some logical empiricist meta-epistemology......page 105

3.4 Genius in Reichenbach's philosophy......page 113

3.5 Reichenbach's neo-Kantianism......page 119

3.6 Nature gives the rule to science......page 127

3.7 Further remarks......page 136

3.8 Conclusion......page 143

4. From Skill to Apriority......page 146

4.1 Talking about slime moulds......page 146

4.2 The Dreyfus and Dreyfus model of skill acquisition......page 150

4.3 Maurice Merleau-Ponty’s A Priori......page 164

4.4 Final concerns......page 174
5. Knowledge of the Existence of Scientific Unobservable Entities is A Priori Justified……page 176

5.1 A different kind of realism……page 176

5.1.1 The position of entity realism in the realist-anti-realist spectrum……page 179

5.2 The styles of reasoning……page 180

5.2.1 The styles of reasoning in the history of science……page 180

5.2.2 Discourse and reality……page 184

5.2.3 Propositions according to a style of reasoning are compelling……page 197

5.2.4 Positivity……page 198

5.2.5 Additional characteristics of the styles of reasoning……page 199

5.3 Truth and truthfulness……page 216

5.4 Reference……page 220

5.5 Experiment……page 233

5.6 Material interaction……page 237

5.7 A transcendental argument for entity realism……page 238

5.8 Reasoning with style……page 251

6. Can Hacking’s A Priori Justification Survive Scepticism? ......page 253

6.1 “On the very idea of a style of reasoning” ......page 253

6.2 Scepticism about the styles of reasoning......page 254

6.3 Enter the subject, or the personal point of view......page 260

6.4 Skills have the traits of the styles of reasoning......page 266

6.5 A transcendental argument for self-authentication......page 292
6.5.1 Aristotelian ethics......page 292
6.5.2 Objections considered......page 299
6.5.3 Self-authentication is a necessary trait of the styles of reasoning......page 304

Concluding thoughts: A definition of practice......page 314

Appendix: Edgar Zilsel and the cult of genius......page 316

Bibliography......page 322
Introduction: Science as Practice

Do historical narratives of science logically necessitate dispensing of epistemic justification? The answer is negative. This thesis is an account of how we arrive at this particular answer. The point of departure is history plus epistemology; I am talking about history-based theoretical accounts of the production of scientific knowledge. Notice that I have not spoken about ‘historical accounts’: the theoretical accounts of science to which I refer transcend the field of history. Hans-Jörg Rheinberger has argued in favour of such an account, which bears the name historical epistemology. Rheinberger’s historical epistemology belongs thematically among a wide interdisciplinary field which studies science as practice.

The “practical turn” (Rheinberger 2010, 87), or “practice turn” (Schatzki 2001, 10) is a contemporary development in the humanities which cannot be easily tagged. In disciplines as diverse as philosophy, cultural theory, history, sociology, anthropology, and science and technology studies we frequently meet “practice” as a new and potent addition to the jargon (Schatzki 2001, 10).

Practice is a potent notion because of its conceived promise for bolstering our theoretical understanding of how we operate in the world. Practices can be adequately described as purposeful operations of agents in their quotidian settings. Practices do not always conform to preconceived conceptual schemata. To investigate what a practice is we have to go local; the situatedness of practices informs our research.

Going local does not preclude the practice theorist’s thinking reaching the loftier levels of philosophical abstraction (Schatzki 2001, 12-13). As we will see in detail, Rheinberger is a practice approach adherent who weaves his historical
research together with epistemological considerations. The thesis you are now reading is replete with epistemological considerations, too. The vantage point of Rheinberger within the practice approach is the history of biology. My vantage point is wider; it is the epistemic normativity in science. The converging point between Rheinberger and me (and many other practice theorists who study science) is the conviction that science is best conceptualized as an activity rather than exclusively as propositional mental content. The safe indicators of the practice theorist of science is her conception of science as activity as opposed to a pictorial-like representation of the world in the form of scientific theories or and the reconsideration of the age-old intuition that nonhuman entities (objects) are not agents (Schatzki 2010, 10, 12), i.e. they are thought of as being passive in terms of affecting our doing and thinking.

But a practice theorist need not be interested predominantly (or at all) in science. “Practice theorist” can be a nebulous term when applied to sketch an affiliation: the diversity of the disciplines where the concept is manifested results in there being substantial entrenchment in the meaning, application and significance of “practice” (Schatzki 2001, 10-11). So, the editors of The Practice Approach in Contemporary Theory (2001), the first collection of articles on the practice approach, have had to “bring together philosophers, sociologists and scholars of science to explore the significance of practices in human life” (Schatzki, Knorr-Cetina, von Savigny 2001, i). Practice theorists have contributed, and continue to do so, to discussions about knowledge, meaning, normativity, human activity and action (action in the lexical, not necessarily 'practical', sense), science, power, social institutions and historical transformation. However diverse their interests and disciplinary affiliations might be, the practice theorists seem to have some points in common; in their
writings most put emphasis on embodied performances (Schatzki 2001, 12), or, even more generically than the word ‘performance’ allows, on “arrays of activity” (Schatzki 2001, 11). Analyses of activity among the practice theorists vary (Schatzki 2001, 11), but the notion of engagement which accompanies the label ‘activity’ allows us to envisage it as a distinct conceptual area made up of various conceptions, which overlap despite their diverse origins.

The landscape on which the overlapping takes place is what Schatzki (2001, 11) calls the field of practices. The definition of the field of practices is that it is "the total nexus of interconnected human practices" (Schatzki 2001, 11). The specialists in the various disciplines in the humanities, for whom the notion “practice” has come to signify the “primary generic social thing” (Schatzki 2001, 10), can be considered to form a theoretical movement the interests of which revolve around the field of practices after the two following ways: The movement's affiliates defend accounts of practice with respect to the broader field of practices or they develop accounts of practice in a smaller portion of the field, like science; or, the members view the field of practices as the place to posit their research questions and/or the locus of the transformations of their subject matter (Schatzki 2001, 11). Through Schatzki's demarcation the concept of "practice" emerges as shorthand for the field of practices envisaged as a set of conceptually related patches. Each patch is a topography of the whole; topographies are surveys of small areas.

Ian Hacking has offered a conception of reason in loose compartments, which affect one another. Hacking's conception belongs to the topographies I have mentioned. The name by which this conception of compartmentalized reason is known is “styles of scientific thinking and doing in the European tradition”
This long label has superseded the older one, “styles of reasoning” (Hacking 2012, 601). It is by the older name that Hacking’s conception of reason in science is better known. Each ‘compartment’ of reason has its own history, even though scientists employ, more often than not, more than a single style during the course of their research. As we may surmise from the longer name of the styles, they are not just ways of thinking about scientific problems, but also about doing something to attack these very problems (Hacking 2002a).

The areas, which the topographies represent, are connected with one another via at least one conceptual bridge, namely regarding practices as arrays of embodied activity.

The embodied character of the arrays of activity shapes the forms of these activities (Schatzki 2001, 11). Consequently, it defines the way activities are conceptualized in the practice approach: embodiment, along with the shared understanding which accompanies practices and an emphasis to the potential of physical entities in the world to mediate activity (Schatzki 2001, 11-12), shape the core, the land per se in my landscape metaphor, of the field of practices. The understanding of the field of practices, therefore, is one where the notion of materiality occupies a central position. The material part of us, our flesh, must be taken into account together with our minds in accounts of meaning, reasoning and action. The content of the notion of embodiment is precisely a rejection of the understanding of the mind as a separate substance (Schatzki 2001, 16). Intending demeanour to mean comportment more than deportment, our demeanour is a function of our bodies, it is also materially mediated by physical objects, and, finally, it is shaped by the shared character
of practices. Demeanour is, at the same time, one of the raw materials for the reshaping of the practices' very same shared character (Schatzki 2001, 11-12).

We can see now that the exploration-like character of the practice approach, viz. its focus on understanding the local, welcoming the contingency and complexity this entails, is a necessity originating in materiality conceived as the triptych embodiment-natural world-social interactions.

Concerning the materiality of the natural world, the practice approach "joins a variety of 'materialist' approaches in highlighting how bundled activities interweave with ordered constellations of nonhuman entities" (Schatzki 2001, 12). As we will see in section 1.4.3, among Rheinberger's motivations why we should pursue historical epistemology is that it helps us apprehend how scientific entities largely compel our understanding of their own properties, in conjunction with the apparatus used to investigate the said properties and the (mainly disciplinary) conceptual background of the people involved in the relevant series of experiments. Some practice theorists argue that the nonhuman entities do not only force us to understand them in certain ways in virtue of their disclosed properties, provided we possess the concepts permitting us to approach these entities -however crudely. They take the nonhuman entities to be agents, along with humans, in that they too partake in activities (Schatzki 11, 12). As Schatzki puts it, they take practices to "comprise human and nonhuman activities" (2001, 12). This strand of practice theorists is called the 'posthumanist' strand¹ (Schatzki 2001, 11). I do not take the

¹For a view arguing for the involvement of nonhuman interrelations in the nexus of practices see (Pickering 1995, 6-9). Bruno Latour points out that in analyses of the social, objects "tend to recede into the background very fast" (Latour 2005, 80). This is a situation Latour believes should be rectified; the agency of objects should be taken into account (Latour 2005, Part I, ch. 4, 63-86). The
posthumanist path, although I am concerned with the objectual materiality’s epistemic implications since I grant that objects influence the ways we make sense of them and the ways we interact with them. From this point on when I speak of materiality I will refer only to the ability of material things to compel us to understand them in certain ways rather than others. The materiality of objects is distinct from the materiality of people’s minds (embodiment), although, strictly speaking, both ‘materialities’ are involved in doing and understanding.

In terms of philosophy, a common denominator of the theorists of the practice approach is their anti-Cartesianism (Schatzki 2001, 16). The anti-Cartesianism is about mental content: the prevailing attitudes informing most contemporary academic dialogue on mental states presuppose the Cartesian assumption that these mental states are philosophically tangible in the sense that they inhabit in a realm of their own, distinct from the empirical world (Schatzki 2001, 16). The philosophy of Hubert Dreyfus is anti-Cartesianist in the sense just described (Dreyfus 2005).

Dreyfus’s philosophy, a phenomenological approach to the mind (Dreyfus 2005, 49-50), offers some major premises for my argument in chapter 6, where I show that Hacking’s conception of a compartmentalized reason at play can withstand scepticism.

Another common point in the variance in points of departure and methodology of the various practice approaches, which is of special interest to philosophy, is the central role of skills in the practice-based approaches (Schatzki 2001, 17-18). Skills concern the psychological aspect of embodiment (Schatzki 2001, 16).

reason I do not bring Latour and Pickering in the discussion is that I do not wish to take a stance on the adequacy of the sociological explanations which by-pass the “agency” (Latour 2005, 63) of objects.
‘Psychology’, as I use the word here, is the philosophical task of analyzing the workings of the human psyche with its feelings, its cognitions, its intentions, its desires, and its ability to judge. With my landscape metaphor of the field of practices I intended to stress the bifurcation in the vantage points of practice theorists: Schatzki’s description of practices can be read to include a rough disciplinary preference for how we are to understand practices, how to best analyze them, and what practices entail concerning the degree to which our comportment—and the practice-related activities, to which we happily engage in knowing no other way but the one rooted in our comportment—is the outcome of projections of our subjectivity. Speaking in broad terms, there is a ‘philosophical’ way to ponder over the field of practices and a ‘sociological’ one. The philosophical way is to focus on the relations between mind and activity and the sociological is to look into the interdependence of individual activity and social manifold (Schatzki 2001, 17).

The two vantage points, the philosophical and the sociological one, overlap by virtue of the notion of embodiment (Schatzki 2001, 17): it is the body as the seat of skilful practical understanding which raises the question if shared skills are adequate to explain arrays of activity (Schatzki 2001, 17). Even though embodiment is the bridge between the philosophical and the sociological points of departure, the disciplinary rapprochement (interdisciplinarity) brought about by the field of practices reveals issues about whether, after which fashion, and to what extent skills must be supplemented by “perception, propositional knowledge, reasons, and goals” (Schatzki 2001, 17); but that is only an issue within sociology. In philosophy—I follow Dreyfus here—we should regard our mental content, like reasons and propositional knowledge, and our perception as necessary ingredients of a skilful performance.
The distinction between philosophical and sociological points of departure is not meant to represent anything more significant than a priority of research interests. For instance, Barry Barnes (2001) and Stephen Turner (1994, 2001) do not eschew the philosophy required to argue their respective positions and its consequences for social theory: Turner (2001) argues that the shared character of practices is an oversimplification. Using accounts of learning grammar, he highlights that practices have a learned component which obliges us, he thinks, to take into our accounts of practices the various purposes and the personal histories of the people performing these practices competently. Barnes (2001) argues that Turner’s arguments have the merit of providing him with the opportunity to point out that practices are indeed the product of continual adjustment between individuals, but they are better regarded as collective accomplishments, sustained by the continuous adjustment. Such accomplishments are not reducible to individuals. This is an example of a debate about the nature of practices in the confines of social theory, but the exact content of the ‘shared’ character of practices is of philosophical interest, too. In the next few paragraphs I explain that a good candidate for what we are to understand to be the ‘shared’ among people engaging in a scientific practice is Hacking’s styles of reasoning. One of the goals of my thesis is to substantiate the claim about the styles of reasoning being the shared element in scientific practice. I will proceed by demonstrating that the notion of the styles of reasoning explains normativity in scientific practices.

The example of the disagreement between Barnes and Turner is useful in that we can now clearly see that there are clear disciplinary orientations in the practice approach; despite the fact that its manifestation does not necessarily affect the studies of the landscape of the field of practices conducted from the
vantage point of other disciplines, it is because of intra-disciplinary discussions like this that the practice approach appears nebulous; but this is one of the approach’s strong points, too. To better illustrate, to my mind, which has not been trained to follow every detail of what is interdisciplinarily at stake with certain sociological concepts and social theory, it seems that both Turner and Barnes have a point: It would be rather misleading to attribute the pervasiveness, the propagation and the dissemination of practices to some ‘shared’ components of them disregarding the contingencies of personal history and the purposes of individuals; at the same time, I concur with Barnes on practices having a collective character and on our not being able to reduce them to individual behaviour.

My intuitive stance is that the subject who engages in purposeful arrays of activities is in dialectic interactions with the natural world and her social environment. Concerning the natural world, we may conceive the dialectic interactions in terms of causality. With the social environment things are more complex; nature may not be kind, certain actions or omissions can lead to death or disease, but nature does not punish. Nature also does not provide readily our interpretations of it. The point where nature and society converge is the embodied subject, who has to live her life in their midst. *Being-in-the-world* entails interacting with objects, with other people and animals, and with concepts in a fashion largely prescribed by one’s physical body and the culture which has assisted us on how to utilize our body’s potentialities.

Using the discussion over the issue of the shared character of practices, I reason in the following way: If we remember Schatzki’s demarcation of the field of practices as either the development of accounts of practices or the study of a
discipline’s usual subject matter under the light of practices (Schatzki 2001, 11) we will see that the best way to characterize the present state in practice theory is that there are either bottom-up approaches, meaning that the goal is to arrive at a description or theory of the nature of practice, or top-down approaches, by which I mean that a notion of practice informs a scholar’s understanding of her subject matter. Is there any way to arrive at a description of practices usable in principle by most disciplinary directions involved in the practice approach?

I believe that it is possible to arrive at an account of practices useable by everyone if we begin with a philosophical (read ‘generalist’ among the chosen adjective’s connotations) account of practices. This belief of mine does not imply that it is possible to achieve a unique definition of practice or that the practice approach should be unified, ceasing to be pluralistic. I think that philosophy can provide the tools we need to evaluate the import of discussions like the disagreement of Barnes and Turner over how to conceive the ‘shared element of practices’ for the entire landscape of the field of practices: in particular, I wish to emphasize one of the strong points of the practice approach, regarding the best research on practices to be local, to be research on the micro-scale. Sociological studies can be very local in scope, but historical studies can be very local, too. The main advantage of historical analyses over sociological ones in the setting I am discussing is the contextuality of the actors (human and nonhuman) within events rather than their sociality. So, I am inclined to read Schatzki’s assertion that practices are the primary social thing to mean that practices are the fundamental web on which contingent events and states of affairs end up shaping familiar contexts.

In virtue of the contingency in their make-up, these contexts are best
approached via their historicality, viz. the study of their origins (when possible) and their development through historical reconstructions.

My reasoning follows Dreyfus’s argument, who “shows that [the] subject/object epistemology [we are accustomed to after Descartes] presupposes a background of everyday practice into which we are socialized but that we do not represent in our minds” (Dreyfus 1991, 3). Continuing to follow Dreyfus, the shared element of practices-at-large (background and other practices, like bicycle riding or scientific practices) might be so basic, that it is impossible to approach theoretically (Dreyfus 1991, 273); the consequence of the elusive character of the workings on the “ground floor” (Dreyfus 2005, 61) of human perception leads us to rest our case about some of the less elusive inhabitants of the upper floors. Those upper-floor inhabitants are called propositions, namely assertions we can express just fine using words. But with the presupposition of the elusive character of the “ground floor” workings of the mind, we are obliged to restrict our analyses in admitting that certain assertoric utterances must be regarded to be known in virtue of being self-evident, their self-evidence founded in being a material human being in a world of material objects and of manifestations of other material living beings. Philosophers would say that these propositions are known a priori. In Dreyfus’s phenomenology the a priori is neither the starting point nor the horizon of investigation: our inquiry on intelligibility “cannot start from what is self-evident as Descartes did, so it cannot arrive at what is self-evident” (Dreyfus 1991, 38). If we are looking for foundations we must turn to practices. Dreyfus’s (1991, 38) assertion does not imply that there are no self-evident beliefs, but it implies that such beliefs acquire their self-evidence (and their normative character) only in a web of practices. There are no absolute grounds (Dreyfus 1991, 155): practices
are the grounds for our thinking and doing but “not only is human being
interpretation all the way down, so that our practices can never be grounded in
human nature, God’s will, or the structure of rationality, but this condition is one
of such radical rootlessness that everyone feels fundamentally unsettled
(unheimlich), that is, senses that human beings can never be at home in the
world” (Dreyfus 1991, 37, original emphasis). It is in this setting of radical
rootlessness in which I wish, nevertheless, to make sense of apriority and
normativity.

At this point I will narrow the talk on practices from practices-at-large to
scientific practices for no other reason than that ‘scientific practice’
encapsulates the whole cognitive spectrum of practices from the often
inexpressible know-how that is skill to the explicit and intersubjective justified-
true-belief. Speaking of a spectrum does not entail that spectrum’s being a
continuum: scientific practices are distinct from everyday practices, although our
everyday practices are so fundamental we still revert to them when the scientific
practices we acquired by training are breaking down in normal laboratory coping
(Dreyfus 2001, 166, 167; see also Dreyfus 1991, 251-255, 279). We are already
forced to go local by the very nature of the practice approach.

The historicality of practices has been emphatically put forward by historical
epistemology. If practices in science are conceived as historically variable
according to Rheinberger’s historical epistemology with its avowed affiliation to
Hacking’s primacy of scientific doing then we arrive a notion of the ‘shared’
which satisfies my intuition that both Barnes and Turner seem to have a point:
the shared element of scientific practices is the styles of scientific thinking and
doing which influence and govern these practices; as we will see in chapters 5
and 6, the styles are reason itself. Of course, the previous discussion is not meant to settle the differences between Barnes and Turner, it is only intended to illustrate my own position within the practice approach; the said position is a Dreyfusian one.

What are practices according to Dreyfus? So far we have had the opportunity to see that Dreyfus regards practices as primary, in line with every other practice theorist, and that in his philosophy there are strata of distinct practices, from the most fundamental, responsible for our routine comportment in everyday living, to the highly intellectualized, like scientific practices which are our way to acquire knowledge of the empirical world. The difference between the scientific and the fundamental practices is that the former are conceptual and can be put into words: they are explicit. The latter are “background” (Dreyfus 1991, 75) practices and it is these that are shared among human beings (Dreyfus 1991, 75). Practices-at-large (background or scientific or otherwise) are skilful coping (Dreyfus 1991, 67). What they have in common is that when we can no longer rely on the routine coping supplied by our skills, we deliberate; the deliberation always happens against the background of the world, at which point we have no other means to cope but our background skills (Dreyfus 1991, 74-75; Dreyfus 2001, 166). Understanding is not in theoretically analyzable mental content (concepts, ideas or, more generally, ‘pictorial’ representations in the mind), but in dealing or attempting to deal with situations in the world (skilful coping) (Dreyfus 1991, 75). Practices as skills permeate human thinking and doing through-and-through. If this sounds counter-intuitive, I must add that the skills which support our understanding are often not chosen by us, we are socialized into them. Much of our comportment (dealing with situations in the world) is based on tacit understandings which we have not chosen to subscribe to: “for
example, one behaves like an older brother or a mama’s girl without having chosen these self-interpretations” (Dreyfus 1991, 96). The not-chosen skills which make up our comportment are constitutive for the identification of our environs (Dreyfus 2001, 166). These fundamental background practices are our last resort when we come face to face with the unknown or the incomprehensible; in the setting of our efforts to understand the strange, they become access (Dreyfus 2001, 166) practices, with a contingent character (Dreyfus 2001, 167). Of course, we often choose which skills to cultivate. For instance, becoming a scientist is a deliberate choice, usually based on explicit grounds. Needless to add, Dreyfus’s use of the epithet contingent to describe practices in access situations draws our attention to the fiduciary nature of practices, background or explicit, and the importance of the cultural setting in which skills are developed and exercised.

It is now apparent that the practice approach has a holistic character in the sense that the conceptual, the human (biological and psychological) and the social are intertwined in complex dances of facts, beliefs, duties, communities, events, discussion and culture: the outcome is profound for explanations about parts of the social as well as for philosophical theorizing. Practices are always understood dynamically, thus bringing firmly in their surroundings a historical dimension.

Up to this point, I have used the issue of disagreement on the precise meaning of the notion of the ‘shared’ in practices to provide an illustration of my own viewpoint in the practice approach. The notion ‘shared’ serves as a beautiful introduction to the questions surrounding embodiment: embodiment has been
our point of departure to start seeing practices as skills. Practices as skills have led us to reasoning and epistemology (apriority) and to historicity.

In the history and philosophy of science the historical dimension of the practice approach is represented by historical epistemology. Before we become acquainted with historical epistemology, I must comment on my notion of normativity, in order to make explicit the link between it and the practice approach. Normativity is associated with responsibility, a sense of duty, and with rules. Following in the steps of Dreyfus’s philosophy I think that normativity is rooted in practices. Normativity is often related to objectivity in virtue of its compelling character; the normative can be conceived as a judgement or belief to which unrelated people can arrive at, each on her own. Objectivity is a problematic notion; the objective is something that Aristotle, a Japanese young woman who will be born in 2078, and we in the present, can all agree upon without reservations, exceptions, or footnotes. To see clearly why this is problematic we need not stray any further away than to revisit Dreyfus’s primacy of skills: if our understanding of the world is rooted in our socialization, then people raised in different cultures will understand the same thing in different ways. These ways of understanding can be radically different, and, as a consequence, totally incompatible with each other. However, it is conceivable that both understandings are justifiable within the stance in which each originated. Moreover, let us imagine that the justification can be communicated in satisfactory detail to a bearer of the other stance, and that she can discern that her interlocutor has reasoned soundly and that the cause of the disagreement is their different perspectives, rooted in their respective personal histories. In such a case, claiming to possess the objective ground is useless for either party in the dialogue, assuming they have no interests at stake. On
occasions like that, what is desirable to find is some common ground. The common ground is the realm of intersubjectivity, and it is the most we can aspire to locate in our philosophical search for widespread grounds. With this background, we can discern that normativity is embedded in practices (in Dreyfusian practices at least). The participle I have used, ‘embedded’, leaves open the option that there is some theory of the mind which necessarily presupposes normativity or explains it (Dreyfus 119, 5), and this theory is what is shared among people; but that is not my intention. This option is not available in Dreyfus’s schema of things (Dreyfus 1991, 6, 85-86), and I follow him in this: Normativity is important and pervasive, but it is not the basic ‘shared’ notion we are after. Practices are not based on tacit rules, they create tacit rules. Dreyfus is critical of the thinking according to which “insofar as background practices contain knowledge they must be based on implicit beliefs; insofar as they are skills, they must be generated by tacit rules” (Dreyfus 1991, 5), because “if we start [our philosophizing] with... tacit or prereflective mental states, we shall distort the phenomenon of everyday coping and be led back to the old epistemological problems” (Dreyfus 1991, 54).

To sum up, when we think of the practice approach the concepts that should come to our mind are activity, embodied understanding and historicality. The historical emergence of our practices takes place in a material world through the activities of beings (I mean human beings) whose access to the world is material, through our bodies.

Now let us move on to an overview of the contents of each chapter.

In the first chapter I introduce the question “what is the meaning of the concept ‘practice’ in historical epistemology”? To do so I begin from the notion of
normativity. Allow me to expand a little further on the epistemological connotations of normativity: Normativity is taken to be an attribute of knowledge. What is the normative? The normative is contrasted to the descriptive. When I say that knowledge is normative, I refer to the characteristic of knowledge to be compelling. The study of knowledge is called epistemology. Epistemology can be about theories of justification, truth, etc. or it can be about the study of the production of knowledge. I label the first kind of epistemology ‘general epistemology’. Following the direction of Rheinberger and Hacking the epistemology in this thesis is of the second variety. Rheinberger’s historical epistemology is an approach in the history and philosophy of science which emphasizes the scientific doing, not only the thinking, in its attempt to understand the acquisition of knowledge \textit{par excellence}, scientific knowledge. Its preferred method is the reconstruction of the actual occurrences of scientific knowledge acquisition. Historical epistemology, as I have mentioned before introducing the practice approach, is one of the theoretical approaches of science focusing on practice. We have seen that the examination of practice is centred on activity. Activities are performed by agents; during some activities, people interact with material objects in ways that the objects afford. I read epistemology to entail that the activities by which the scientists produce knowledge are normative in character. History provides descriptions. Therefore, when we speak of historical epistemology, we have an apparent tension at hand.

The second chapter clarifies epistemic concepts which are useful in my attempt to provide an account of practice. The elaboration is done from the standpoint of general epistemology. It is a summary of contemporary views on a priori justification and knowledge, propositions and meaning, belief, judgement and
reasons. The central concept of justification is narrowed down to a priori justification. An a priori justified proposition, following Immanuel Kant, is known independent of experience. An a priori justified proposition is self-evident. The contemporary consensus on a priori justification is faithful to Kant’s definition of it, with the qualification that an a priori justified proposition can be false or defeated by more evidence. A priori justified beliefs (which are types of propositions) can be shown not to be justified, after all. The second chapter begins with the classic definition of knowledge as justified true belief (or justified true judgement). Justification is the part that explains knowledge’s compelling character. Beliefs (and judgements) are propositional mental attitudes. Propositions are assertions; they are units of meaning represented by grammatical sentences. Regarding truth, I introduce it here as a preamble to Hacking’s semantic conception of truth (Tarskian conception of truth), a primitive version of which he (in my opinion correctly) reads in Kant and especially Aristotle. A semantic conception of truth is important for my goal, since it allows meanings to change in the course of time. Another consequence is that in everyday usage of words among contemporaries, a semantic theory of truth allows us to overcome the problem of reference: this is one of the thorny points (from a philosophical standpoint) for Rheinberger’s historical epistemology. Finally, in the second chapter I introduce aprioristic thinking. It involves propositions which are self-justified in virtue of their meaning, or by means of reason alone. Experience however, is not excluded from aprioristic reasoning since it provides us with many concepts which we can use in thinking independent of experience at some later moment. One of the ways we employ aprioristic thinking is when using transcendental arguments. This type of argument is deductive; it is used against scepticism and serves to show that our
mental contents are in harmony with the external world. General epistemology is normative.

Moving on to chapter 3, one of Rheinberger’s claims is that with practice epistemologies we can overcome the context of discovery/context of justification distinction, introduced by Hans Reichenbach. Reichenbach’s distinction has made the concept of justification loaded with connotations that we should leave behind. The main purpose of this chapter is to distinguish Reichenbach’s context of justification from the normative concept of epistemic justification I have been using in order to approach practice. Since justification is normative, its connotations include intersubjectivity. The quest for intersubjectivity had been one of the major issues for the logical empiricists. It took the form of a debate about very basic units of meaning, the protocol sentence debate. The debate ended inconclusively. Reichenbach had never taken an active part in it; he had chosen a different path to the same point, developing a complex probabilistic theoretical edifice representing scientific thought. His choice of framework would have benefited from the protocol sentence debate, but Reichenbach had chosen to abstain from it. Why? In this chapter I argue that Reichenbach had gradually come to regard nature as self-revealing following Kant’s *Critique of Judgement*, so he did not need to find any basic statements: scientific statements are basic in virtue of conveying the empirical. I go on to show that the context of justification/context of discovery distinction, Reichenbach’s introduction to going about representing scientific thought, is a maxim imposed by reason. Maxims are provisional rules of the form ‘if you want to accomplish x, then do y’. The conclusion is that the contexts distinction seems to be a relational distinction stemming from the logical empiricist agenda of abandoning metaphysics. Thus, the distinction’s perceived role as the
cornerstone of the philosophy of science is an unduly emphatic position. Reichenbach had a pragmatic, as opposed to dogmatic, conception of justification. From my chosen point of view, the problems with the interpretation of Reichenbach I defend are i) its emphasis on scientific theories as the (mostly) accurate representations of nature and ii) its assuming a Kantian understanding of the faculty of reason, which means that the appeal of science is affecting everyone endorsing its conceptual framework irrespective of cultural variations in understanding. The first problem is especially hard to reconcile with Rheinberger’s demonstration of experimental knowledge acquisition in biology, so indeed with historical epistemology we overcome the distinction.

The fourth chapter is about skill and embodied perception. I begin by examining a particular instance of scientific knowledge production; it is a narrative by developmental biologist John Tyler Bonner about his discovery that slime moulds, a primitive species, respond to chemical signals. The discovery happened in the mid-1940s. Bonner’s narrative is a section of his autobiography, so it is an assortment of his goals and thinking, how he used the experimental techniques which were available to him, some background on the knowledge of the time and how the young experimenter’s life felt. In the type of experience Bonner shares with us we are talking about skills approached from the personal point of view, viz. how an individual performs in matters technical and in matters of reasoning. Dreyfus has offered an account of skills conceived from the angle that interests us. The account is in the shape of a model of skill acquisition. We have already seen that Dreyfus’s concept of skills covers every learned aptitude. Some of them, like climbing, can be called physical. The sphere of the physical skills does not exclude technology. Driving a motorcar is such a skill. Some of them are socio-cultural: an example is the implicit norms
of distance and attitude when addressing people who command respect, like older people. Some of them are intellectual, like playing chess or like training other people in a school or university. Dreyfus links the model of skill acquisition to Maurice Merleau-Ponty’s embodied philosophy of perception. In Merleau-Ponty’s arguments on the nature of perception we encounter apriority. It is the outcome of Merleau-Ponty’s bringing together of empiricism and the post-Kantian developments of rationalism, labeled by him “intellectualism”, that leads him to argue that the self-evidence of many propositions is a by-product of our material embodied interactions with things. This line of argument is promising for my purposes about a priori justification emerging spontaneously in pretty much every context, but there are objects as diverse as ‘genes’, ‘tRNA’, and ‘tables’. Merleau-Ponty’s philosophy, logically fitting as it is to apply to science, is not a philosophy of science: objections may be raised that it is of consequence for objects like tables, but not about genes or tRNA. We will get back to his stream of argument via Hacking’s philosophy of science.

The central theme in the fifth chapter is Hacking’s entity realism. It is the reconstruction of entity realism that will logically necessitate the emergence of the notions of normativity and being-in-the-world, the latter regarded from the personal point of view. Hacking has famously argued that if you can manipulate unobservable entities, then they exist. He considers himself a philosopher of experiment, which means that scientific thinking and doing are not neatly separated in theory and experiment, they overlap. He argues that experiments have been conducted without any scientific theoretical assumptions. Hacking’s label for the scientific thinking-and-doing is scientific reasoning. One of the concepts apriority has led us to in chapter 2 is reason. Hacking’s label is appropriate, reason. Conceived as sound ordering of mental content, reason is
about both doing and thinking. In his argument for entity realism, reason does not feature much, but its role is important: it is not only detached and theoretical (understanding), but it is also *motivating* (practical). In the case of science it motivates people to, e.g., clone genes. This is a major premise in Hacking’s “experimental argument for realism”. Hacking’s argument for realism has been criticized on a number of grounds: that manipulability is a weak criterion for the existence of unobservables, that there is no failsafe way to link certain causal effects observed during experimentation with the theoretical entities we expect to be responsible for these effects, and that experiment always carries some theoretical load. Most of the criticisms of this sort miss the point. There is another type of criticism, often occurring in tandem with the previous types, which consists in attempting to find the missing premise in the argument in order for it to be valid (i.e. for it to be a deduction): the objection that the argument presupposes an assumption about the success of science and the objection that the argument is an inference to the best explanation in the guise of a deduction fall in this category. Hacking has clarified that such objections are based on misconception. The argument, its author implies, is a deductive one. But what sort of a deduction can it be? Hacking says explicitly that his argument has scepticism as its target. Something that is obvious from its conclusion is that it attempts to link mental content (belief in the existence of unobservables we know how to use in the laboratory) with the world (the said unobservables). Hacking’s deduction is a transcendental argument. Its conclusion is the widely familiar formulation “if you can spray electrons, then they are real”, which is itself a priori justified. Aprioristic reasoning takes place on a background of some basic understanding. In Hacking’s philosophy of science the background of understanding is provided by the scientific styles of
reasoning. According to Hacking, scientific reasoning has a history and there are a number of kinds of it, like taxonomic thinking and experimentation, which are collectively called styles of reasoning. The styles have a history. A characteristic of the styles is that they are “self-authenticating or self-stabilizing”. As such they are reason, they lead us from the universal to the particular, and they are able to function as the background of apriority, exactly as Kant had systematized the consensus of his predecessor philosophers on reason. Unlike Kant’s conception of reason, however, reason itself has a history.

The first part of chapter 6 concerns scepticism about the styles of reasoning. The self-authentication of the styles has been challenged: the syllogism is that without a more deep-seated background (such a background would be Kant’s reason) the self-authentication of the styles is idle speculative talk. This is the point where the Merleau-Pontean line of thought on understanding from the subject’s embodied perceptive comes into play. In more detail, the notion of the embodied a priori is shorthand for saying that understanding is a balance between the material world, a person’s way of accessing the world and her personal history, including her convictions, training, the cultural milieu in which she has learned to reason, etc. The second part of the chapter consists in showing that the styles of reasoning are skills by comparing Hacking’s list of their traits one by one with Dreyfus’s conception of skill. Self-authentication is among the traits of skills. The styles of reasoning are skills, but most skills are not styles of reasoning. I then proceed to offer a transcendental argument showing that skills are by definition self-authenticating.

The picture of practice I draw in the dissertation is the following: Practice is a dynamic balance between interactions of people (embodied minds) with the
material world taking place in discursive settings. The “people” constituent is drawn from Merlau-Ponty and Hacking, the “material” constituent is drawn from Rheinberger and Merlau-Ponty and the “discursive” is drawn from Hacking and Rheinberger. Practice according to this account implies fallible and defeasible apriority. Practices are normative despite the fact that we cannot hit the bull’s eye when we aim for certainty. Practices do provide knowledge.
1. From Historical Epistemology to Practice: the Question of Normativity

1.1 The starting point is normativity

In this chapter I introduce historical epistemology. It is my starting point for an inquiry on the significance of a priori reasoning in relation with epistemic normativity in the philosophy of science. The central question I see emerging from historical epistemology, especially in the version provided by Hans-Jörg Rheinberger, is ‘what is the content of the concept ‘practice’ in historical epistemology?’ To answer that question we will begin examining the issue of normativity in this particular brand of epistemology. My conception of normativity is not one of abstract rules, the slightest deviation from which has as a consequence the degeneration of the practice or the transmutation of the practice into something else. I regard normativity as an indicator of an action’s fitness and appropriateness in a particular setting.

The way I have preferred to investigate normativity on matters epistemic is to home in on justification. In anticipation of the type of justification entailed in a Rheinbergerian practice approach to epistemology, the full exposition of which will have to wait until we review the justification in Hacking’s account about why we should believe in the existence of unobservable scientific entities, I restrict my focus on a priori justification. Hacking is a philosophical affiliate of Rheinberger’s, as we will see in the course of this chapter. A priori justification is justification independent from experience. The definition of a priori justification just articulated does not entail its being independent from any experience; the definition allows for our thinking about concepts acquired from experience independent of those concepts’ immediate empirical setting.
Rheinberger’s epistemology belongs to a loose assortment of affiliated theoretical views in the history and philosophy of science, which I have discussed under the label ‘practice approach’ in the introduction. The practice approach seeks to utilize cultural historical material for the establishment of premises reflecting actual epistemic phenomena to use in speculative analysis. The adjective actual is intended to indicate that the phenomena under investigation are examined in the complex settings in which they take place; I speak of hands-on-oriented research, which translates in sociological and historical reconstructions.

By the end of this chapter I aim to have introduced Rheinberger’s historical epistemology as the more robust version of historical epistemology. Rheinberger’s epistemology is the least criticized of the three historical epistemologies available. It is also, I contend, the most ambitious one; despite its being historical, where the emphasis is on the local, it does not shy off the traditional normative character of epistemology.

What is the normative? The normative is to be contrasted with the descriptive. Descriptions are very useful in that they can inform about the unknown and, by extension, explain (make known the unknown). Explanations and information, useful and captivating for our cognitive powers as they might be can hardly be the stuff that will keep us awake at night. The normative can do that. Normativity has to do with the sphere of responsibility and rigorous thought, concerning both what we believe and how to act.

In the present chapter I elucidate Rheinberger’s epistemological intentions on the matter of normativity. His intentions on normativity are interwoven with his
historical research in the biosciences. I introduce Rheinberger’s historical research in the course of this chapter, as well.

In this thesis, I do not assess Rheinberger’s epistemology solely on the basis of its own merits and shortcomings: I mainly do so through its affiliation with Hacking’s philosophy, expressed by Rheinberger on a number of loci in his published work. It is rather hard to find an epistemological work of Rheinberger lacking a reference to Hacking’s *Representing and Intervening* (1983). By the end of this thesis I aspire to have demonstrated Rheinberger’s insistence on the relevance of Hacking’s thought to be a well-founded one, even if it is so for reasons beyond Rheinberger’s explicit intentions: Rheinberger finds Hacking’s philosophy to be more “traditional” than his own in the sense that it grounds the possibility of the scientific understanding of the world in “the nature of man as representing being” and in ontology (i.e. in the world itself, conceived to be populated by an assortment of beings, inanimate objects and concepts) (Rheinberger 2010, 85).

Rheinberger situates his historical epistemology among those who understand “…the step from the dynamic of theory to the dynamic of practice as opening a field of historical inquiry that obeys rules which cannot be derived from the conscious mind alone” (Rheinberger 2010, 85, original emphasis). According to Rheinberger, Hacking’s approach is to be located in the same area (Rheinberger 2010, 85).

1.2 Three Historical Epistemologies

1.2.1 Jurgen Renn’s historical epistemology
There are a number of historical epistemologies (Sturm 2011). A version of historical epistemology is due to Jurgen Renn (1995; 1996; 2004; Renn et al. 2004). Renn's interests lay in investigating the historical origins and development, i.e. the structures, of wide strands of epistemic traditions of thought, like mechanics or the relativity revolution in physics (Sturm 2011, 206). Renn’s historical epistemology is rather broad; it “attempts to open up a space for exploring the relationships between all relevant dimensions of the development of scientific knowledge” (Renn 1996, 4). There is a normative dimension to it: historical epistemology can help “overcome the problems of traditional philosophy of science to establish universal norms of scientific rationality” (Renn 1996, 2).

Expanding a little on what Renn’s research aims to do:

If one wants to study, for instance, the impact of material tools on the development of knowledge about bodies as it is represented in mechanics, one cannot limit the field of study to the early modern period or to scientific texts alone…[T]he transmission of antique [technological] knowledge provided an important starting point for early modern mechanics… At the same time early modern mechanics was developed against the background of new technological developments such as the introduction of ballistics… (Renn 1996, 8).

Renn reconstructs the interaction of science with a broad array of skills and practices. In this case we can say that ballistics was used as a tool during the development of early modern mechanics.

1.2.2 Lorraine Daston’s Historical Epistemology
Another version of historical epistemology is due to Lorraine Daston. The purpose of Daston’s historical epistemology is “to understand the history of the categories that structure our thought, pattern our arguments and proofs, and certify our standards for explanation” (Daston 1994, 282). Daston talks about a kind of history, but what is entailed in labeling this kind of history ‘historical epistemology’ is her belief it will have implications for the status of epistemic claims. Daston’s project is to inquire into the historically varying meaning of epistemic concepts which loom large over the scientific enterprise in the sense that they are the widely acknowledged standards of research (Daston 1994; Galison 2008; Sturm 2011, 206), like objectivity (Daston & Galison 2007).

Daston and Galison (2007) research the transformations in the category of objectivity using the evolution in the production of scientific atlases from the 18th century onwards. Scientific atlases are “those select collections of images that identify a discipline’s most significant objects of inquiry” (Daston & Galison 2007, 17). Atlases are images (sketches or photographs) that visualize knowledge; knowledge of course is meant to be objective (intersubjective following the terminology I used in the previous section (section 1.2)). Daston and Galison have studied the pictorial manifestations of intersubjectivity. The point Daston and Galison is that there are some particular ways how to make and read a scientific image, certain styles of scientific imagery (Daston & Galison 2007, ch. 7). Scientific imagery is not just pictorial, it is “epistemologically saturated” (Daston & Galison 2007, 368), each style revealing “epistemological loyalties” (Daston & Galison 2007, 368). Scientific vision is plural, it is scientific visions in fact, and these visions are “ways of seeing”, which “become ways of knowing” (Daston & Galison 2007, 368). Ways-
of-seeing as ways-of-knowing are practices (Daston & Galison 2007, 369) and they have philosophical implications:

...close consideration of these practices seldom enters into the ancient and still continuing philosophical debate over the epistemological status of vision per se... In this book, we have focused on practices of seeing, rather than theories of vision. We nonetheless hold these practices [of seeing] as well as theories [of vision] to be of philosophical import. They dictate not just how the world looks but also what it is – what scientific objects are and how they should be known (Daston & Galison 2007, 368, second and third emphases added).

This passage is telling: practices of scientific depiction reveal not only veridical properties of real objects (“what scientific objects are”), they also contain the necessary epistemic normativity that makes knowledge the right kind of belief to have (“how [the scientific objects] should be known”). The passage leads us to a question we have not had the opportunity to raise in our discussion of Dreyfus’s conception of practices as skills; it is a question arising from the dimension of the historicality of practices: does the historicizing of scientific knowledge lead us to relativism? Martin Kusch (2011) argues that Daston’s historicism entails relativism. Daston claims that “historicizing is not identical to relativizing” (Daston 1994, 284), a claim which is related with her thinking about scientific objects as being “simultaneously real and historical” (Daston 2000, 3, original emphasis).

Daston is able to talk about historicized objects without relativism as a result of her appeal to practice. Practices are not haphazard, they are normative, yet the
normativity in question must not be rooted only in social convention. It must also stem from the objects themselves. Daston has a lot to say about the embodiment ingredient of practices under the label of epistemic virtues. The (admittedly fundamental) activity ingredient is present, too (e.g. some of the text I omitted from the (Daston & Galison 2007, 368) quotation above is a commentary on the philosophical import of Daston and Galison’s work that reads: “Proponents and opponents treat theories and valorizations of vision historically and with discerning attention to nuance, but they rarely address the actual activity of seeing”). The epistemic virtues are “collectively held, epistemic-ethical concerns that guided… atlas makers” (Daston & Galison 2012, 36); their epistemic-ethical character (recall my description of normativity in section 1.1 where I spoke of responsibility, which is ethical as well as epistemic) is revealed in Daston and Galison’s finding that the atlas’ makers “regulative ideals” of right depiction were “both aspirational and pragmatically directive” (Daston & Galison 2012, 36, original emphasis). The epistemic virtues are communal, but their application was done by individuals: the atlas makers “so often concerned about long-term and cross-national robustness [i.e. intersubjectivity], were often explicit in plumping for one set of image-making practices against another [this is the personal implementation of the virtues]” (Daston & Galison 2012, 36). The bottom line is that “scientific atlases are at once all about the nitty-gritty of image making and about what scientific images (and scientific image makers) ought to be” (Daston & Galison 2012, 35, original emphasis).

Daston’s practice approach encompasses ontology. She has edited a volume (Daston 2000) on “applied metaphysics”, i.e. empirical historical ontology (Daston 2000, 5), of scientific objects (Daston 2000, 1). Her way of doing
historical epistemology allows the scholar to explore how scientific conceptions of some abstract stuff like dreams, mortality, centers of gravity, and the self (Daston 2000, 1), along with concrete stuff like atoms and cytoplasmic particles (Daston 2000, 1), are used as tools for the expansion of our field of knowledge.

1.2.3 The third historical epistemology is Rheinberger’s

The third historical epistemology is the historical epistemology of Rheinberger. I will not devote much more space to it now as it will be presented in detail in the rest of this chapter. What we will see after the full exposition of Rheinberger’s historical epistemology is that the three historical epistemologies are complementing each other. Historical epistemology viewed from the point of materiality of the objects of science might be visualized to have an onion shape, with Rheinberger’s version in the core, Daston’s in the outer layers and Renn’s in the periphery.

1.3 Rheinberger’s historical epistemology

1.3.1 Experimental systems and epistemic things

A sustained practice-oriented historiographical framework for the interpretation of experimental life in the life sciences is Rheinberger’s. In the book *Toward a History of Epistemic Things* (1997) Rheinberger builds his approach around a stronger version of Hacking’s dictum that experimentation has “a life of its own” (Hacking 1983, 160). In Rheinberger’s work the experiments are not just expressions of an inquiring attitude, the outcomes of which are often incorporated in a body of theory in some later time; for him it is in the realm of experiment that we can locate the smallest unit of knowledge generation, and we can concentrate on it without any loss (Rheinberger 1995b, 1998). These
“integral units of research” are, according to Rheinberger, “experimental systems”. The terminology has not been coined by Rheinberger. He has repeatedly encountered it in accounts of the day-to-day practice in biology laboratories, particularly during the twentieth century. Rheinberger claims that once a scientist has chosen an experimental system, she is confined in that system’s capacities and limitations (1997, 25-28). Experimental systems are not cages, however. They can be adequately represented as exemplars of instrumental reasoning, as compromises for the pursuit of conquering the unknown. Such compromises are often convenient on a variety of grounds.

Rheinberger asserts that “biological research in particular begins with the choice of a system rather than with the choice of a theoretical framework” (1997, 25). The system is not prescribed by the question at hand, but it must be devised. Experimental systems are not just constituted by arrangements of instruments; they are systems of manipulation that include conceptual and material elements. Scientists must control them sufficiently to reproduce phenomena, but they should not be able to exercise so tight control that these systems become mere technical devices. Experimental systems, therefore, are by definition open-ended, so that new phenomena can be generated based on differential results:

...an experimental arrangement must be sufficiently open to generate unprecedented events by incorporating new techniques, instruments, model compounds, and semiotic devices. At the same time it must be sufficiently closed to prevent a breakdown of its reproductive coherence. It has to be kept at the borderline of its breakdown (Rheinberger, 1997, 80).
Experimental systems are the “smallest integral units of research” (Rheinberger 1997, 28), they are “a basic unit of experimental activity combining local, technical, instrumental, institutional, social, and epistemic aspects” (Rheinberger 1997, 238).

Experimental systems look a lot like cozy small investigative niches; as such, they increasingly define what the scientist can or cannot do, and often lead the research in directions that could not have been anticipated either by the skilled practitioner or by conjectures based on a piece of theory. In other words, experimental systems increasingly acquire a varnish of reality, making the objects discovered under their regimes “simultaneously real and historical”, as Daston (2000, 3, original emphasis) has put it. It is in this sense that Rheinberger says experimental systems have a life of their own.

Rheinberger emphasizes that experimental systems are partly material and partly conceptual. They involve instrumental apparatuses and the agents that manipulate them. So far, nothing has been said about what is being manipulated. He includes the objects of research in his theory using a second organizing idea, the “epistemic thing”. The terminology is borrowed from George Kubler’s (1962) *The Shape of Time: Remarks on the History of Things*, which centres on the objects of art rather than their creators (Rheinberger 1997, 4). The epistemic things are the epicentre of activity within the borders of an experimental system. They are also material and conceptual in varying degrees but never only material or only conceptual: “things are embodying concepts” (Rheinberger 1997, 8) is Rheinberger’s way of putting his view. Things are the traces which fuel our continuing to follow them to where they might lead, but every time we think we have arrived at the terminus of our exploration, we find
out that the terminus was but another trace, after all (Rheinberger 1995a, 51). 
As epistemic things, the objects of research are incessantly redefined when 
experimentation brings about unknown properties or unpredictable phenomena 
(Rheinberger 1997, 197). The stabilization of an epistemic thing marks its 
passage from object of scientific research to technical thing ready to be used as 
stable known fact or procedure in the future (Rheinberger 1997, 31). Widely 
accepted ways of treating epistemic things in the laboratory and sedimented 
technical things used in the investigation of phenomena involving other 
epistemic things are ways representation for Rheinberger (1995a). Rheinberger 
does not intend any philosophical connotations for his choice of the word 
‘representation’, he uses it sous rature (Rheinberger 1995a, 51), French for 
‘under erasure’, with a line crossing the word out, indicating that the term 
‘representation’ is inadequate but necessary to convey what he has in mind. 
Representing means “standing for something else” (Rheinberger 1995a, 51). 
“[A]nything ‘represented’, any referent, upon closer inspection and as soon as 
we try to get hold of it, is turned itself into a representation” (Rheinberger 1995a, 
51). This is how epistemic objects become technical objects, viz. entities about 
which we possess enough knowledge to be able to use them in our 
experiments. Rheinberger is confident that:

If we think of representations as referring to stable external 
referents, to reality, this makes perfect sense in everyday life as 
well as in routine scientific work in which a representation 
usually is an unproblematic symbol of identification. It becomes 
problematic, however, if we look at the process of establishing 
representations in research – and elsewhere. Engaging in the 
production of epistemic things means engaging in the potentially
endless production of traces, where the place of the reference is always already occupied by another trace (Rheinberger 1995a, 51, original emphasis).

This is a passage which is hard to assimilate\(^2\), but what it suggests is that the things we encounter in the lab and in everyday life are compelling; we simply are at a loss to account why they are compelling. In other words, we cannot justify why the epistemic thing came to be represented as it did. If this reading is correct, we would expect to find a passage in Rheinberger’s work stressing that the material things possess some brute force which directs us to discern which of our possible understandings of them are appropriate and which understandings are out of the question. We will see in section 1.5 that this is indeed what Rheinberger wishes to convey.

1.3.2 Epistemic things emerge unexpectedly in experimental systems, reorienting the latter

Now we have been acquainted with what epistemic things and experimental systems are in Rheinberger’s thought. In this section I present Rheinberger’s major historical case, which led him to the terminology we have been familiarized with in the section 1.3.1.

\(^2\) This is also the case with chapter 7 of (Rheinberger 1997, 102-113), entitled “spaces of representation”. Rheinberger illustrates the “space of representation” saying: “By means of differential centrifugation, the cytoplasm gradually unfolded into a new and powerful space of representation, a space in which unknown substances showed up, were characterized, isolated, purified, and articulated. With ultracentrifugation, the traditional connotation of representation was undermined: ‘representing’ was definitively uncoupled from ‘imaging’” (Rheinberger 1995a, 60). Daston and Galison seem to echo Rheinberger when they write that the trend in twenty-first century scientific depiction moves from fidelity in ‘representation’ (Daston & Galison 2007, 381) to creative ‘presentation’, which shapes both the scientific entities and their image simultaneously (Daston & Galison 2007, 382-412). This is in part why I say that Daston and Rheinberger’s historical epistemologies are complementing each other.
Rheinberger (1997) has examined closely\textsuperscript{3} the history of the experimental system developed and used from 1947 until 1962 by a group of biochemists in Paul Zamecnik’s laboratory, one of the John Collins Warren laboratories in the Collis P. Huntington Memorial Hospital of Harvard University at Massachusetts. Zamecnik’s team set out to do research on cancer. Cancer is a form of unregulated or erroneously regulated cellular growth. So, Zamecnik’s team intended to identify criteria as pointers of normal or abnormal growth, in order to allow for greater understanding and more accurate diagnoses of cancer.

Instead of focusing on cancer as such, they approached the problem as one of characterization of protein synthesis in normal and cancer tissues. They were soon obliged to devise a cell-free experimental system, using biochemical techniques to pioneer a type of system in the test tube that would allow them to investigate in detail normal protein synthesis. They used an ultracentrifuge to separate cellular components. Their experimental system led them to observe some unprecedented events.

Their system led them to establish the existence and importance of a family of small ribonucleic acids as necessary operators in the protein synthesis. Their provisional name was “soluble RNA” or “sRNA” for short. Today, they are called transfer RNA (tRNA). Zamecnik and his group found out that sRNA was responsible for the transport and for what they called “activation” of amino acids, the building blocks of proteins. Without sRNAs, protein synthesis in the devised system came to a halt. By 1958, they knew that there is a large number of sRNAs, all of them small relative to other molecules found in cells, and that each one of them is bound enzymatically with a single amino acid, which they

\textsuperscript{3} For the full history of Zamecnik’s and colleagues’ experimental system see also (Rheinberger 1992a; 1992b; 1993; 1995a).
transfer to the cellular protein-composing apparatus, following directions coming from other cellular molecules.

During the fifteen-year duration of Zamecnik’s and his colleagues’ experimental system, it generated results that nobody could have anticipated and which led to the emergence of sRNA as an epistemic thing. Moreover, the sRNA studies led the experimenters from the methods and terminology of tissue experimentalists to a new field. They did not know where their system was leading them until they had reached their destination.

In Rheinberger’s historiography there is a deliberate shift of the focus “from scientists to… scientific things” (1997, 3-4). His position is a framework for the reconstruction of a “biography of things, a filiation of objects, …as records of the process of their coming into existence” (Rheinberger, 1997, 4). Experimental systems and their investigated objects, the epistemic things, are used by Rheinberger as the integrators of research questions, theoretical background (if it is available), technique choices, task definitions, unprecedented occurrences and discoveries, arrangements of instruments and discursive teamwork.

1.4 The experiment in the history and philosophy of science

Having being acquainted with Rheinberger’s historical epistemology, we will have to talk about the role experimentation in the history and philosophy of science. Experimentation is a significant part of scientific practice, yet it has not always been central in the philosophical accounts of scientific knowledge. Doing has often been neglected in favour of thinking. During experimentation objects

par excellence, viz. material stuff, are often used as tools. In this section we also encounter the notion of justification for the first time.
In the early twentieth century, the analysis and reconstruction of science by philosophers were intended to seek radical new solutions to traditional epistemological problems. The logical empiricists, the first modern philosophers of science, attempted to address those problems in a new way. They wished to resolve the inadequacies of nineteenth century empiricism about knowledge, and to rejuvenate philosophy in the process, by purging it from metaphysics. Their attempts to do so were centred around concentrating on science as the most promising model for philosophers to reconstruct and understand. One of the points that came to constitute their basic research agenda was the distinction between the context of justification of scientific theories and the context of scientific discovery.

The concept of justification was one of the major epistemological concepts to be found in the core of the premises and the claims of the logical empiricists. Giving a justification is to provide a rationale (or specific reasons) for arriving at a conclusion, making a decision, forming a belief, or performing a certain action rather than another. Justification can also be conceived in a stronger sense; in this case it amounts to a warrant to believe something, to act in such-and-such a way, etc. (Plantinga 1993, 3). In both senses, to be justified is to have adequate grounds (discussed in detail in chapter 2). In the setting of the philosophy of science, the logical empiricists gradually argued in support of the claim that the philosopher’s task was to explicate the apparent stability, the leading to accumulation of knowledge, and the progressive character of scientific theories: the philosopher’s task was to illuminate the context of justification. The context of justification, in the logical empiricist construal, is everything the context of discovery is not. Contexts of discovery are to be understood as isolated moments of inspiration and breakthrough, for which
contingencies, like the prevailing atmosphere in the scientific communities in a specific time, elements of personal biography and other unpredictable influences, are responsible (Reichenbach 1938, 5). The empiricists presented a case for the disciplinary separation of the two contexts: the philosopher’s job was to be concerned with explicating the context of justification. In the logical empiricist scheme of things, for a philosopher, researching the context of discovery would be hopeless. Philosophers should be interested in reproducing the usually clear, systematic and reliable outcomes of the science in a way that would not be a prescription to scientists about what they should or should not do in their scientific work.

Reichenbach is credited with introducing the context of discovery/context of justification distinction in his *Experience and Prediction* (1938, 5-7; chapter 3). In that book, Reichenbach supported the view that the philosopher’s toolkit (in this case formal logic) can only fruitfully address the context of justification in science. The purpose of the distinction was to restrict philosophical speculation from excursions in the territory of ephemeral and contingent events (instances of discovery), or anything else that would defy explication on terms of logic (Schickore & Steinle 2006, vii). The delineation of the appropriate content, domain and goals for the philosophy of science reinforced the opinion that historical, sociological, psychological and other empirical contributions on science would have little effect on a rigorous reconstruction of how science discloses the workings of the natural world. It also resulted in the assumption that there is no such thing as logic of discovery⁴ and discovery can be accurately understood only as instances of genius, personal insight and incidental better-than-usual collaboration (Schickore & Steinle 2006, viii).

⁴ *Pace* Popper (2005).
Discoveries according to the empiricist tradition are just brief ‘aha’ moments, whose importance for the philosopher of science is limited.

Emphasis on the context of justification as the philosophers’ proper domain was not limited to the logical empiricists. Karl Popper (2005) shared their preference to focus on scientific theories, choosing not to concentrate too much on experiments. According to Popper, experiments cannot strictly, i.e. deductively, disprove a theory (Popper 2005, 28).

The empiricists’ argument in favour of a neatly articulated distinction between discovery and justification was an attempt to define the limits of philosophy of science in respect to its subject matter: science can be philosophically reconstructed, but it definitely cannot be explicated in full by philosophy. The logical empiricists conceived science as a system, which they admired for its effectiveness and its ability to organize understanding. By separating the context of discovery from the context of justification they could argue for the autonomy of the philosophy of science and communicate to other fields in philosophy science’s democratic ideals (Richardson 2006). The adroit distinction between discovery and justification was to have a turbulent history. At times applauded as the hallmark of the philosophy of science, it has been criticized as ambiguous, distorting and meaningless (Schickore & Steinle 2006, vii): the empiricists’ intentions for renewed fruitfulness in philosophy can lead to reconstructions of science that portray it as a set of decontextualized curios in a museum bearing the guise of logical struggles for precise representations of the world.

Recent positions in the philosophy of science oblige us to conceive justification in science under a different light; historical epistemology is one of these
positions. The claim that justification in the philosophy of science means examination of the conditions and reasons for adopting, amending or discarding scientific theories is no longer tenable. The contemporary consensus in the history and philosophy of science is that the subject matter is better construed as a process composed of experimentation intertwined together with theory application and development. Science is conceived as a process of knowledge generation, not as a system of knowledge. The novel part in science-as-process analyses is the shift from scientific theories and models to experimentation, aiming at more holistic units of analysis. Since the early 1980s there have been repeated calls from philosophers, historians and sociologists of science for the scholars of science to be more attentive to the role of experiments in the development of science.

In the anglophone philosophy of science, science began to be investigated as a historical process after the publication of Thomas Kuhn’s book *The Structure of Scientific Revolutions* in 1962 (Kuhn 1970). In the continent, already, a number of thinkers continued to work on analyses of science that did not consider the contexts of discovery and justification separate. Irrespective to their histories, the prevailing arguments in the continental and the English-speaking world philosophies culminate in historicizing epistemology (Rheinberger 2010, 1-2). The attention to experimentation and history in the science studies can be affiliated, as we have already seen in the description of Daston’s and Renn’s historical epistemologies, with the practice approach.

Owing in a large part to Hacking’s work, the first half of the 1980s witnessed widespread interest in the neglected experimental side of science (Holmes 2009, 66). Historians of science like Allan Franklin called for attention to
laboratory goals and their outcomes. Franklin complained about the “general neglect of experiment and the dominance of theory in the literature on the history and philosophy of science” (1986, 1). His appeal has been frequently cited and repeated (Le Grand, 1990, ix). The outcome of such petitions has been a conception of “experimental autonomy” from theory that aims at narrating a “story… about experimental life that can capture laboratory concerns that have little to do with high theory” (Galison, 1987, 6, 12). However, portions of Popper’s view continued to be manifested throughout that period, probably because Popperian philosophy does not exclude experiments from the philosophy of science. In 1981, the philosopher Rom Harré published a book entitled Great Scientific Experiments: 20 Experiments that Changed our View of the World. In this work Harré presents his research material as climactic events of tremendous importance, even though he warns his readers that experiments, rather than “isolated events”, are “steps in a sequence of studies through which a delineated subject matter is explored” (1981, 12). Those years culminated in Steve Shapin’s and Simon Shaffer’s influential study of Boyle’s experiments, Leviathan and the Air Pump (1985). In that book Shapin and Shaffer intend to assume a “stranger’s” (Shapin & Schaffer 1985, 4) point of view in order to explain why Robert Boyle’s experimental methodology prevailed over Thomas Hobbes’s natural philosophy. They argue that the disagreement between Boyle and Hobbes was not only about standards of intellectual rigour about knowledge production, but it entailed the endorsement of a particular social philosophy (Shapin & Shaffer 1985, 14).

It will have become obvious by now that the practice of experimentation is difficult to delineate and to represent accurately. As we will see in chapter 5, this
feature of experimentation is not an obstacle for the defence of a normative account of it. Doing can inform thinking.

Rheinberger’s framework for compositions of histories of experimentation along with his epistemological positions is an appropriate point of departure in order to examine epistemic normativity in a philosophical environment where there is no theory-oriented focus or any theory priority. Rheinberger’s contributions to epistemology carry special weight, because they are not the result of just analyzing a single or a couple ‘great’ or ‘pivotal’ experiment(s) or a particular series of experiments culminating in a breakthrough. Breakthroughs in Rheinberger’s account are still glorious, but they lack the lustre associated with them in older portrayals.

1.5 Epistemology, historicized

My purpose in this section is to show how Rheinberger’s historical epistemology is a heuristically fertile vantage point to begin my argumentation for the account of practices I promised earlier, in section 1.2. Rheinberger’s account is not systemically self-contained like Daston’s historical epistemology: I mean that it does not offer cogent accounts of embodiment plus materiality as Daston (2000) has attempted to do. As we will see in the following pages, Rheinberger offers a complete account of the materiality of physical objects (and their interactions), but he gestures to Hacking’s direction for the embodiment component, through the concept of representation. I am not an enemy of pluralism in the meta-epistemic level of the nature of practices, and I subscribe to pluralism in the philosophy of science⁵; but I think it worthwhile to make a

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⁵ It is the thesis that there can be no unified philosophical account for the language, the subject matter and the methods of the various scientific disciplines (Suppes 1978).
case for a common core in the practice approach. Of course, under the lights of
the nature of the practice approach – the source of my avowed comfort with
pluralisms-, this common core will be less of a core and more of a common lore,
as Hacking (1983, 264) puts it. As we will see, the fitting device to bring the
argument home to embodiment is not representation, but the normative notion
of justification, building on Rheinberger’s apparent ambivalence on the
normative status of his historical epistemology.

But first things first: Deploying his basic concepts of epistemic things,
experimental systems and experimental cultures, Rheinberger’s goal is:

…to prepare the ground for a history and epistemology of
experimentation that dissolve the traditional hierarchy between
context of justification and context of discovery and free the
experiment from its subsidiary role in rationalistic accounts of
theory development and theory change. My narrative, however,
does not focus on the history of scientific institutions and
disciplines. It is an attempt to understand the epistemic
dynamics of the empirical sciences in terms of the peculiar
structure of practices from which these practices spring and in
which they dwell. Experimental cultures are not homogeneous
spaces. They are as patched up and tinkered with as the
experimental systems they are composed of. But they are held
together by a specific kind of glue: material, not institutionally
formalized interaction; epistemic, not theoretical compatibility in
its narrow and constricted sense (Rheinberger 1997, 138).
We have just affirmed that Rheinberger is a practice theorist, too. Rheinberger’s philosophical starting point, the deficiency in our thought he has identified and which he aims to remedy, is the distinction between the context of discovery and the context of justification. The distinction is a fitting starting point in our review of the notion of justification; for now we will restrict our examination of the notion of justification and the contexts distinction to Rheinberger’s epistemology.

According to Rheinberger, the distinction between context of justification and context of discovery was a mistaken bifurcation: scientists’ work contains both contexts; therefore it is extremely difficult to separate them. Even if the separation could be performed accurately at the theoretical level, it would be far from the actual way science is conducted (Rheinberger 2010, 3), and thus of limited importance. Considering myself to be a practice theorist, too, I am more than sympathetic to Rheinberger’s diagnosis: our philosophizing must commence from actual occurrences and not from the armchair. The bottom line is that philosophy should be aided by her siblings in the humanities to arrive at the correct conceptualization of scientific knowledge.

The ‘bottom line’ remains to be substantiated. This will happen in the course of the present and the following paragraphs. Rheinberger’s call for philosophizing without heeding the contexts of discovery and justification distinction is in need of substantiation, too. This will take place in the course of this thesis on grounds different than Rheinberger’s. At this point we should note that Rheinberger credits the demise of Reichenbach’s distinction to the philosophy of Kuhn (Rheinberger 2010, 55). The discarding of the contexts distinction is a premise developed during the course of the historicizing of epistemology (Rheinberger
But the validity, scope and strength of the contexts distinction is a meta-epistemological issue, not an epistemological one. Meta-epistemology is philosophizing about our accounts/theories of knowledge. Epistemology is theorizing about knowledge. For now we put aside the meta-epistemological concern on Reichenbach’s distinction, in order to see it emerging through the examination of Rheinberger’s epistemology. The goal is to prepare the ground for the philosophical implications of historical epistemology to be revealed sensibly and cogently through the basic assumption of every variant of the practice approach, namely that we should speculate on things like science and knowledge using actual occurrences of events as our starting point. In the case of scientific knowledge we should focus on experimentation. A number of these philosophical implications is meta-epistemic, of course, but these arise in the context of the epistemic ones.

Rheinberger acquaints us with his intended content of the term epistemology:

> My use of the term *epistemology* requires a brief explanation. I do not use it as a synonym for a theory of knowledge *(Erkenntnis)* that inquires into what it is that makes knowledge *(Wissen)* scientific, as was characteristic of the classical tradition, especially in English-speaking countries. Rather, the concept is used here, following the French practice, for reflecting on the historical conditions *under* which, and the means *with* which, things are made into objects of knowledge. It focuses thus on the process of generating scientific knowledge and the ways in which it is initiated and maintained. If I am right, …theory of knowledge in the received sense started to be
transformed into epistemology in the sense in which I use the term here. This shift also marked a transformation of the problem situation. A reflection on the relationship between concept and object from the point of view of the knowing subject was gradually replaced by a reflection of the relationship between object and concept that started from the object to be known (Rheinberger 2010, 2-3, original emphases).

The last sentences of the quoted paragraph suggest that Rheinberger’s practice approach has materiality covered. Rheinberger’s historical epistemology appears to be the reverse from Daston’s where the emphasis had been on embodiment.

Indeed, the importance of material stuff to guide us towards the ways we understand it, conceptual achievements permitting, is in the centre of Rheinberger’s historical epistemology. He explains:

The general thrust of my whole argument is about the power of material objects –in contrast to ideas or concepts- as driving forces in the process of knowledge acquisition… According to my position, scientific or epistemic objects are clearly material things. They function as scientific or epistemic objects by virtue of their opacity, their surplus, their material transcendence, if you like, which is what arouses interest in them and keeps them alive as targets of research (Rheinberger 2005, 406).

In the passage defining historical epistemology (Rheinberger 2010, 2-3), Rheinberger emphasizes what he calls the “transformation of the problem situation”; the important question in the new epistemology is not whether the
knowing subject has actually disclosed the workings of the world. The important question appears to be about the historical circumstances and the technical means with which knowledge was generated in the first place. So far, we must assume, Rheinberger’s epistemology appears to focus on the descriptive (i.e. the explanatory) aspects of the genesis of this or that particular fact about the natural world. Richard Burian (1995, 131-132) quotes Rheinberger having introduced his “historically informed epistemology of experimentation” as giving “descriptive coordinates for an understanding of… [the] ‘discursive practices’ [of the sciences]” in the paper which accompanied an oral presentation. Later on, Rheinberger had changed the formulation (Burian 1995, 132) to read: “the epistemology of experimentation… [provides] conceptual coordinates for an assessment of what, within a framework of sedimentation analysis or archaeology of knowledge, could be called the practical dispositions and depositions of the sciences” (Rheinberger 1995c, 108). Despite Rheinberger’s apparent ambivalence concerning the wording about the function of the epistemology of experimentation, Burian understood him as advocating a normative epistemology. I understand Rheinberger as offering a normative epistemology, too.

There are two ways that we might direct our focus to get a grasp of a normative historical epistemology: it is normative about scientific knowledge (epistemically normative), or, at the meta-epistemological level, by virtue of its being a normative theory, it can accommodate certain traditional philosophical insights, e.g. explain objectivity. Now, as we have seen, historical epistemology in particular and the practice approach more broadly, do not fare well with theories (Schatzki 2001, 12-13), but the recalcitrance of the phenomena under investigation need not stop us from attempting to theorize about them in the
sense of *theorein*, i.e. to provide abstract accounts of how things stand. The example of objectivity I have used in this paragraph is deliberate. Daston theorizes about objectivity in precisely the sense of *theorein* I have just evoked. To put it in philosophical terms, Daston and Rheinberger do not claim that there are no epistemic standards of evaluation of our scientific knowledge, simply that these standards cannot be *reified*; standards fluctuate in the course of history. So, we would expect historical epistemology to be able to be epistemically normative. We would also expect it to be able to be meta-epistemically normative, i.e. to stand out as a better account of knowledge compared to others, exactly what Rheinberger has in mind when he talks about the assessment of the scientific practices, as we can surmise from the first formulation of the description of the task of historical epistemology which did not include the word ‘assessment’ and is handed over to us by Burian (1995, 131-132).

Rheinberger’s language does not always help in distinguishing between the epistemological and the meta-epistemological tasks of historical epistemology. Discussing how history started to become epistemological after the Second World War, Rheinberger contrasts an “epistemology that takes history seriously”, like his own historical epistemology, to an epistemology which follows “self-defined normative principles” (Rheinberger 2010, 61). The usage of the adjective ‘normative’ in (2010) is consistent with its usage in a similar context, how history came to affect epistemology after 1945, in (Rheinberger 1994, 67); although in the (1994) paper it is not the principles for understanding science which are normative, but science is misrepresented by previous epistemologies as a “normative process” (Rheinberger 1994, 67).
So far, it is clear that Rheinberger intends to label normative those epistemologies which either ignore the historical dimension of knowledge or that grant it, but seek to confine it in a pre-existing philosophical mould. Philosophy should be aided by the humanities (in this case history) in her epistemic pursuits.

Despite the narrow content his utilization imposes on the word ‘normative’, we infer that Rheinberger’s disagreement with normativity is at the meta-epistemological level. Science may not be a unitary normative process (Rheinberger 2010, 61), but this does not preclude scientific practices, a plurality of which compose what we call science, from being normative. Recall that normativity as I described it, tied with judgement, is not just epistemic but moral, too; it is localized to the times, places and the characters of the people making these judgements. Thus, this normativity can be historicized. Rheinberger does not phrase it in my terms, but he says: “…the activity of scientific representation is to be conceived as a process without ‘referent’ and without ‘origins’. As paradoxical as it may sound, this is precisely the condition of the often touted objectivity of science, and of its peculiar historicity as well” (Rheinberger 1995a, 51). This passage requires some explanation, which follows in the next paragraphs.

We have already encountered in section 1.3 how Rheinberger speaks of representation sous rature (Rheinberger 1995a, 51), stressing that the moment we try to examine, understand or tinker with an object, it becomes a representation itself (Rheinberger 1995a, 51), hence there is no concrete referent. He also adds that there is no representation without a chain of representations (Rheinberger 1995a, 51), thus it is meaningless to search for
origins. Rheinberger concludes (1995a) with a summary-cum-reformulation of his argument concerning representation: “All representation is production/reproduction, and the 'evention' of epistemic things is distinguished by being deprived of any possibility to refer to prototypes. Representation is (int)e(r)vention” (Rheinberger 1995a, 89, original emphasis). He explains the last pun as a rephrasing of Hacking’s *Representing and Intervening* (Rheinberger 1995a, 89, fn. 117), creating the slogan ‘representing is intervening’. Keeping in mind that Rheinberger draws his conclusions from historical studies on biology, this is fine as slogans go, but what are we to do with it?

The concept of representation has come to the fore through Rheinberger’s having associated it with some conception of intersubjectivity, through the concept of knowledge (Rheinberger 2010, 2-3). Intersubjectivity (or objectivity) is linked to normativity via the insight that when we think of a belief as normatively bounding we expect others to agree with us, or at least see our point when we explain the grounds on which we think our belief to be compelling. When we bring grounds in the picture we effectively bring in the notion of justification.

So we might make matters totally clear if we see what Rheinberger has to say on epistemic justification apart from Reichenbach’s context. In fact, the most we can say on Rheinberger’s views on justification is that they are inspired from Gaston Bachelard, a major influence who Rheinberger quotes frequently. Commenting on Bachelard, Rheinberger explains that: “Scientific thought… cannot be characterized as a system of propositions; it is rather a process of evolution. It finds its justification, not in the unity of a thinking ego [as Descartes
believed], but rather in the historical structure of its replaceability” (Rheinberger 2010, 26). The extent to which Rheinberger endorses Bachelard’s views on justification can be surmised by his explaining that “For Bachelard, the achievements of science are and remain emergent phenomena. They have the character of events, and although they form a chain, the individual links remain historically contingent” (Rheinberger 2010, 26-27). This passage is helpful in understanding better what is meant by the word “evention”. It also is Rheinberger’s way of pointing to Hacking’s direction concerning representation without abandoning his philosophically inert usage of the word (cf. Rheinberger 1995a, 88). Notice that I have not claimed that Rheinberger intends his reconstruction of Bachelard’s account of justification to be his own view on the matter.

Why does Rheinberger point to Hacking? The answer can be found in his discussion of Bachelard. Bachelard had something to say about the justification of scientific thought because he had pursued theoretically the effects of the historicity of knowledge for the scientific mind. This brings us squarely to the embodiment aspect of the practice approach. We have already noted that Rheinberger’s historical epistemology does not offer an account of embodiment. This is because during the long process of historicizing epistemology:

The question now was no longer how knowing subjects might attain an undisguised view of their objects, rather the question was what conditions had to be created for objects to be made into objects of empirical knowledge under historically variable conditions (Rheinberger 2010, 3).
We have returned to the acquisition of empirical knowledge about things. We recall Rheinberger explaining that: “The general thrust of my whole argument is about the power of material objects—in contrast to ideas or concepts—as driving forces in the process of knowledge acquisition…” (Rheinberger 2005, 406). But the crucial role of materiality does not exhaust historical epistemology’s potential. Rheinberger recognizes that in a practice approach materiality should be complemented with embodiment, returning, after a fashion, historical epistemology to its origins:

[The nascent historicized epistemology] sought, steering its way between the poles of an empirically underpinned historicism based on the causal linkage of facts and a traditional, anthropologically motivated rationalism that privileged the consciousness of the knowing subject, to reveal the specific life of the sciences and their development. In the course of time, historical reflection on epistemology began to merge with epistemological reflection on the history of science. It is no accident, seen from this perspective, that means and media have moved center stage—gradually but increasingly—in a comprehensive analysis of scientific practices in all their discursive and material dimensions. If it is ultimately from this shift that the question of a historical anthropology of the sciences has been newly raised, the latter should not be misconstrued as a return of anthropocentrism, either in its empiricist-decisionist variant or in its rationalist-creativist one. It should rather be read as an attempt, in the context of a thoroughly altered system of coordinates of the growth of
science, no longer defined in Cartesian terms, to newly assess the role of human actors and their ever changing position in a network that embraces them and yet allows them to remain decentered (Rheinberger 2010, 89-90).

The “assessment” of practices now includes the human understanding, conceived in a non-anthropocentric way, so that we will not backtrack to “normative” epistemology. The historical anthropology of the sciences Rheinberger refers to is partly due to Hacking’s conception of representation (Rheinberger 2010, 85-86). Sketching the degree of affiliation with Hacking, Rheinberger remarks that his epistemology is “linking up” with Hacking’s philosophy (2010, 85-86) in their directing “special attention to the practices of obtaining knowledge” (2010, 85, original emphasis), and which “understand the step from the dynamic of theory to the dynamic of practice as opening a field of historical inquiry that obeys rules which cannot be derived from the conscious mind alone” (Rheinberger 2010, 85). This is the clearest formulation we have on Rheinberger’s part that historical epistemology has a normative dimension. Our appeal to the notion ‘justification’ has helped us get so far, but still we cannot pinpoint what Rheinberger’s conception is. Finally, we are left with an approach to representation which is still in desperate need of clarification of the claim that we can do away with reference.

The purpose of this thesis is to show that there are answers and remedies to these concerns, which are to be found in the direction Rheinberger is pointing us, to embodiment, through Hacking’s philosophy.

1.6 Towards embodiment
We have seen how embodiment without materiality and materiality without embodiment can evade the attention of philosophers. We have examined in detail Rheinberger’s account of materiality and we have identified the direction he is pointing us to complement this account: Hacking’s philosophy with its sensitivity to history and its discursive view of representation. But we are still a great distance from embodiment. We will get there after overcoming scepticism about Hacking’s styles of reasoning, in chapter 6. In the meantime, to reach the styles of reasoning, we will follow the link between Hacking, Rheinberger, Daston and others, most of whom feature in (Rheinberger 2010), and epistemic normativity, through the prism of epistemic justification, which we will have to narrow down further to a priori epistemic justification as a result of Hacking’s work, a direction foreshadowed by Rheinberger’s account of the compelling character the unobservable entities we discover and use in the laboratory have for our understanding of them. The aim is to provide a working synthesis of Rheinberger’s materiality of things and Hacking’s styles of reasoning vindicated by resources found in Dreyfus’s philosophy, which will answer Feest and Sturm’s (2011, 300) request to begin sketching the content of the word ‘practice’.
2. What is a priori justification?

2.1 The outline of the present chapter

In this chapter I introduce the concepts that play a major part in this thesis. Our getting familiar with concepts such as knowledge, justification in epistemology and entity realism in the philosophy of science is necessary for the clarity of the arguments that follow in the next chapters. The notions of knowledge, justification and entity realism (that is, realism according to Hacking) converge at a point which is located in the domain of a priori justification. A priori justification is the central concern presently.

The concepts introduced here are located above Dreyfus’s epistemic “ground floor”. They lay at the level of explicit knowledge, able to be formulated in clusters of meaning, the propositions. The propositions I talk a lot about in this thesis, an example of which is Hacking’s “if you can spray [unobservable entities], then they are real” (Hacking 1983, 24) differ from other propositions in that they cannot be justified on the basis of direct experience. In the aprioristic framework emerging in this thesis through the reconstruction of the main argument for entity realism, propositions like Hacking’s are self-evident. Justified, non-groping thinking-and-doing giving rise to self-evident propositions does not entail immutability for justification. As we will see, justifications can be defeated by more evidence or they can be false. Justification is fallible.

Additionally, I introduce verificationism in the course of this chapter. Verificationism is about meaning. In one of its simpler forms it is a principle stating that if a statement cannot be verified, it is meaningless. Some version of verification principle is required for transcendental arguments to be valid. Transcendental arguments were first used by Kant and their target is
scepticism. Transcendental arguments are a type of deduction; they have been historically associated closely with aprioristic reasoning. We will encounter transcendental arguments in chapters 5 and 6. In chapter 5 I show that Hacking’s entity realism is best conceived as a transcendental argument and in chapter 6 I deploy a transcendental argument of my own in support of Hacking’s concept of the styles of reasoning against scepticism about them.

2.2 Concepts related to justification

2.2.1 Knowledge and justification

The starting point in this thesis is the concept of justification and its role in the philosophy of science. Justification is associated with knowledge. According to the traditional definition (Plato, *Theaetetus*, 201d-210a; *Meno* 97e-98), knowledge is ‘justified true belief’ (Gettier 1963, 121). In the Loeb Classical Library translation of *Theaetetus* knowledge is “true opinion accompanied by reason” (Plato 1921, 201d); in more recent rendering (Plato 1997a, 201d), Plato’s phrase is translated “true judgement with an account”. The discussion about the nature of knowledge in *Theaetetus* remains inconclusive, but Plato seems to accept the definition proposed in *Theaetetus* (201d) in a passage from *Meno* (98):

True opinions. For true opinions, as long as they remain, are a fine thing and all they do is good, but they are not willing to remain long, and they escape from a man’s mind, so that they are not worth much until one ties them down by [giving] an account of the reason why (Plato 1997b, *Meno* 97e-98).
From early on, the concept of justification has been associated with reasoning (the original text (Plato 201d) reads *meta logou*) and with providing answers to ‘why’ questions.

The concept of justification is a central concept in our quest for greater understanding; it has been so from the beginning of Western philosophy (Swinburne 2001, 1). Justification belongs to the field of epistemology. Despite its location at the core of explicit understanding\(^6\), it can be hard to provide a definition of justification. Justification is usually approached in the literature through synopses and analyses of contemporary *theories* of justification (see e.g. Plantinga 1993, 3-29, 66-86, 182-209; Swinburne 2001, 9-31, 165-191); on the contrary, I approach justification through the lens of a particular *kind* of justification, a priori justification. The term justification designates either a process (i.e., the process of arriving to the conclusion that a judgement is justified) or the outcome of this process (i.e. we can ask or wonder about the justification of a particular belief) (Audi 1993, 26, 300). Synonyms for justification are the words grounds, warrant and basis. Other relevant concepts are the concept of reasons (Williams 1981a, 103) and the concept of rationality (Williams 1981b, 22-24). Justification is both an epistemic and practical concept. There is evidence to believe and there are reasons to do\(^7\) (Schroeder 2008, 57). Having evidence to believe and having reasons to do are grounds for believing and doing. When we think we have grounds to do an action, we engage in a process of providing reasons for believing or having done something; we engage in justifying our beliefs and our actions. Justification is a normative concept: a justified judgement or belief is compelling (Mares 2011, 3).

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\(^6\) I.e. understanding with an account.

\(^7\) For an influential early account of reasons as justifying grounds see (Williams 1981a, 101-113).
Since we talk here about compelling stuff which can be communicated, justification is related with the notion of objectivity, too: when we are satisfied that our beliefs and our actions have been based on sound grounds, we tend to think that others should also regard our beliefs and actions to be well-founded. To provide a preliminary working description, justification concerns explication. Along with explanation, it partakes in our efforts to make things explicit, understandable and communicable.

As a constituent of explication and knowledge, the notion of justification is special in that it does not only depend on the empirically observable, but in the fields of meaning and of reason (logos) itself. When a belief we hold is justified independent of experience, then it is an a priori belief. An example of an a priori belief is the statement ‘All bachelors are unmarried men’, which is self-justified in virtue of the meaning of the concept ‘bachelor’. The independence of experience as the hallmark of apriority will be revisited in greater detail in the present chapter. Knowledge that is a priori justified is called a priori knowledge.

2.2.2 Belief, judgement, reasons

Before I move on to the description of the properties of a priori justification and a priori knowledge, I will introduce the concepts of belief, judgement and reasons. The starting point, once more, is Plato’s proposed definition of knowledge. The Greek word that has been translated in the passages mentioned in the previous section as ‘opinion’ and ‘judgement’ is doxa, meaning ‘notion, opinion, judgement, not different from what one expects’ (Liddell & Scott, 1996). I already have mentioned them repeatedly in relation to knowledge. I now move on to briefly describe their characteristics.
Beliefs are a type of mental content, i.e. mental states which are available to an individual’s consciousness; Swinburne (2001, 32) describes beliefs as a person’s view of the world, which implies acceptance. Beliefs have contents: they signify something. These contents are usually thought to be represented by sentences. These sentences, in virtue of their having a particular meaning as a result of their content, are called propositions (Swinburne 2001, 32). These propositions can be true or false. Often we are not entirely certain if a belief is true or false: belief can be weak or strong (Swinburne 2001, 34). Knowledge is a type of strong belief with the additional requirement of an account. It is hard to isolate a belief from other beliefs and other mental contents; they form a web (Swinburne 2001, 40-41). Another property of beliefs is that we have privileged access to them; we know what we believe (Swinburne 2001, 38-39). Believing is a state we are in, it is not something we are doing (Swinburne 2001, 39); believing is also involuntary: we cannot help holding beliefs all the time, e.g. that we are in a certain place, that today it is Friday etc. (Swinburne 2001, 39). Other examples of belief include my believing that I need a saw to prune a tree, my believing that a Swiss army knife is adequate to prune a tree, and my believing that right now I am hungry. Beliefs may become public through communication and actions (Swinburne 2001, 47-48).

Judgements are also a type of mental content. A judgement is an assessment or evaluation (Martin 2006, 1-2). This description suggests that judgements are the outcome of slow, careful thought. Judgements can be like that, we can make judgements at will, but judging might not be deliberate, it might not require careful thought and it need not involve any significant degree of responsibility (Martin 2006, 2). Judges procure judgements, but the quick choice to step on this stone rather than on the other one, which is loose, when mountain hiking, is
a judgement as well. Judgements play a role in the speculative and practical
activities (Martin 2006, 3) of cognitive agents (Martin 2006, 1). Like justification,
the term judgement denotes both a process and the outcome of this process.
Judgements (as outcomes) can be regarded as propositional attitudes (Martin
2006, 31). Propositional judgements can be treated as beliefs (Martin 2006,
31). Judgements may become public through communication or action.

Belief and judgement can influence action; reasons, on the other hand, are
taken to pertain to the field of action (Schroeder 2008, Williams 1981a). This
does not mean that it does not make sense to talk about reasons to believe as
opposed to talking about reasons to do (Audi 2004, 119). A philosophical
analysis of reasons to believe is effectively a treatment of possible explanations
or, –if we talk about normative, opposed to instrumental, reasons- such an
analysis is a foray into the notion of justification. Reasons to do, on the other
hand, are more complex: in addition to their possibly being normative or
explanatory, they also are motivating (Audi 2004, 121; Williams 1981a, 102-
104). We would expect that from reasons to do. Of course, having (or there
being) a reason to do x does not necessarily lead to x being done. This is
because what motivates people comes in sets in each person’s mind (Williams
1981a, 102-103), the particular elements of which are weighed against each
other. Williams’s point is that in order to do or refrain from doing something, it is
not sufficient to be able to justify following a possible course of action; we must
also care about (not) doing something in the first place (Chappell 2010). If the
point Williams is making is true, then rational action is not independent of what
an agent is inclined to do. The most important consequence of Williams’s

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8 For an actual instance of judgements being considered to be beliefs see
(Papineau & Tanney 1999f, 17, fn. 1).
9 I.e. justifiable.
argument about the nature of reasons is that if he is right, then the presumed
objectivity which accompanies the expression “there being a reason to do”
(“having a reason to do” may be either objective or subjective) is not there to be
found by analysis; it is just a case of a number of people (or a society) (Williams
1981b, 37) having similar reasons (shared reasons) to act in a particular way.
The ideal analysis of shared reasons would be a historicized one (Chappell
2010; Williams 1981b, 37). Reasons to do can become public, like beliefs and
judgements. Reasons to do can also be treated as propositions.

Plato’s proposal for the definition of knowledge shows the role of justification in
the theoretical sphere. Judgement connects justification with thought,
thoretical or practical. Finally, reasons (to do) link firmly the concept of
justification with the field of action. Through the concept of reasons we have
also illustrated the limits of justification, namely that justification alone is not
sufficient for action.

2.2.3 Propositions

Beliefs are propositional attitudes. Judgements and reasons often –but not
always- are propositional attitudes, or, at least, they can be regarded to be such
for the purpose of analysis. Propositional attitudes are the mental attitudes
involving propositions. In the section introducing belief, I have mentioned that
propositions are the meaning of declarative utterances, what a person wishes to
express (Mares 2011, 17; Swinburne 2001, 32).

In particular, for a given context, propositions are the objects of acts of assertion
(Carrara & Sacchi 2006, 1). A second characteristic of propositions is that they
are true or false. In virtue of this characteristic, propositions participate in certain
logical relations, like entailment (Carrara & Sacchi 2006, 2; Mares 2011, 17).
Third, a proposition is a cognitive attitude (Carrara & Sacchi 2006, 1). When people utter a sentence with a specific propositional content they understand the meaning they are conveying. Fourth, propositions are public, in the sense that they are communicable and understandable by many (Carrara & Sacchi 2006, 2). Fifth, they are traditionally conceived to be mind-independent and language-independent objects (Carrara & Sacchi 2006, 2); viz. the content/meaning of a proposition is objectively accessible to most human beings, even if the accessibility requires elaboration or translation or both.

The declarative character of propositions, along with their being cognitive mental attitudes and their being communicable makes them readily reportable for a competent language user, eloquence permitting: in this text, when I use the adjective explicit, I will refer to propositional content, implying the relation of such content to the understanding.

When we approach the notion of justification as the outcome of a process, not as the justifying process *per se*, it seems that justification must be expressible. Justification must be explicit, or at least it must be able to become explicit after we put to words what we are thinking.

2.3 A priori

2.3.1 A priori justification and knowledge

A priori justification is a kind of justification which is either thought of as particularly interesting or as an illusory philosophical construction because its connotations include truth (BonJour 1998, 6) and necessity (Casullo 2003, 11-13; 15-22). To illustrate, a proposition like 'all squares are rectangles' seems to be both true and necessary just by understanding its meaning; this particular
example belongs to a brand of apriority called analytic apriority (Mares 2011, 70-73). Another kind of apriority is apriority based on conceptual analysis (Mares 2011, 47-49). The example proposition about squares is self-justified just by understanding it; consequently, it can be known without resorting to experience for evidence that squares are indeed rectangles. The independence of experience and empirical evidence is the basic trait of a priori justification and knowledge (Mares 2011, 4).

The notion of a priori justification is useful when we encounter two types of propositions: first, propositions that state necessary truths, like the proposition ‘2+3=5’, and second, propositions stating norms of some kind, like the proposition ‘it is morally wrong to harm innocent people’ (Mares 2011, 2-3). These two examples seem impossible to empirically justify. Apart from moral norms there are epistemic norms about what sorts of propositions we should give credence to and about what kinds of justification are acceptable (Mares 2011, 3); of course these norms must be themselves justified. We have seen that the notion of justification, along with the notion of truth, figure in the Platonic proposal for a definition of knowledge, according to which knowledge is justified true belief. Apriority is associated with knowledge; apriority is an epistemic predicate of propositions. An a priori proposition, on the face of it, is knowledge, since it is necessarily true. A priori knowledge is knowledge that rests on a priori justification (Russell 2012).

2.3.2 Kantian origins

The definition of apriority as independence of experience is due to Kant. He defined apriority as follows:
...we will understand by a priori cognitions not those that occur independently of this or that experience, but rather those that occur absolutely independently of all experience. In distinction to them, there are empirical cognitions; those that are possible only a posteriori, i.e. through experience. Among a priori cognitions, however, those are called pure with which nothing empirical is intermixed. Thus, e.g. the proposition ‘Every alteration has its cause’ is an a priori proposition, only not pure, since alteration is a concept that can be drawn only from experience (Critique of Pure Reason, B3, original emphasis).

An a priori proposition like Kant’s example ‘every alteration has its cause’, which includes empirical concepts is a synthetic a priori proposition in Kant's terminology. On, the contrary, an a priori proposition which does not include empirical concepts and consequently is understood on the basis of its meaning, is an analytic a priori proposition. The squares and the bachelor examples in sections 2.3.1 and 2.2.1 respectively are examples of analytic a priori propositions. In this text, when I write about a proposition being a priori without qualification, I refer to synthetic a priori propositions.

The contemporary definition of apriority, viz. that a proposition is a priori known only if it is independent of experience, has its origins in Kant’s definition (Casullo 2003, 3). In the modern context, the Kantian independence from experience means that a priori knowledge is not perception, introspection, memory or testimony (Casullo 2003, 29-30; BonJour, 7). In addition, if abilities like telepathy or clairvoyance were a common source of mental content and evidence, they would count as experience, and they would not be bases for a
priori knowledge (Casullo 2003, 143; BonJour 1998, 7-8). A priori knowledge and justification appear to be based on reason alone, or they are exclusively based on the meaning of the proposition considered (Russell 2012).

According to Kant there are also a priori cognizable judgements and concepts (Critique of Pure Reason, B4-B6), and apriority is continuously present in perceiving (Critique of Pure Reason, B6). The “pure” a priori about which Kant talks about is based on certain innate concepts, beliefs and intuitions (Mares 2011, 106); their innateness is a very good explanation why these concepts, beliefs and intuitions are independent of experience. In virtue of their being innate, these elements of our mental content are not learned (Mares 2011, 106). They are principles that underlie all reasoning. An interesting feature of these principles, which will be a central concern later on, is that they are ahistorical: once Kant’s—or similar- arguments have been corroborated, these basic concepts, intuitions and beliefs hold for all time. The idea here is that there is a uniform nucleus of humanity. Kant’s position about these basic principles is called nativism (Mares 2011, 106). Nativism (Mares 2011, 54, 61) is not an ontology of abstract principles, it is a position which is epistemic through and through. An interesting feature of critical philosophy (critical philosophy is Kant’s system) is that for a contemporary philosopher, who takes Kant’s overall aims into account, it is possible to abandon Kant’s belief in the pure a priori (Mares 2011, 115, 119), i.e. to abandon Kant’s nativism.

It is reasonable to leave Kant’s nativism behind: one of the main reasons is geometry. In his system of the understanding, Kant argued that the axioms of geometry, i.e. its principles, are a priori on the basis of the human a priori intuition (not concept) of space, which has the form of sense perception
(Critique of Pure Reason, B40), but it is not sense perception (Critique of Pure Reason, B41). In Kant’s lifetime, the only known geometry had been the Euclidean geometry. The situation changed later, in the course of the nineteenth century. According to the Kantian system, it is the a priori intuition of space which warrants Euclidean geometry’s status as knowledge as opposed to geometry being just a descriptive framework. Propositions of geometry (as well as propositions of arithmetic), according to Kant are synthetic propositions (Critique of Pure Reason, B14-B15). The advent of non-Euclidean geometries and the demonstration that the geometry of space is not Euclidean, owing to Albert Einstein’s work, negate the Kantian idea of the a priori intuition of space, and, consequently, are strong premises in an argument against Kant’s nativism.

Kant’s postulation of the existence of what he called pure a priori cognitions is not tenable today (Reichenbach 1958, 30-31); we are, therefore, left with the second part of the distinction, namely that the understanding presupposed by apriority is acquired by exposure to experience.

2.3.3 Contemporary apriority

The two aforementioned criteria of apriority are necessity and universality.

...if a proposition is thought along with its necessity, it is an a priori judgment; if it is, moreover, also not derived from any proposition except one that in turn is valid as a necessary proposition, then it is absolutely a priori... [!]If a judgment is thought in strict universality, i.e., in such a way that no exception at all is allowed to be possible, then it is not derived from experience, but is rather valid absolutely a priori... Necessity and strict universality are therefore secure indications of an a
priori cognition, and also belong together inseparably (Critique of Pure Reason, B3–B4).

Necessity and universality bring apriority together with a traditional understanding of objectivity. Kant contrasts the necessity he refers to with the necessity of association and habit, which David Hume uses to explain our making causal inferences. The latter is only subjective necessity (Critique of Pure Reason, B5). Of the two Kantian criteria the most prominent for contemporary views on the a priori is necessity (Casullo 2003, 11-13).

Necessity is a concept which is prominent in analyses of both a priori justification (Casullo 2003, 11-13; 15-22) and a priori knowledge (Casullo 2003, 99-100). Necessity is a predicate usually applied to truth (Casullo 2003, 12); we usually speak of necessary truths. The criterion of universality does not play an important role in contemporary analyses of apriority, but it can be related with certainty (Casullo 2003, 97, fn. 25), an assumed characteristic of a priori knowledge.

A priori propositions and a priori beliefs are also traditionally related with the notion of infallibility (Casullo 2003, 56-57). Once discovered, a priori principles cannot be found to be false. Their infallibility entails their being considered timelessly valid—we are talking about a certain sense of ahistoricity-as-eternal-truth. In more recent analyses the demand for infallibility is waived (Casullo 2003, 62-69; 77-78; Russell 2012); we have seen one of the reasons why with the geometry case (section 2.3.2). An a priori proposition can be shown to be false. In the case that another proposition is responsible for the demonstration of falsehood, then the correcting proposition must itself possess a priori
Apart from being fallible, a priori justified propositions can also be defeated. An a priori cognition or judgement can be corrected by experience; further evidence has the ability to defeat a conviction held on an a priori basis. Contemporary philosophers generally support the defeasibility of a priori justification and knowledge (Casullo 2003, 57, 62-69, Russell 2012). To illustrate the relationship between fallibility and defeasibility consider the following example: Einstein seems to have proved Kant wrong; the conclusion that any space viewed as intuited space governed by rules must necessarily be governed by the rules established by the Euclidean system is false. Kant’s conclusion is also defeated, since Kant’s deduction concluding to it remains valid (rationally compelling), but the conclusion is false.

Apart from truth, necessity’s connotations include its being the opposite of contingence. The contemporary consensus on apriority is that a proposition can be contingent and known a priori. An interesting case of contingent a priori pertaining to science and to every other evaluation of knowledge claims about the actual world is found in Gareth Evans’s (1979). Before I move on to the presentation of Evans’s argument, I will introduce briefly the notion of a possible world. A possible world is simply how the universe might have been. Prominent examples of possible words are the fictional -to varying degrees- settings in which many science fiction or fantasy stories take place. Possible worlds are the contexts in which the truth value of a proposition can be evaluated (Mares 2011, 14-15).
Evans argues that conditional sentences of the form ‘if actually p, then p’ can express a priori truths. A particular instantiation of the conditional would be ‘if the post is actually red, then it is red’. The adverb ‘actually’ plays no other role than indexing in which possible world the post is being red, in this case the actual world (W1). The proposition is clearly not necessary, because there is a possible world, say W2, where the post is green. The fact that the post is indeed red in W1 does not make it red in W2, although the conditional ‘if the post is red in W1, then it is red’ is true in every possible world. The conditional is known independent of experience because both its consequent and antecedent are to be assessed in W1, the actual world (Evans 1979, 183-185). Hacking’s statement that “if you can spray [electrons], then they are real” (Hacking 1983, 24) is a candidate for being a contingent a priori proposition, since the manipulation (spraying) is performed and assessed in the actual world. As we will explain in chapter 5, it indeed is a contingent a priori proposition.

In this section I have outlined the consensus on the properties of a priori justification and knowledge in the contemporary analytic philosophy. In sum, the modern picture of apriority is recognizably Kantian, although Kant’s two “secure indications”, strict universality and necessity have been watered down drastically. A priori justification still amounts to warrant to believe and to do, although the agent believing or doing may find out at a later time that they were wrong to think they were justified. The contemporary picture entails that the agent must remember her reasons remain always in principle defeasible and there is a possibility for her justificatory conclusions to be false. Nevertheless, it is possible for the agent to aspire to her well-founded beliefs and reasons for action to be granted universal sanction; we still are entitled to thinking that our a priori grounds must be compelling for everyone who might find herself in our
circumstances. It is the strong attachment to metaphysical necessity –necessity in every possible world (Mares 2011, 15)- which we must detach from our a priori reasoning. We must conceive an a priori justified proposition as necessarily true with a pinch of salt.

2.4 Realisms and anti-realisms

2.4.1 Scientific realism and its contrasts

I speak of ‘realisms and antirealisms’ in this section as a result of there being a number of them. In speaking thus, I follow Hacking’s usage of plurals about ‘–ism’ labels. Hacking (1983) has offered his own version of scientific realism, entity realism. The case for the centrality of practices in Hacking's work revolves around his argument for a new brand of scientific realism. Hacking's realism is a higher-order realism, because it stems from a philosophical view able to explain the many arguments for scientific realism and the equally numerous counterarguments against it. I reconstruct Hacking’s realism in chapter 5. In order to proceed with my reconstruction in that chapter, I have to introduce scientific realism at this point.

Contemporary realisms and anti-realisms are summarized well by David Papineau (1996, 2-5). According to Papineau, a realist, about science or otherwise, supports that 1) there is a world which exists independent of our awareness of it and our judgements answer for their truth to that world, and 2) that, by and large, we can know which of these judgments are true. There is an internal tension in realism as represented above: if the world is independent of our awareness of it, then how can we have secure knowledge of it? The anti-realist thinks that the realist's position is untenable. There are scepticist anti-realists, who, in broad terms, think that it is wrong to believe any scientific
theories since these theories seek to portray an unobservable world. Sceptic anti-realists may add that scientific theories can nevertheless be regarded as useful instruments for predictions and can be accepted as tools without any warrant that they really represent the world. The sceptic grants that there is a world independent of our awareness of it, but doubts that we can know it. There is also a different variant of anti-realism; this anti-realism doubts that our judgements can answer to conditions that are beyond the power of human beings to verify. According to this second species of anti-realism we can only know the aspects of the world that are disclosable to us; there is no warrant that that we experience the world in its fullness or the world's full aspects. For this sort of anti-realist, the world is dependent on us.

Hacking’s entity realism does not fit neatly into Papineau’s classification. As we will see in detail in chapter 5, Hacking’s position is primarily a reply to the sceptic anti-realist. It also entails that we can have justified belief even if we cannot be absolutely sure that we have arrived at the core of things. The idea is that there are cohorts of things in the world which do not appear to be dependent on us either in terms of classifying them (cows, pine trees, etc.), or concerning their existence.

2.4.2 Truth

The scientific realist and both species of anti-realist have in common their commitment to a substantive theory of truth (Psillos 1999, 224). Their only difference is that the realist pursues a metaphysical –or just metaphysically loaded as Psillos (2005, 387) prefers to call it- account of truth, but the anti-
realist has to defend an epistemic theory of truth\textsuperscript{10} (Psillos 1999, 224).

Construed either epistemically or metaphysically, the truth of the realist and the anti-realist means that there are truth-makers which make propositions true or false (Psillos 1999, 223). The scientific realist is also committed to the thesis that ultimately these truth-makers depend on how the world really is, independent from our minds and our epistemic standards (Psillos 1999, 223).

The anti-realist, on the contrary, thinks that these truth-makers are linked with epistemic notions such as some sort of verificationism\textsuperscript{11} or a mind-dependent justificatory process (Psillos 1999, 223). For the scientific realist, it is the world that lies ultimately at the end of our analyses of what makes certain propositions in science true and others false. This does not signify that the world is disclosed without effort. For the scientific anti-realist it is the standards of our epistemic appraisal which lay at the bottom of our analyses about what makes our scientific claims true. We can never know the workings of the world beyond doubt, but this does not mean that we should not trust our scientific theories for explanation and prediction: on the contrary, since our scientific theories develop according to our strictest possible epistemic standards, it is right that we always rely on them.

A priori justification appears to be closer to the anti-realist position in virtue of it being an epistemic boundary beyond which any inquiry for explicit understanding is fruitless: the anti-realist is the one who links what is known of the world to what can be known of it. This appearance is misleading: since contemporary apriority is still Kantian at heart, we should remember that Kant was the one who accomplished the bringing together of rationalism and

\textsuperscript{10} This assertion applies also to Bas van Fraassen’s (1980; 1989) constructive empiricism, a distinct variety of anti-realism.

\textsuperscript{11} Verificationism is fully explicated in the penultimate section of this chapter.
empiricism. With apriority in the picture, we are in effect talking about a situation that both the world and the constitution of our socialized mind play a part in making sense of things.

In chapter 3 we will see that a priori justification has played a nascent role in the philosophy of science since its beginnings, with Reichenbach. It has recently re-emerged in the entity realism of Hacking (chapter 5), in a totally different setting than that of logical empiricism; the new setting is about understanding philosophy through the prism of practice. We can see at this point that among the motivations for the scientific realism and anti-realism debate has been the ambition to accommodate the fact that whole disciplines might have the wrong picture about the world. The example *par excellence* is, of course, the revolution in physics brought about by Albert Einstein. The realist takes very seriously the fact that the empirical corroboration of Einstein’s proofs and insights did not upend our understanding of the world, it *expanded* it: students are still taught Newtonian mechanics and practicing physicists still use Isaac Newton’s equations. The anti-realist thinks that the *change* that occurred is more *radical* than the realist grants. Put in other words, the realist contends that science is successful where our understanding of the world is concerned. The average anti-realist –there is more room for conceptual maneuvering in anti-realism-contends that it is our understanding *per se* that is successful. The realist and the anti-realist are both after normative epistemology. Both the anti-realist and the realist, however, strive to make sense of science as it has actually developed without resorting to a priori justification: the realist by attributing the truth of our scientific claims to the world itself and the anti-realist by relying on our epistemic standards, culminating in their efforts to incorporate a substantive conception of truth in their respective approaches. The realist (and the anti-
realist, too (Psillos 1999, xix-xx)) is after external (objectivist) conditions for their normative aspirations, which apriority cannot satisfy: before the emergence of realism and anti-realism, Rudolf Carnap introduced a type of analysis\textsuperscript{12} a side effect of which is to make scientific theories \textit{trivially} a priori true (Psillos 1999, 60-63). The realist is looking for a deeper kernel of truth than apriority. The anti-realist, examining which truth conditions are verifiable, would not like Carnap’s assessment either, on the grounds of it being too broad. The reconciliation of contemporary apriority (fallible and defeasible a priori warrant) with a substantive account of truth is, I think, quite hard.

We have seen that usually truth is connected conceptually to necessity and necessity to apriority. The position of both the realist and the anti-realist for a substantive notion of truth creates some problems for them: scientific realism is too metaphysically loaded, truth included, and the typical anti-realist has a hard time explicating why the concept of truth is intuitively compelling even if our scientific assertions can prove totally or partially mistaken under the light of new evidence (Wright 1992, 45).

I am not opposed to substantive theories of truth, but I believe that this discussion misses the point: I am after a normative account of science that will not impose on it constraints primarily satisfying uniquely philosophical concerns. The theoretical treatment of science must start from science itself, as Rheinberger stresses (chapter 1). Hacking’s entity realism is a robust realism which can help formulate a normative epistemology, an epistemology able to account for the epistemic achievements of science, not regarding them as

\textsuperscript{12} For the neo-Kantian framework in which Carnap and other logical empiricists had been trained and they never totally overcame, see Michael Friedman’s (1999a).
saving the phenomena and without implicitly prescribing to the scientists which
metaphysical convictions it is rational to hold.

2.5 Transcendental arguments

2.5.1 Kant revisited

After having provided the basic tenets of realism and anti-realism, as well as an
analysis of the properties of apriority, there are two basic notions that are
needed before I develop my argument concerning Hacking's practice approach
and what kind of justification is to be found in it (viz. non-trivial a priori
justification) in chapter 5. One of them is the notion of the transcendental
argument. The other is verificationism.

The transcendental argument is a form of deduction deployed for the first time
by Kant. The most famous instance of a widely accepted transcendental
argument made by him concerns the legitimate application of causality, a
question raised by Hume (Enquiries, 26-27). Hume had questioned the
legitimacy of inductive and causal reasoning on the grounds that the link
between occurrences in the world, i.e. the causality itself, is nowhere to be
found. Hume's concerns about causality effectively cast doubt on our ability to
have any certain knowledge about how events are linked. He resorted to the
notion of habit and custom formation (Enquiries, 43) in manners compatible with
human nature in order to explain how expressions of the sort "A caused B" are
routinely used seamlessly. For Kant, Hume's naturalism was not enough to
dispel the doubt that could be evoked from his empirical reasoning about
causality. Kant agreed with Hume that there is no direct perception of causation,
and also thought that the requirement for such a direct perception as the only
means of the vindication of causal reasoning does not imply a contradiction
being present in the core of our thinking; Kant developed a complex account to explain how we manage to reason inductively and apply the causal relation to events. Our perceptions are rather chaotic to begin with, not as a result of the quantity and variety of objects and events, but because the part of the world we experience changes radically just with a movement of the head. We make sense of the world of sensation by thinking of the sensations as caused by objects and events external to ourselves. So far, there is concordance with Hume. In fact the problem can be described if we consider the following question: 'granted that I experience objects and events and that I have the mental ability to link objects and events causally, how can I ever be certain that the linking is corresponds to the actual facts and states of affairs?'. Kant thought of the linking as the application of a rule, something like a law of nature in Newton's physics:

1) We have experience of things in space and events in time in a law-like way (this is a proposition the sceptic cannot doubt; we experience a world which lends itself for us to have certain expectations based on regularities and patterns - moreover, we can even interpret the world in such a way that we can arrive at the mathematicized Newtonian physics).

2) The understanding (i.e. the regularities and patterns) of the perceptions of objects (things and events) as perceptions of objects presupposes an a priori (Hume had shown that the linking per se is not located in the actual perceptions) belief that events follow one another in a law-like way.

3) Therefore, we are right to believe that events will follow one another in a law-like way in spite of the impossibility to pinpoint the rule in question (Critique of Pure Reason, A191/B236 - A195/B240).
Kant’s argument amounts to this: So far as human beings are concerned, causality is a part of the fabric that makes the world what it is. It is interwoven with intelligibility. So, Kant's answer to the last question would be along the lines of the following: ‘if you can make sense of the world you perceive -never mind how incomplete or mistaken your overall understanding might be, then you need not worry about isolating the rule you apply in the first place: rest assured it is there by definition’. The power of the reply is readily apparent in something as regular and widely applicable as the principle of causation. For Kant the fabric of understanding the world is universal and timeless; thinking causally is unavoidable, not a matter of choice. Kant thought that he had identified the principles of all reasoning. The geometry crisis about the actual geometry of physical space after the developments in physics in the early 20th century showed that Kant's insight about having explicated the structure of all reasoning had been misguided.

The general form of a transcendental argument in Kant is like this (form 1):

- P (a proposition that the sceptic cannot doubt)
- P presupposes Q (Q is a proposition about our mental contents, which is in doubt)

Therefore Q (Mares 2011, 112)

Apart from the general outline above, there is a more practical way to understand the form of a transcendental argument. In the previous general outline the statements 1 and 2 are the premises of the argument. In the next outline the statement 1 need not be a declarative assertion. In this case general form of a transcendental argument becomes like this (form 2):
P

P presupposes Q

Q

Therefore, if P then Q (Mares 2011, 116)

The trick in the second variant is that P, which invariably is an empirical proposition, does not have to be known to be true or false; it can be a working hypothesis. The conditional conclusion 'if P then Q' is a priori valid irrespectively of the truth or falsity of the hypothesis. In transcendental arguments that are actually deployed in the second form the emphasis may be on Q (the proposition about our mental content) rather than on P. This can happen as a result of abstraction from actual circumstances or the argument is about issues where there is no consensus about the states of affairs and more research is needed. In Kant's system there is emphasis on the premise P, as well. Transcendental arguments of the second form still show that Q is the condition of possibility of P.

Kant thought that objective necessity was attainable. Traditionally, necessity and objectivity have been thought to be related with apriority. Kant's a priori is intended to be absolute, and not relative to a particular way of understanding the world\textsuperscript{13}. For him there can be no experience that contradicts the principle of causation because our ability to have experience depends on that principle. But what about dreams\textsuperscript{14}? Events in dreams often happen in a haphazard way following no rules and have no sequence. A reply to such an objection would be a consideration of experience’s qualifications: dreams are not experience, they

\textsuperscript{13} This is once more Kant’s nativism.

\textsuperscript{14} This point has first been made by Lewis (1956, 221).
rely on experience instead. Still, one could object that there is no warrant that the experience of a person who is awake is the only possible experience. The reply to this, second, objection would be that the transcendental argument just shows that if there is experience, then it must be law-like. The apriority involved in this case is for all intents and purposes an apriority severed from any conception of metaphysical necessity. We recall that a statement (S) is said to be metaphysically necessary in the actual world, if and only if the proposition "S is metaphysically necessary" is true in every possible world.

I want to stress at this point that even if Kant intended the second, relativized, understanding for the conclusions of his arguments then the relativity involved is of the weakest sort possible; we cannot imagine ourselves or any other possible rational entities to have the ability to make some sense of their experience without some rules.

The backbone of apriority is reasoning\textsuperscript{15}: a priori knowledge or thought is knowledge or thought acquired/occurring independent of experience. Here reason is synonymous to thinking; under this conception reason is contrasted to feeling. Reason as something-other-than-feeling is thought by Kant to be constituted by three a priori powers: i) understanding (relevant for cognition and science), ii) (pure) reason (relevant for desire and ethics, for the characterization of this notion of reason as pure see Kant (\textit{Critique of Judgement}, 207'-208', 396)) and iii) judgement (relevant for beauty). Their

\textsuperscript{15} Analytic apriority rests on meaning rather than on reasoning, but this fact does not mean we do not have to reflect occasionally a bit in order to use the appropriate word to express the concept we intend. A nice description of analyticity of mathematical and logical statements is offered by (Hempel 1964, 368): “Their validation naturally requires no empirical evidence; they can be shown to be true by a mere analysis of the meaning attached to the terms which occur in them”. Analytic apriority may be ultimately based on convention, since the meaning of words is conventional (Misak 1995, 59).
definitions determine their relationship with each other; for Kant, understanding is the ability to cognize the lawlikeness of the universal, reason is the ability to determine the particular from the universal within its (the universal's) confines and judgment is the mediator between understanding and reason (Critique of Judgement, 201’, 391-392).

Heretofore I will use the word ‘reason’ meaning ‘thinking’, including reflecting on the meaning of analytic concepts, and not as the Kantian second power. My choice comes as a result of the distinction between absolute and relative a priori as viable neo-Kantian possibilities for the content of apriority; the distinction owes its paternity to the young Reichenbach (Friedman 1999b, 60-63). These two possible understandings of the a priori call for terminology different from the one which has its origins in Kant, to avoid confusion. Confusion is possible because of the primacy of practical reason over theoretical reason in Kant’s system. I have already mentioned that Kant speaks explicitly in the third Critique about reason as the ability to determine the particular through the universal (Critique of Judgement, 201’, 391) which is fine for matters epistemic and as “the higher mental power” (Critique of Judgement, 245’, 434) responsible only for the “mental power [in general]” of desire (morals) (Critique of Judgement, 208’, 396; 246’, 435), which raises questions\(^\text{16}\). Kant is explicit on the primacy of reason in the second Critique:

But if pure reason by itself can be practical and [it] actually is, as is evinced by the consciousness of the moral law, it is yet always only one and the same reason which, whether for a theoretical or a practical aim, judges according to a priori

\(^{16}\) Not to mention that it can also raise many an eyebrow, particularly of those not familiar with the differences between Kantianism and neo-Kantianism.
principles. Thus it is clear that, even if for a theoretical aim reason's ability is not sufficient to establish certain propositions affirmatively [e.g. the existence of God], while indeed they also do not contradict reason, as soon as these same propositions belong *inseparably to the practical interest* of pure reason, it [theoretical reason] must assume them… (*Critique of Practical Reason*, 121, 154, original emphasis; cf. Williams 2013).

Kant’s assertion of the primacy of practical over theoretical reason means that for him epistemic normativity and practical normativity are one and the same\(^\text{17}\). In fact, for Kant epistemic normativity is genuinely practical. The last assertion means that in the Kantian system the source of epistemic normativity is the same with the source of practical normativity: this source is the will\(^\text{18}\) (Korsgaard 1996, 97-98). In Kant, in virtue of his nativism, each of our own subjective wills is able to legislate universally, in an objective manner; we all have access to the same a priori principle(s). This assertion can no longer be made (chapter 3). Instead of Kant’s conception of reason, we must opt for Aristotelian *logos* for reasons that will become fully apparent in chapter 6. By doing so we are not led astray from Kant’s insight that epistemic normativity is practical; on the contrary

\(^{17}\) Onora O’Neill (1989, ch. 1) has in fact argued that Kant’s comments commit him to a common principle for reason which is the supreme principle of disinterested (i.e. pure) practical reason, the Categorical Imperative. I am convinced that O’Neill is right even if Kant’s writings offer only scarce direct evidence (cf. Williams 2013).

\(^{18}\) Alan Richardson’s instigation “…that our scholarly attention must also be focused on the philosophical resources the logical empiricists brought to bear philosophically to explain their voluntarism” (Richardson & Uebel 2005, 87) is an insightful one. We will see in chapter 3 that Reichenbach’s normative epistemology had always been Kantian. Reichenbach’s source of normativity is the will.
it will help us establish that scientific norms are epistemic\textsuperscript{19}. To see how this happens, I must quote Aristotle on the principles of reasoning:

...from perception there comes memory, as we call it, and from memory (when it occurs often in connection with the same item) experience; for memories which are many in number form a single experience. And from experience, or from all the universal that has come to rest in the soul (the one apart from the many, i.e. whatever is one and the same in all these items) there come a principle of skill or of understanding —of skill if it deals with how things come about, of understanding if it deals with how things are. Thus the states [of being familiar with and knowing the principles of reasoning] neither inhere in us in a determinate form nor come about from other states which are more cognitive; rather, they come about from perception... (\textit{Posterior Analytics}, 100a4-12, J. Barnes trans.).

According to Aristotle, something like Kant’s \textit{pure a priori} is a philosophical fiction. That is the reason why when I speak of a priori I always refer to a priori principles which are possible only after a good deal of experience. My Aristotelian understanding of reasoning is not an estrangement from Kant, who after all, as we have seen, emphasized that concepts acquired from experience do play a big part in aprioristic reasoning, it is just a de-Cartesianization of Kant.

\textsuperscript{19} It is only peripherally important, but the source of the a priori epistemic normativity that I argue is established by Hacking’s philosophy is labelled “reflective endorsement” by Korsgaard (1996, 50). Reflective endorsement does not involve the will; its basic assumption is reflection on human nature (Korsgaard 1996, 50, 66). The sort of reflective endorsement that the argument I defend in this thesis leads us to is the variety of Bernard Williams (see (Williams 1985) for the definitive account).
The final word in this section concerns the notion of presupposition which is at play in every transcendental argument. In Kant the meaning of 'P presupposes Q' is not fixed throughout his critical writings, but the various uses are understandable, as well as consistent and relevant with each other (Mares 2011, 113). If I say that with presupposition Kant has in mind the conditions of the possibility of the intelligibility of a statement, i.e. that if Q was not true then we would not be able to think about P at all, I will not be far off for most of the occurrences of ‘presupposition’ in the critical Kantian corpus. Kant’s line of thought is cogent, but Clarence Irving Lewis has criticized Kant’s notion of presupposition:

…if what is presupposed in [Kant’s] sense be regarded as thereby established or proved necessary, the fallacy involved is easily detected. If I assert that two feet and two feet are four feet, I do not thereby commit myself to the proposition 2+2=4. It is required only that this be true of linear measure (Lewis 1956, 201).

I consider that Lewis is right in making this point, but I judge it to be minor. His grounds are the relativization of geometry (Lewis 1956, 203), which also serves as the starting point for Reichenbach (1957, 30-31). When I use the notion of presupposition in my reconstruction of Hacking’s transcendental argument (chapter 5) for entity realism I have Lewis’s objections in mind: by presupposition in a transcendental argument I only intend an implicit assumption about the world, or I intend background belief, which is, nevertheless, of a practical character.

2.5.2 The scope of transcendental arguments
The strength of a transcendental argument has been debated since Barry Stroud's paper of (1968). In that paper Stroud argued that the use of transcendental arguments against scepticism is ineffective. A transcendental argument, Stroud contends, does not bridge the gap between what we believe to be the case about the world and how the world actually is: "the skeptic can always very plausibly insist that it is enough to make language possible if we believe that S is true, or if it looks for all the world as if it is, but that S needn't actually be true" (Stroud 1968, 255, original emphasis). If we can make knowledge claims about S, then we must be able to establish the truth or falsity of a statement S, which, in turn, requires S to be meaningful or intelligible to us. A version of verificationism is implied if the transcendental argument is not deployed within the confines of a brand of idealism; this version of verificationism would prescribe that a proposition is meaningful only if we are able to confirm or disconfirm it. The presupposition of verificationism, Stroud thinks, would render the appeal to a transcendental argument unnecessary; moreover, verificationism is a contested position. In Stroud's words:

Any opposition to skepticism on this point would have to rely on a principle that it is not possible for anything to make sense unless it is possible for us to establish whether S is true, or, alternatively, that it isn't possible for us to understand anything at all if we know only what conditions make it look for all the world as if S is true, but which are still compatible with S's falsity. The conditions for anything making sense would have to be strong enough to include not only our beliefs about what is the case, but also the possibility of our knowing whether those beliefs are true; hence the meaning of a statement would have
to be determined by what we can *know*. But to prove this would be to prove some version of the verification principle, and then the skeptic will have been directly and conclusively refuted. Therefore, even when we deal in general with the necessary conditions of there being a language at all, it looks as if the use of so-called 'transcendental arguments' to demonstrate the self-defeating character of skepticism would amount to nothing more and nothing less than an application of some version of the verification principle, and if this is what a transcendental argument is then there is nothing special or unique, and certainly nothing new, about this way of attacking skepticism (Stroud 1968, 255-256, original emphasis).

In chapter 5 I reconstruct Hacking’s (1983) entity realism, arguing that it is the conclusion of a transcendental argument. Stroud’s (1968) comments raise the question if Hacking’s deploying a transcendental argument for his entity realism is sensible. Stroud's more recent view is that the deployment of a transcendental argument can show "thoughts [like judgements] or beliefs in question to have a special status or position in our thought" (Stroud 2000, 216). Following Stroud (2000), Hacking is not deploying an ineffective or redundant type of argument, as Stroud (1968) had suggested.

### 2.6 Verificationism

The logical empiricists paired formal logic with a theory of meaning, which, in its most (in)famous instantiation is put: the *meaning of a sentence consists in its method of verification*. What this "verification principle", as it came to be known, signifies is this: understanding the meaning of a statement is to know how to
The most widely known construal of the verification principle is by A. J. Ayer in his (1952) *Language, Truth and Logic* (2nd edition) (Ayer 1952, 5-15, 34-39). A verificationist position is a strong empiricist one. Verificationism is a position for the correspondence between words and the world (Misak 1995, 57). The only source of meaning, as well as knowledge, is experience. All knowledge with factual content, that is, everything except mathematics and logic, is *a posteriori*. This factual knowledge is a body of propositions whose justification relies upon experience; they are contingent. There is no synthetic a priori knowledge.

The function of a verifiability principle is to safeguard against meaninglessness (Misak 1995, 60-66). A meaningful proposition is one that has a determinable truth value. Reichenbach describes verification thus:

> When do we call a sentence true? We demand in this case that the symbols should be in certain correspondence to their objects; the nature of this correspondence is prescribed by the rules of language. If we examine the sentence *Kt c3* [knight on square c3 of a chessboard], we look to that square which has the coordinates c and 3; and if there is a knight at this place, the sentence is true. Verification, therefore, is an act of comparison between the objects and the symbols. It is, however, not... a comparison which would demand a certain similarity between objects and symbols. It is... a comparison in which we must apply the rules of language, understanding their contents (Reichenbach 1938, 31-32).
Verificationism reached its zenith with logical empiricism, but the seeds can be found earlier in the empiricist tradition (Misak 1995, 62). Carnap often echoes Auguste Comte (Misak 1995, 59; 65). The original version of verificationism (strong verificationism) defended by the logical empiricists had severe consequences for every inquiry that was not scientific (Misak 1995, 66); such inquiries were considered nonsensical metaphysics. But strong verificationism had its own share of problems, too: for instance, some statements which are by no means meaningless are however unverifiable, like statements about the past or about the future. Reichenbach’s description of a verification process cannot help us if we want to verify the statement “There were a hundred dogs in a sixty-mile radius from Exeter’s city centre thirty years ago today”. Even if some technology allows us a thorough forensic examination of past canine presence around Exeter, the problem remains with statements that have apparently left no trace, like “Winston Churchill sneezed exactly 47 times in 1949” (Misak 1995, 67).

The logical empiricist verifiability principle caused problems concerning natural laws and scientific predictions. They can be regarded as summaries of past experience and they concern the future (Misak 1995, 78). Ironically, verificationism undermined empirical science. Problems like these called for an amendment of the strong verification principle. A weak version was developed:

It is today generally agreed among logical empiricists that the criterion of meaningfulness is to be construed as a norm\textsuperscript{20}

\textsuperscript{20} Feigl's usage of the word ‘norm’ is the explanation why I never use that particular word to describe the compelling character of knowledge. Norms are often thought of as conventional. The normative can be conventional, but often it is not; an example of non-conventional normativity is Antigone’s motivations for not upholding the law in Sophocle’s homonymous tragedy.
proposed for the purpose of avoiding unanswerable questions…

By regarding the meaning criterion as a proposal rather than as
a proposition it becomes impossible to subject it to its own
jurisdiction or to ask whether it is true or false (Feigl 1963, 237-
238).

So, by 1963 the verifiability principle eventually had lost its potential, becoming,
from a prescription, a recommendation (Misak 1995, 75). Transcendental
arguments became current once more in the environment of weak
verificationism.

2.7 Summary

In this chapter we have spoken about a priori justification being fallible and
defeasible, about the relation of apriority with reasoning and of reasoning with
experience. In doing so we have retained Kant’s insight of a priori propositions
being self-evident but we have dropped any connotation of their being
immutable.

We have seen that a priori justification, which is amenable to change after being
made, has some severe implications about the concepts of truth and necessity.
No substantive truth or deep-rooted necessity can be easily reconciled with our
picture of a priori justification.

From the transcendental arguments in their original place in Kant’s philosophy
we have arrived to verificationism and meaning. We recall that meaning has to
do with analyticity, and analyticity is contrasted to the synthetic a priori. The
notions of truth and synthetic a priori are accounted for in Hacking’s philosophy.
Truth (a non-substantive conception of it) in particular is tied to Hacking’s own
understanding of verificationism. It is in chapter 5 where we will encounter all these concepts again, along with the issue of reference we left pending in chapter 1.

Our acquaintance with these concepts is a further step towards embodiment in a Rheinbergerian historical epistemology.
3. A Priori Justification in the Philosophy of Hans Reichenbach

3.1 Context of discovery and context of justification

The present chapter provides me with the opportunity to distinguish my conception of justification from the context of justification. The central question around which this chapter is organized is this: “Is the context of justification justified?”, where the meaning of the passive participle, ‘justified’, is to be understood in the sense of justification I introduced in the previous chapter (chapter 2): This is the original philosophical encompassing-everything-compelling notion of justification encountered from Plato to Kant and beyond. As we have already witnessed in chapter 2, it is still alive and well in general epistemology discussions.

The concept of justification was re-invented in the philosophy of science in an unusual way, as part of a context, rather as the central notion in a theory of justification or in the setting of a grand philosophical system. Reichenbach was the first to clearly articulate a distinction between the context of discovery and the context of justification. Reichenbach’s distinction has dominated over similar conceptions found earlier in philosophers of varying opinions and school affiliations (Hoyningen-Huene 1987, 502-503). So, despite the multiple theoretical origins of the proponents of the contexts distinction, or an equivalent postulate, it has been associated with the philosophizing of the logical empiricists. Reichenbach, whom we have already met in the context of verificationism, belonged to their ranks.

My argument in this chapter is that the most important part of Reichenbach’s legacy is his and the other logical empiricists’ insistence to follow the actual paths of knowledge establishment as closely as possible and to use our
conclusions from this process as premises in our philosophizing. I also propose that the continuation of this logical empiricist legacy is guaranteed in the practice approach. I do not speak about the normative/descriptive pair of opposites; I refer to the general tendency of the logical empiricists to construct theoretical representations of science, paralleling exactly the work of science, which constructs theoretical representations of the actual world. The practice approach is not a friend of theoretical representations, but it is affiliated with the spirit of following science closely when philosophizing about science.

In the recent past, the contexts distinction has served as the *sine qua non* starting point for the philosophy of science, offering the most robust response to what differentiates the philosophy of science from empirical inquiries of science (Schickore & Steinle, 2006, ix). Although it is seldom mentioned today, it has not been refuted (Schickore & Steinle 2006, ix), even though it is now clear that activities of discovery cannot be separated from activities of justification (Hoyningen-Huene 2006, 120, 121).

### 3.1.1 One single science

In this chapter I begin to visit the issues that I have opened in the first chapter and which are still pending. One of them is Reichenbach’s distinction between the context of discovery and the context of justification, which has emerged in the discussion of historical epistemology. Rheinberger believes the result of the various ways of historicizing epistemology has been that:

...the contexts of discovery and justification, so neatly separated in between, were joined again. The idea of science as a process replaced the obligatory view of science as a system. *One single*
science gave way to many sciences, not reducible to one
another (Rheinberger 2010, 1, original emphasis).

The contexts distinction is loaded with assumptions about the nature of science. The "one single science" Rheinberger stresses in this passage was a conviction of the logical empiricists. The idea introduced here is the idea of reduction: it is the thinking that the discipline of biology is built on basic units like concepts and theories belonging to chemistry, and chemistry in turn is based on physics. So, in a sense, there is a continuum from the most substratal empirical study of the natural world, which is physics, up to the world of living beings and beyond, in the realms of the human psyche (Feigl 1970, 14) and human societies (Feigl 1970, 13). The implicit hierarchy in the reductionist view is the result of the contingent facts a theory T1 uses as anchors to the empirical world being explained by another theory T2. T2 is a “higher level” theory (Feigl 1970, 11-12); T2 explains what T1 takes for granted in order to explain other phenomena. The hierarchy in question is a hierarchy of “greater and greater explanatory power” (Feigl 1970, 12). The hierarchy of explanatory power is the manifestation of “the aim of scientific explanation throughout the ages, [namely] unification, i.e., the comprehending of a maximum of facts and regularities in terms of a minimum of theoretical concepts and assumptions” (Feigl 1970, 12, emphasis added). The passages from Feigl illustrate the content of the conception of science as a system.

Feigl's (1970) views just presented are the late ones in the development of notion of the unity of science. It was written in a time when the predominance of the logical empiricist style of analysis was being challenged. The currency of the contexts distinction was intensely debated in the 1960s and 1970s (Hoyningen-
Huene 2006, 119), after the wide acceptance of the idea that the history of science discredits the logical empiricist fashion of philosophizing, namely abstracting scientific practice in elaborate philosophical representations of it, called rational reconstructions (Feigl 1970, 4). I explain in further detail what these are in the context of Reichenbach’s philosophy (section 3.3).

In Anglophone philosophy, the pivotal event for historicizing of the philosophy of science was the publication of Thomas Kuhn’s *The Structure of Scientific Revolutions* (1962), although the stage had long been prepared by others (Rheinberger 2010, 79). The logical empiricist way of analysis through rational reconstructions, being self-avowedly “highly artificial” (Feigl 1970, 13), ran out of steam (Passmore 1967) when more and more people became aware of the existence of an alternative.

Rheinberger’s anti-contexts-distinction position is the reasonable position to assume; it simply can be called “scientific” in the sense of being led by actual events in the history of science. On the contrary, logical empiricist scientific philosophy is “scientific” in the sense of being able to yield models of science—in parallel with the sciences’ having theories modelling the phenomena they study. Today, despite the widespread lack of interest in rational reconstructions in the logical empiricist style, there have been attempts to reinstate the distinction, albeit without its former connotations of unification, at least not explicitly. Its purpose, it is argued, is to preserve epistemic normativity (see, e.g., Hoyningen-Huene 2006; Potthast 2006) in the new world of philosophizing on science, where description is the main source of philosophical input (i.e. the source of premises for arguments). Of course, I believe that Rheinberger's historical
epistemology preserves epistemic normativity just fine: the purpose of the thesis is to show how.

The passage from Rheinberger (2010) I quoted above is more than a dismissal of the possibility that any fine-tuned, historically-informed version of the contexts distinction as a principle of the philosophy of science is not viable. It is also an assertion that it has been a mistake to begin with. I intend to show that Rheinberger is right by arguing that Reichenbach had a more light-hearted conception of the distinction’s significance. I do so by tracing the meta-epistemological positions Reichenbach espoused. In other words, I intend to show that the contexts distinction is not fundamental for a logical empiricist philosophy of science. Since other philosophies of science have no need of the contexts distinction -if they do not actively oppose it, my argument entails that the contexts distinction is not fundamental for the philosophy of science in general.

3.2 Scientific philosophy

The logical empiricist point of view underlines the need for a reformed philosophy, based, like the sciences, on the secure foundations of empirical observation. The logical empiricists wished to propagate "an empiricism which recognizes only sense perception and the analytic principles of logic as sources of knowledge" (Reichenbach 1938, 310). Philosophy possesses the tool, namely logic, which would lead to its own scientification and it would purge it from the meaninglessness of various concepts and statements that had plagued it throughout its history (Blumberg & Feigl 1931, 296). Philosophy was to become scientific. The possible extent to which the scientification of philosophy
could be achieved is the nucleus of the varying strands within logical empiricism that I introduce in the next section.

Scientific philosophy has no room for synthetic *a priori* propositions (Blumberg & Feigl 1931, 282). Without any synthetic a priori propositions, the logical empiricists had to identify the basic statements that constituted the elementary blocks of the representation of the world. These basic propositions are known as protocol statements, and the aspiration of their characterization sparked a long, finally unsuccessful, attempt to pin them down, known as the protocol sentence debate. The protocol sentence debate was a major concern for the Vienna Circle empiricists until its petering out in the early 1940s (Uebel 1992, 21-27).

Unlike his Austrian colleagues, Reichenbach was not interested in basic propositions. As we will see, his approach was to regard nature as self-revealing to those who regard it as an empirically intelligible system.

3.3 Some logical empiricist meta-epistemology

The two prominent interlocutors in the protocol sentence debate after Moritz Schlick's death were Rudolf Carnap and Otto Neurath. Carnap, as early as 1928, articulated in *Der Logische Aufbau der Welt (The Logical Construction of the World)* the goal of a logical analysis theory of justification, the product of which would be a theory of protocol sentences in the following -baffling- way:

> Even though the subjective origin of all knowledge lies in the contents of experience and their connections, it is still possible, as the constructional system will show, to advance to an intersubjective, *objective world*, which can be conceptually
comprehended and which is the same for all observers (Carnap 1969, paragraph 2, original emphasis).

The early Carnap's point of departure is the subjective; he claims that it can be the source of the objective. Kant's atemporal necessity has been relativized from the beginning; now, intersubjectivity must amount to objectivity. In fact, in paragraphs 146-149 of the Aufbau, Carnap attempts to reconstruct intersubjectivity from the solipsistic point of view he had assumed early in the book. Since the appraisal of a certain proposition as justified amounts to its being compelling, one of Carnap's central aims undoubtedly is the demonstration of the emergence of the epistemically normative from the subjective. Carnap’s aspirations about arriving at intersubjectivity follow the classical philosophical way: they begin with the subject. Carnap seems to follow in the blueprint drawn by Kant.

At the beginning of his career, Neurath published a small essay which is essentially a roadmap of all the main constituents of his later philosophy of science. It carries an unusually long title: "The Lost Wanderers of Descartes and the Auxiliary Motive (On the Psychology of Decision)" (Neurath 1983). Neurath draws inspiration from a passage in Descartes's Discours de la méthode, in which Descartes reflects on the sharp contrast between theory and practice. Descartes finds that action requires our making firm decisions and obliges us to stick to them, no matter how unwarranted they might be. In the practical realm, unlike science, we are wanderers in an unfamiliar forest, persistently advancing in the direction we had chosen on arbitrary grounds, hoping to reach the plains before long. Neurath thinks that Descartes was terribly misguided in thinking that science belongs to the realm of certainty.
Science, like practical action, requires ungrounded decisions. Social norms are such ungrounded decisions; decisions which at some point became established and widespread. These ungrounded decisions are called conventions. In Neurath’s understanding of things, in contrast to Carnap, it seems that any vestige of Kantianism is out of the question.

Reichenbach was not a direct participant in the protocol sentence debate; however, in his *Experience and Prediction* (1938) he chooses to occupy a middle ground between Carnap and Neurath on this subject, leaning —more than slightly— towards Carnap’s side. *Experience and Prediction* was written in English, in Turkey, during Reichenbach’s exile from 1930s Germany. He spent five years (1933 to 1938) in Turkey, before he moved to the United States at the University of California, Los Angeles (UCLA) (Glymour & Eberhardt 2012). The reason for the selection of the text’s language was his intention to introduce himself and logical empiricism to the North American audience; more specifically, one of Reichenbach’s main aims is to acquaint the philosophical audience in the United States with his theory of probabilistic logic (Reichenbach 1938, vii).

In the first chapter of the book, its full title aptly including the clarification “*an analysis of the foundations and structure of knowledge*” (Reichenbach 1938, ii), Reichenbach introduces the well-known distinction between the context of discovery and the context of justification. The distinction would serve as the hallmark of the philosophy of science and would become the subject of much criticism (Schickore & Steinle 2006, ix). Despite the promise about foundations (plural) in the book’s supplementary title, the only basic epistemic foundation apart from sense perception found in (Reichenbach 1938) is the contexts
distinction, itself a codification (Reichenbach 1938, 6-7) of the Carnapian notion of rational reconstruction, found in the *Aufbau* (Reichenbach 1938, 5, n.). The scientific philosopher’s work, according to Carnap and Reichenbach, is the rational reconstruction of her subject matter, science. The part of actual reasoning which can be reconstructed is only the part that is susceptible to logical analysis. Actual reasoning as a whole is simply too complex; it often possesses logical gaps, and most of the times it defies explication:

There is a great difference between the system of logical interconnections of thought and the actual way in which thinking processes are performed. The psychological operations of thinking are rather vague and fluctuating processes; they almost never keep to the ways prescribed by logic and may even skip whole groups of operations which would be needed for a complete exposition of the subject in question. That is valid for thinking in daily life, as well as for the mental procedure of a man of science, who is confronted by the task of finding logical interconnections between divergent ideas about newly observed facts; the scientific genius has never felt bound to the narrow steps and prescribed courses of logical reasoning. It would be, therefore, a vain attempt to construct a theory of knowledge which is at the same time logically complete and in strict correspondence with the psychological processes of thought.

The only way to escape this difficulty is to distinguish carefully the task of epistemology from that of psychology. Epistemology does not regard the processes of thinking in their actual
occurrence; this task is entirely left to psychology. What epistemology intends is to construct thinking processes in a way in which they ought to occur if they are to be ranged in a consistent system; or to construct justifiable sets of operations which can be intercalated between the starting-point and the issue of thought-processes, replacing the real intermediate links. Epistemology thus considers a logical substitute rather than real processes. For this logical substitute the term rational reconstruction has been introduced... (Reichenbach 1938, 5).

At the beginning of the reconstruction there are facts: the epistemologist starts her work by examining the available events and the thinking employed during a discovery, in order to compose a description of the scientific process (Reichenbach 1938, 3-4). The second step of the rational reconstruction involves the logical analysis of the data available from descriptions and their critical assessment (Reichenbach 1938, 7-8). During the second step, "we replace actual thinking by such operations as are justifiable, that is, as can be demonstrated as valid" (Reichenbach 1938, 7). However, some epistemic choices are a matter of decision or convention. There can be no neat logical frame for those: they remain unjustified, even if they can be explained, which is not always the case. As it happens, decisions must be made sometimes in the course of discovery. Such decisions may be logically harmless, or they can affect future research choices by restricting the available options. The points where a decision must be made are termed by Reichenbach volitional bifurcations (Reichenbach 1938, 10). The choices which are restricted by past decisions are called entailed decisions (Reichenbach 1938, 13).
The entailed decisions in science affect the epistemologist's role. The epistemologist has the authority to provide guidance and advice to the scientist:

We may... [use] the following systematic procedure: we renounce making a proposal but instead construe a list of all possible decisions, each one accompanied by its entailed decisions. So we leave the choice to our reader after showing him all factual connections to which he is bound. It is a kind of logical signpost which we erect; for each path we give its direction together with all connected directions and leave the decision as to his route to the wanderer in the forest of knowledge. And perhaps the wanderer will be more thankful for such a signpost than he would be for suggestive advice directing him into a certain path. Within the frame of the modern philosophy of science there is a movement bearing the name of conventionalism; it tries to show that most of the epistemological questions contain no questions of truth-character but are to be settled by arbitrary decisions. This tendency, and above all, in its founder Poincaré, had historical merits, as it led philosophy to stress the volitional elements of the system of knowledge which had been previously neglected. In its further development, however, the tendency has largely trespassed beyond its proper boundaries by highly exaggerating the part occupied by decisions in knowledge. The relations between different decisions were overlooked, and the task of reducing arbitrariness to a minimum by showing the logical interconnections between the arbitrary decisions was forgotten.
The concept of entailed decisions, therefore, may be regarded as a dam against extreme conventionalism; it allows us to separate the arbitrary part of the system of knowledge from its substantial content, to distinguish the subjective and the objective part of science. The relations between decisions do not depend on our choice but are prescribed by the rules of logic, or by the laws of nature (Reichenbach 1938, 14-15).

In the previous quote, Reichenbach refers to the Cartesian epistemological wanderer in the context of decisions, entailed or arbitrary, and conventions: in disagreement with Neurath, he rejects extreme conventionalism. Rational reconstructions of contexts of justification are not reducible to sociological analyses. Reichenbach is firmly on Carnap’s side; he is a defender of renewed philosophy, but his logical empiricism is still a continuation of the philosophical tradition. For Reichenbach, the scientification of philosophy does not entail philosophy’s losing its autonomy.

My reconstruction of Reichenbach can be summarized thus: Reichenbach subscribes to the positions i) that the philosophy of science is not reducible to social science and ii) that the philosophy of philosophy (meta-epistemology in this case) is still philosophy. But, according to Reichenbach, the philosopher and the scientist have some things in common: they have to start from the empirical. Reichenbach is in good company there; Alfred Ayer was “concerned to emphasize…the unity of philosophy with science” (1952, 151), too. The epistemologist is just another kind of scientist.
What is special about science? Not much, Reichenbach contends. There are no higher purposes at play, just a decision for honest engagement with phenomena.

What is the purpose of scientific inquiry? This is, logically speaking, a question not of truth-character but of volitional decision, and the decision determined by the answer to this question belongs to the bifurcation type. If anyone tells us that he studies science for his pleasure and to fill his hours of leisure, we cannot raise the objection that this is ‘a false statement’ - is no statement at all but a decision, and everyone has the right to do what he wants (Reichenbach 1938, 10).

Becoming a scientist is an act of the will. We can safely assume that becoming a logical empiricist philosopher requires the involvement of the will, too.

We know that when committing to pursue natural science, the scientist decides to follow the rules of the game, in this case not prescribed by any particular legislator, but set in place by the desire for coherence, congruity and consistency, and imposed further by the subject under investigation. The rules of the game may be normative, conventional (social norms), and arising from natural necessity, but Reichenbach downplays conventionalism and describes the actual subject matter of scientific discovery as too complex to serve as a starting point without some logical treatment. His epistemic theory, discussed above, is a code of good practice. There are some things the epistemologist is advised to do, and some things she must avoid. By extension, there must be a code of good practice for the scientist, too. We do not need an argument to
know that there is: young people spend years training to be scientists. Reichenbach takes the scientist’s rules of conduct for granted.

What I think the scientist and the epistemologist-according-to-Reichenbach have in common is commitment to epistemic normativity. In the confines of logical empiricist scientific philosophy, likening the task of the philosopher with that of the scientist is only reasonable. Philosophy and science are not totally alike; the most scientific logical empiricist philosophy is Neurath’s (Uebel 1992, 259; Uebel 2005, 95). It is a safe bet to believe that the degree to which the logical empiricists thought philosophy was susceptible to become scientific itself was to become a sort of social science. In essence, I am saying nothing more provocative than that the protocol sentence debate was the context of justification (i.e. the defensible façade) of profound concerns about how philosophy would become scientific.

The passage last quoted conceals Reichenbach’s deep belief in the responsibility that accompanies a life dedicated to research, scientific or philosophical, behind the language of the logician. This degree of commitment would go without saying in the late 1930s. In fact, a deep sense of responsibility on the part of the researcher is still required, and it will continue to do so in the future.

The take-home of this section is that it is sensible to assume that the logical empiricists viewed themselves as scientists, but disagreed on the specific content of that situation.

3.4 Genius in Reichenbach’s philosophy
Bearing in mind the multiple purposes the composition of *Experience and Prediction* served, we would expect that if Reichenbach had a well-formulated opinion about the source and the nature of epistemic normativity in logical empiricism it would be included in this particular work; as a matter of fact, a clue can be found there. The clue is a little word, which has found its way repeatedly in his writings: it is the word ‘genius’.

Agents are not always bound by the rules of logical reasoning; science was taken to be the exemplar of rationality. How is that possible? The protocol sentence debate had arisen because some of the logical empiricists (Carnap, Neurath) were only too aware of that apparent tension. The rough-and-ready answer the logical empiricists usually deployed was that modern science is based on teamwork (Blumberg & Feigl 1931, 281; Reichenbach 1951, 119-120). The scientific enterprise is composed of the contributions of numerous people in varying fields (Blumberg & Feigl 1931, 281), but sometimes it is individual persons who produce the groundbreaking work. They are, Reichenbach tells us, exemplary manifestations of the scientific genius. We have already encountered one of the instances this concept appears in Reichenbach’s work in the passage from page 5 of Reichenbach (1938). Even though the scientific genius does not feel bound by the precise rules of logical exposition (Reichenbach 1938, 5), she, nevertheless, conforms to their essence and reaffirms them by her creativity:

> Scientific genius does not manifest itself in contemptuously neglecting inductive methods; on the contrary, it shows its supremacy over inferior ways of thought by better handling, by more cleverly using the methods of induction, which always will
remain the genuine methods of scientific discovery
(Reichenbach 1938, 383).

The scientific genius also appears in Reichenbach's later work, in *The Rise of Scientific Philosophy* (1951):

The mystical interpretation of the hypothetico-deductive method as an irrational guessing springs from a confusion of the context of discovery and the context of justification [Reichenbach alludes to Popper's work here (Popper 2005)]. The act of discovery escapes logical analysis; there are no logical rules in terms of which a 'discovery machine' could be constructed that would take over the creative function of the genius. But it is not the logician's task to account for scientific discoveries; all he can do is to analyze the relation between given facts and a theory presented to him with the claim that it explains these facts. In other words, logic is only concerned with the context of justification (Reichenbach 1951, 231).

The word genius, in the last passage separated from the accompanying adjective "scientific" found in the older book (Reichenbach 1938), appears again in a setting where Reichenbach elaborates, however briefly, on the background of the distinction between the contexts of discovery and justification. Logic's inability to offer explicative articulations of the context of discovery does not signal the downplaying of the compelling appeal discovery instances have. Discovery, in Reichenbach's brand of logical empiricism, is inexplicable, but, when the dust has settled and it has been confirmed to be genuine discovery, it
remains the traditional normative character philosophers have always ascribed to any authentic disclosure of the workings of the world.

Apparently, the argumentation involved in the defense of the foundations of logical empiricist philosophy was not an issue on which Reichenbach was prepared to dedicate much page space, even though he promised he would “attempt” to justify the “foundation” of logical empiricism (Reichenbach 1938, v). Absorbed by themes on probability and causality, and doing work on the philosophy of physics, he treated foundational concerns only in texts dedicated to introducing logical empiricism to audiences unfamiliar with it. This suggests that the foundational justification for Reichenbach’s epistemology could not be treated as a theory validated by research (scientific theories are like that, as well). This is where genius comes in: The most influential incarnation of the concept of the genius is found in Kant’s third Critique, the Critique of Judgement. The genius is the person who creates compelling original art without following the received rules. The genius is the person who gives the rule to art “by an act of legislation that is somehow not indebted to prior reasons, that is, concepts” (Pinkard 2002, 85).

If I am right, then the reliance, on Reichenbach’s part, on a Kantian concept is another instance of his endorsement of the Carnapian view of an objective world based on intersubjectivity. The assumption which underlies my last comment is that in Kant’s aesthetics the genius creates masterpieces which are compelling for everyone. It also helps us to fully understand the motivation behind Reichenbach’s debunking of conventionalism: Science’s universal appeal, pace Neurath, is not an accident of history, even if the beginnings of science may have been accidental. Science is worth of its appeal and,
moreover, it *must* be appreciated, even by the unversed or those who choose to
direct their energies to other pursuits. The logical empiricists’ general motivation
to reinvigorate philosophy in the image of science attests to their
wholeheartedly believing so.

Every justification for the distinction between context of discovery and context of
justification must emphasize the subjective, but fittingly compelling, element in
discovery, and must not let the voluntarism entailed in -presumably- every
pursuit become an obstacle to the recognition of the respect and the admiration
science deserves. My claim meets these demands, but I leave the elaboration
to wait until the section 3.7.

The genius expands the horizon of an established tradition. Science in the
modern age does not depend on its geniuses. Referring to traditionally-minded
historians of his day, Reichenbach writes about teamwork:

> Writers for whom the great personality of an individual, the
genius, constitutes the aim of historic developments, who
measure the significance of a period by a scale gauged in
numbers of masterminds, have spoken disparagingly of a century
[the nineteenth century] whose cultural aspect is not determined
by its poets, or painters, or philosophers... But the history of the
age of science and industry will never be understood by the
romanticist. The intellectual achievements of the nineteenth
century cannot be measured in terms of great personalities -
although there are such personalities- because the contribution of
an individual, outstanding as it may be, is small compared with
the group product. The number of scientific discoveries through
group-work during this period is overwhelming (Reichenbach 1951, 119-120).

I think that the sparing use of the word "genius" by Reichenbach is rather intriguing. Other than in the immediate or broader context of the contexts distinction, it appears in a few instances throughout his work, always describing particular individuals, except for the passage last quoted. He grants the attribute to a handful of historical personages and in every single instance the use of the epithet is possible to be meaningfully understood both if he has in mind his version of the genius, the genius responsible for the discovery of compelling theories of unprecedented excellence, which redefine the disciplines they belong to, or he intends the casual natural language usage.

According to Reichenbach, the mark of genius has been demonstrated by David Hume in instances where "he could give good grounds", despite the occasional unsupported insightful conclusion (1951, 87). Gottfried Wilhelm Leibniz can be said to bear the imprint of genius, because his "reducing time order to causal order" can be interpreted as having "anticipated the conception of the relativity of space and time" (Reichenbach 1971, 25). The generalization of the Gaussian treatment of surfaces to manifolds of multiple dimensions bears testimony to the genius of Bernhard Riemann (Reichenbach 1958, 248). Isaac Newton, "with a vision of a genius", realized that gravitation is a property of all mass (Reichenbach 1942, 25). Ernst Mach's genius, which allowed him to foreshadow relativity, was recognized by Albert Einstein (Reichenbach 2006, 121), whose own "philosophical vision and mathematico-physical certainty" attest to his "creative genius" (Reichenbach 2006, 159). Reichenbach's use of the characterization genius is more or less consistent, with the exceptions of
Leibniz and Mach, perhaps, to describe individuals who attained profound theoretical insights; but in these passages it can also be understood as just a token of Reichenbach's admiration for the person in question. The interpretation of the "scientific genius" appearing at the threshold of the philosophy of science might be more fruitful. The genius of Hume and Leibniz, attributed for their philosophical contributions, supports my thesis that for Reichenbach the scientist and the philosopher have more in common than what sets them apart.

We can conclude that in Reichenbach’s vision of how knowledge is produced, i) most of the work is done in groups, but ii) there are those individuals who grasp something profound and help reshape their respective fields. We should note that in Reichenbach’s day Mach, Riemann and Einstein were contemporary or near-contemporary geniuses (Riemann died in 1866, Mach in 1916 and Einstein in 1955). In addition, Riemann’s non-Euclidean geometry was used by Einstein in his general relativity theory: geniuses and teamwork did co-exist in the age of science and industry. So, in Reichenbach’s view of things there is room for genius.

3.5 Reichenbach’s neo-Kantianism

Michael Friedman has argued for the existence of neo-Kantian foundational concerns among some of the logical empiricists in a series of influential essays, most of which can be found collected in *Reconsidering Logical Positivism* (1999a). I fully subscribe to his position. During the early stages of logical positivism, before the unanimous adaptation of the name logical empiricism for the movement at Reichenbach’s instigation (Uebel 2013, 58\(^\text{21}\)), some of the

\[\text{\(^{21}\) Actual manifestations of this instigation are to be found in Reichenbach 1938: e.g. in page v, Reichenbach calls the philosophical school of which he was a member “logistic empiricism”.} \]
movement's affiliates explored in technical depth the foundations of the programme to which they subscribed. Schlick, Carnap, and Reichenbach were the most prominent figures of the sub-group with the profound foundational concerns, and it is to their work that Friedman's analyses in (1999a) refer to.

Friedman's approach calls for thinking about the beginnings of logical empiricism not as an empiricist reaction to neo-Kantianism, but as a reformation of neo-Kantianism: "Characteristic of my approach is the idea that when we take due account of the scientific and philosophical context within which logical positivism developed, we see that their central philosophical innovation is not a new version of radical empiricism but rather a new conception of a priori knowledge and its role in empirical knowledge" (Friedman 1999a, xv).

In the case of the early Reichenbach, Friedman (1999b, 60-63) reconstructs the arguments found in his first published book, Relativitätstheorie und Erkenntnis A Priori (1920), where Reichenbach argues that Kant's a priori includes two distinct but conflated notions. The a priori can be conceived as principles which are necessarily true, without any possibility of revision. It can also be conceived as just constitutive of the objects of knowledge. Reichenbach thought that the second conception should be retained. Reichenbach argues for the retention of apriority in the logical empiricist framework under the provision that it is only constitutive of knowledge relative to particular theories. In Friedman's words:

What we end up with... is thus a relativised and dynamical conception of a priori mathematical-physical principles, which change and develop along with the development of the mathematical and physical sciences themselves, but which nevertheless retain the characteristically Kantian constitutive
function of making the empirical natural knowledge thereby
structured and framed by such principles first possible (Friedman
2001, 31).

Eventually, the young Reichenbach was persuaded by a critique by Schlick
(Friedman 1999b, 67), never to rely on Kantian epistemic foundations explicitly
again.

Friedman argues persuasively that Carnap and Reichenbach were very
conscious about the need for a philosophical foundation for the logical empiricist
programme and that they provided it with one by never severing their neo-
Kantian roots. Reichenbach’s disavowals of apriority are disavowals of Kant’s
nativism only (in the following passage the disavowal is accompanied by an
advertisement of the merits of scientific philosophy, namely thorough explication
and clarity, entangled with a –presumably healthily- forceful will):

There might be raised, instinctively, an objection against our
time of induction: that there appears some thing like ‘a
necessary condition of knowledge’—a concept which is
accompanied since Kant’s theory of knowledge with an
unpleasant flavor. In our theory, however, this quality of the
inductive principle does not spring from any a priori qualities of
human reason but has its origin in other sources. He who
wants something must say what he wants; he who wants to
predict must say what he understands by predicting
(Reichenbach 1938, 360).

These “other sources” are the will and nature itself, as we will see in section 3.6.
The first chapter of Reichenbach's *Experience and Prediction* (1938) is testimony that he had not abandoned his neo-Kantian origins later in his career. However peripherally, he provided a complete systematic framework that would exclude extreme conventionalism, represented in their own ranks by Neurath, a framework which would be a justificatory background for Carnap's epistemology as represented by the *Aufbau*, and it would also be an answer to why science, being not inevitable, is here to stay; it would be an explication of science's universal appeal. I refer to the concept of genius.

Young Reichenbach’s historicized a priori should not be confused with Edmund Husserl’s historical a priori. The young Reichenbach thought that there are certain mathematical-physical principles, which pertain to science (as we would expect since they are mathematical-physical), and which change. An example of the operation of these principles is the necessary conclusion that Euclidean geometry is an inappropriate measurement representation of spacetime after the validation of special relativity. In the next sections we will see that later in his life, Reichenbach continued to think in terms of the a priori, the connotation of necessity still a characteristic of representations of the world (theories). Husserl's historical a priori is a characteristic of the thinking and doing pertaining to disciplines, not a characteristic of theories.

Let us see what Husserl’s historical a priori is. Husserl mentions it in his text “The Origin of Geometry” (Husserl 1989). In that text he problematizes the objectivity of geometry as way to reflect on the objectivity (Husserl 1989, 162) of “spiritual structures” which can be “handed down” from generation to generation of practitioners (Husserl 1989, 179), including all sciences and philosophy (Husserl 1989, 175): “…geometrical existence is not psychic existence; it does
not exist as something personal within the personal sphere of consciousness: it is the existence of what is objectively there for ‘everyone’ (i.e., for actual and possible geometres, or those who understand geometry)” (Husserl 1989, 160).

The purpose of Husserl’s line of argument is to show that there is a core of meaning in geometry, a core which persists through the historical transformations of that discipline, and which cannot be disclosed from any vantage point emerging from within the confines of any particular socio-cultural setting (Husserl 1989, 180).

Husserl argues that our empirical intuitions include the *eidetic essences* of things (either physical objects, or objects of the understanding) apart from these the factuality of these things; roughly, these essences are abstract features of things at the level of the kind (species) the relevant thing belongs to (Husserl 1983, paragraphs 2-3, 8-12, 9-11).

Husserl weaves his analysis for the essence of geometry (Husserl 1989, 165-166; 180) around certain familiar contingencies: There is the world and our sense perceptions of it (Husserl 1989, 161). Then, there is language (Husserl 1989, 161-162), which gives rise to complex communication. There are also traditions, which are established ways of doing things and which are handed over from one generation to the next through communication (Husserl 1989, 158). There are some traditions which are scientific (Husserl 1989, 165). There is the subjective thought of particular individuals, which takes place in historical settings of communication and tradition, which Husserl calls “civilization” (1989, 162). We inherit much from the past, among them tools and symbols. Husserl’s focus in this text is on symbols and on the self-evident meaning accompanying geometrical symbols (Husserl 1989, 177). The symbols which are handed down
to us acquire their significance by the functions of communication of tradition through language. Via the symbols we reactivate what-it-is to do geometry in every present (Husserl 1989, 164). Husserl asserts that this is how geometry is valid for everyone, including the deceased and any possible human being.

Husserl concludes his reflection on the contingencies and the objectivity of the scientific enterprise by bringing the historical a priori to the foreground:

Making geometry self-evident, then, whether one is clear about this or not, is the disclosure of its historical tradition. But this knowledge, if it is not to remain empty talk or undifferentiated generality, requires the methodical production, proceeding from the present and carried out as research in the present, of differentiated self-evidences… (Husserl 1989, 173).

Husserl presents us with the following picture: doing geometry is to deploy a priori principles at every present. (Husserl makes some comments which suggest that this is also ideally the case about doing history, as we will see in the next paragraph).

At the particular time Husserl happened to be writing in, a search for epistemological groundings for the sciences was a major concern (Husserl 1989, 175). However, Husserl reminds us, if this historical inquiry is to have a meaning it has to presuppose the historical a priori, which gives “factualness” to facts (Husserl 1989, 176). The historicity of the sciences does not amount to epistemic relativism. This is a conclusion we contemporaries can still associate with. For Husserl, doing science is to penetrate –consciously or not- through the historical self-evidences of each discipline and each tradition to a broader self-
evidence: it still makes sense for someone to claim that she is familiar with this broader self-evidence; we could label it plainly as ‘the way to do science’.

Husserl’s final conclusion is about every science which is concerned with “unconditioned objectivity” (1989, 179), any science which “appears” as “aeterna veritas” (=eternal truth, so history is included in the conclusion so far as it can provide appearances of eternal truth) (Husserl 1989, 179):

It is a general conviction that geometry, with all its truths, is valid with unconditioned generality for all men, all times, all peoples, and not merely for all historically factual ones but for all conceivable ones. The presuppositions of principle for this conviction have never been explored because they have never been seriously made a problem. But it has also become clear to us that every establishment of a historical fact which lays claim to unconditioned objectivity likewise presupposes this invariant or absolute a priori (Husserl 1989, 179).

So, the historical a priori of geometry is at the core of what it is to do geometry, as it persists through any contingency. These contingencies accrete on the core, allowing it to both change and remain the same, not unlike a human being who is the same and not the same as her life proceeds. Husserl's historical a priori is, for us human beings, a part of the fabric of the universe; this conception of apriority is different at a major point from the conception of apriority which we have seen in chapter 2. In that chapter we discussed apriority as one of the ways we have knowledge, not as a property of the (historically situated) scientific (i.e. objective) pursuits of human beings. Husserl's
conception of apriority is more than epistemic; our conception (and Kant’s) is merely epistemic.

In chapter 4 we will talk about Maurice Merleau-Ponty’s conception of apriority which, at first glance, appears to have similarities with Husserl's historical a priori. Merleau-Ponty is not after the disclosure of essences, since for him there are not any. With Merleau-Ponty we are still in the familiar territory of apriority as a type of knowing, a sort of getting to feel certain about one's judgements, etc.

We have seen that Husserl brings the socio-cultural element into his debate of the historical a priori. In Husserl we encounter the triad comprised of the knower, the knower’s socialization and the known. We will see again this important triad emerging in chapters 5 and 6. Our conclusion will be that reason has a history. In particular, we will see that it is the bases of apriority (reason and meaning) which are historical. Husserl does mention reason in the last paragraphs of the "Origin of Geometry" (Husserl 1989, 180), but only in passing.

Our conclusion is that Husserl's historical a priori is tied to the core (the Husserlian eidetic essence) of what it is to be a historically situated human being (Husserl 1989, 174, fn. 1) and the core of science (Husserl 1989, 177). If my overall argument in the thesis is valid, then we will have made a step in the direction that there are no such cores, contrary to what Husserl was convinced about.

In the next section I introduce Kant’s concept of genius, intending to show how Reichenbach’s thinking was groundbreaking; how he had conceived a Kantian
explication of epistemic normativity which applied to science and philosophy alike.

### 3.6 Nature gives the rule to science

Although he was not the first to include the genius as a major creative force in a philosophical theory, the most prominent treatment of the concept of the genius is found in Kant's aesthetics. He introduces the concept of genius in paragraph 46 of the *Critique of Judgement* (Kant 1987, heretofore CJ):

> Genius is the talent (natural endowment) that gives the rule to art. Since talent is an innate productive ability of the artist and as such belongs itself to nature, we could also put it this way: *Genius* is the innate mental predisposition (*ingenium*) through which nature gives the rule to art (CJ, 307, 174, original emphases).

In the same paragraph, Kant goes on to describe the characteristics of the genius, which are originality, the production of exemplary works, inability to describe or explain how the masterpieces were created and inability to create another masterpiece at will. Kant adds a last characteristic: "Nature, through genius, prescribes the rule not to science but to art, and this also only insofar as

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22 The text in the square brackets and the parentheses in the quotations in this section are clarifications and presentation chosen by the trans. (W. S. Pluhar) of the *Critique of Judgement* respectively. The discussion in this section is informed by Paul Bruno’s ananysis of Kant’s concept of ‘genius’ (Bruno 2010, ch. 3 & 4) and by Paul Guyer’s assessment of Kant’s positions on reason and reflective judgement, comparing the *Critique of Pure Reason* and the *Critique of Judgement* (Guyer 2005).

23 Where the word ‘nature’ appears in this section and the next, its intended meaning is that of Kant in the *Critique of Judgement* and not his meaning in the *Critique of Pure Reason*. The only instance where the second meaning is relevant here is in a quotation where Kant speaks explicitly of the “concept of nature” (CJ, 207′, 396).
the art is to be fine art" (CJ, 308, 175-176). He repeats the role of the genius in (CJ, 311, 179): "Judging beautiful objects to be such requires taste, but fine art itself, i.e., production of such objects, requires genius" (original emphasis).

A significant point, brought up by Desmond (1998, 598), is striking: in the Critique of Pure Reason the self gives the rule to nature. In the Critique of Judgement the reverse seems to be the case. This could not have escaped the attention of a serious student of science, like Reichenbach. With Kant's theses on knowledge and science largely banished from logical empiricism, the thought that nature eventually dictates itself to the genius can sensibly lead to the view that instead of fine art, groundbreaking scientific theories are better candidates for participation in Kant's framework for judgement. In short, I claim: science is the elucidation of the sublime qualities of nature, or, even briefer, there is fine science.

Let us examine fine art more closely. In the Critique of Judgement, fine art is contrasted to mechanical art, which is a mere presentation of a possible object to our cognition, and with agreeable art, whose purpose is just enjoyment. Mechanical art is not aesthetic, but agreeable art is, along with fine art (CJ, 304-306, 172-173). Then Kant offers a definition of fine art: "Fine art... is a way of presenting that is purposive on its own and that furthers, even though without a purpose, the culture of our mental powers to [facilitate] social communication" (CJ, 306,173). For Kant, culture is "man's aptitude in general for setting himself purposes" (CJ, 431, 319). Social communication needs a minimal common ground in order to take place as Kant intends it, i.e. to possess a definite normative character despite the subjective nature of aesthetic judgement (CJ, 292-293, 159). This common ground is provided by a feeling shared by all
human beings, the feeling of aesthetic pleasure. Kant asserts that “This pleasure must of necessity rest on the same conditions for everyone” (CJ, 292, 159).

Kant's aesthetics include some restrictions to genius, brought forth by the need for social communication based on a common ground. Kant uses the concept of taste to take into account both the subjective agreeableness and the objective perfection of a masterpiece (CJ, 341, 214). First, he clarifies that taste is definitive for the objective recognition of fine art as such:

...insofar as art shows genius it does indeed deserve to be called inspired [geistreich], but it deserves to be called fine art only insofar as it shows taste... In order [for a work] to be beautiful, it is not strictly necessary that [it] be rich and original in ideas, but it is necessary that the imagination in its freedom be commensurate with the lawfulness of the understanding (CJ, 319, 188, original emphasis).

Kant says nothing more profound in this passage than the following: fine art is not radical for the sake of being radical, but it pushes the established boundaries (rules) to amendment or even demise through affirming the reasons for their having been set up in the first place. The alignment with the other parts of Kant's critical philosophy comes when Kant introduces what he calls the "antinomy of taste" (CJ, 338-339, 210-211): taste is subjective, but despite its personal character, we can still disagree and quarrel about matters of taste. So, Kant thinks, the reconciliation between these two opposed theses (CJ, 338-339, 211) must be the "supersensible" (CJ, 340, 213; 341, 214), which, very
interestingly for our purpose here, is "the point [where] all our a priori powers are reconciled" (CJ, 341, 214):

...all contradiction disappears if I say this: A judgment of taste is based on a concept (the concept of a general basis of nature's subjective purposiveness for our power of judgment), but this concept does not allow us to cognize and prove anything concerning the object because it is intrinsically indeterminable and inadequate for cognition; and yet this same concept does make the judgment of taste valid for everyone, because (though each person's judgment is singular and directly accompanies his intuition) the basis that determines the judgment lies, perhaps, in the concept of what may be considered the supersensible substrate of humanity (CJ, 340, 213).

In order to shed full light on the preceding quote, some terminology is useful. For Kant, understanding is “the ability to cognize the universal (i.e. rules),” reason is “the ability to determine the particular through the universal,” and judgement “mediates the connection [Zusammenhang] between understanding and reason” (CJ, 202', 391-392).

Nature, according to Kant, makes itself intelligible through the idea of purposiveness of nature, which allows to our subjective judgements to grasp its (nature's) lawfulness:

Now it is clear that reflective judgment, by its nature, cannot undertake to classify all of nature in terms of its empirical variety unless it presupposes that nature itself makes its transcendental laws specific in terms of some principle. Now
this principle can only be that of [nature's] appropriateness for the power of judgment itself, [i.e., for judgment's attempt] to find among things, [despite] their immense diversity in terms of [all the] possible empirical laws, sufficient kinship to be able to bring them under empirical concepts (classes), and bring these under more general laws (higher genera), and so arrive at an empirical system of nature (CJ, 215’, 403).

Through the idea of purposiveness, nature -for Kant, nature always as it is represented by art and not as described by scientific theories- reaches our minds and reveals aspects of its lawfulness to us. Notice that Kant is talking about reflective judgement. A reflective judgement is its own a priori law: “A reflective judgement cannot take laws from somewhere else (since judgement would there be determinative)” (CJ, 180, 19). The conclusion of this line of argument is that so long as we can assert an empirical system of nature, with its categories, hierarchies and patterns, we can "regard nature as art" (CJ, 215’, 403). The cognition that we can regard nature as art is the concept of purposiveness of nature.

Purposiveness is entirely subjective. Kant writes that: "This concept [of purposiveness] belongs to reflective judgement, not to reason, because the purpose is not posited in the object at all, but is posited solely in the subject: in the subject's mere power to reflect" (CJ, 216’, 404). Kant is even more emphatic: "...purposiveness does not determine anything regarding the forms of natural products, since it is only a subjective principle of the division and specification of nature" (CJ, 219’, 407).
It is the subjective nature of purposiveness which forces Kant to introduce the concept of taste in order to show that the beautiful is more objective than just what we like. What we like, however, is binding, even if it is not universal in its raw form. Its compelling character rests on the power of judgement alone:

Now the power of cognition according to concepts has its a priori principles in pure understanding (in its concept of nature), and the power of desire has its a priori principles in pure reason (in its concept of freedom). That leaves, among the general properties of the mind, an intermediate power or receptivity, the feeling of pleasure and displeasure, just as judgment is left as an intermediate power between the [other] higher cognitive powers [understanding and reason]. What is more natural to suspect that judgment will also contain a priori principles[,] for the feeling of pleasure and displeasure? (CJ, 207'-208', 396).

The argument up to this point goes like this: Nature conforms to our ability to make judgements. Its intelligibility as a system, by virtue of the idea of purposiveness of nature, would not be possible if judgements were not invested with apriority, i.e. if they were not self-justified. Our ability to regard nature as an intelligible system leads to the creation of artistic representations of nature, some of which are masterpieces. Masterpieces are the work of genius.

I think that Reichenbach never abandoned the leaning in favour of aprioristic foundations he showed during his early career. For masterful scientific representations of the world, like Darwin’s evolutionary theory and Einstein’s relativity theory, Reichenbach’s adopting the Kantian conception of genius
signifies that in Reichenbach’s logical empiricism these theories are self-evident, accurate representations of the world. In effect, I think that Reichenbach might have thought of scientific theories as art (which, of course, represents nature). As such, they prescribe the varieties of conventional systems which have empirical significance; Euclidean geometry is definitively not an empirically significant metric of spacetime.

The young Reichenbach’s attempt to define apriority only as constitutive of the objects of knowledge and not as a warrantor of necessary truth or warranting non-revision for all time (Reichenbach 1965, 48) included his claim that there are certain constitutive a priori rules, the principles of coordination (Reichenbach calls them axioms of coordination in 1965, 54), that establish the existence of reality through a process, effectively an interplay between logically ordered propositional representation of the world and experience as such, which Reichenbach called mutual coordination (Reichenbach 1965, 42). In Newtonian physics Euclidean geometry had been a priori and, in virtue of that quality, constitutive. In the context of general relativity Euclidean geometry is no longer constitutive; in fact, no physical geometry (the metric of physical space) is any longer constitutive. Within general relativity, geometry is empirical; in addition, within general relativity Euclidean geometry is false (Friedman 1999b, 66). The mathematicians might develop multiple speculative frameworks, but they are not all epistemically equivalent. The world cannot be represented accurately if we substitute one such framework for another. In Reichenbach’s words:

...mathematicians asserted that a geometrical system was established according to conventions and represented an empty
schema that did not contain any statements about the physical world. It was chosen on purely formal grounds and might equally well be replaced by a non-Euclidean schema. In the face of these criticisms the objection of the general theory of relativity embodies a completely new idea. This theory asserts simply and clearly that the theorems of Euclidean geometry do not apply to our physical space (Reichenbach 1965, 3-4).

Moritz Schlick thought that in the context of general theory of relativity geometry remains non-empirical. In an exchange of correspondence with Reichenbach in the autumn of 1920, Schlick argued that no empirical considerations can force us to adopt a particular geometrical system over another. When the systems of mathematical representation change, the laws of nature also change. Schlick points out that it is not just physical geometry alone that is confronted with reality, but our total theory of nature. If we choose a certain geometrical system as the metric of space(time), the totality of natural laws will be affected. It is required, then, that we single out the geometry which gives us the simplest totality of natural laws under the light of what is known from experience (Friedman 1999b, 62-65\textsuperscript{24}). In Schlick’s conception Euclidean geometry remains a viable option if the empirical data allow it and simplicity considerations lead us to it. The geometrical system in the correspondence between Schlick and Reichenbach is an example of a constitutive principle. For both of them the choice of principle is relativized, but Schlick stresses that such principles cannot be properly called a priori, because they are stripped of any necessity by definition. (Friedman 1999b, 63). Reichenbach finally agreed with Schlick

\textsuperscript{24} The letters are available online at http://echo.mpiwg-berlin.mpg.de/content/modernphysics/reichenbach1920-1922
(Friedman 1999b, 67), explaining that the whole matter was a confusion over terminology (Friedman 1999b, 63). After the exchange he never mentioned the relativized a priori explicitly again.

For Reichenbach it is the wholehearted commitment to research that would culminate in the cultivation of epistemic taste:

We may add the remark that the distinction of the context of justification from the context of discovery is not restricted to inductive thinking alone. The same distinction applies to deductive operations of thought. If we are faced by a mathematical problem, say, the construction of a triangle from three given parameters, the solution (or the class of solutions) is entirely determined by the given problem. If any solution is presented to us, we may decide unambiguously and with the use of deductive operations alone whether or not it is correct. The way in which we find the solution, however, remains to a great extent in the unexplored darkness of productive thought and may be influenced by aesthetic considerations, or a 'feeling of geometrical harmony' (Reichenbach 1938, 383-384)

To recapitulate: Reichenbach's writings are silent on the extent he would wish to apply Kant's views in logical empiricism, but from his insistence on the primacy of the epistemic agent’s will (Reichenbach 1938, 10), it is just plain that he would not be at all inclined to subscribe to any universal conception of taste. But there is no need for such a thing: Reichenbach, with his emphasis on genius rather than on what I have called fine science points directly to the individual subject's power of judgement.
Reichenbach’s insistence on the role of the genius in science entails that once an agent has decided to become a scientist, the conceptual frameworks to which she subscribes include empirically indemonstrable convictions about the aptitude of nature to be made sense of. The indemonstrability of those convictions can be overcome by Kant’s appeal to the apriority of judgement. So, it seems that for Reichenbach there is indeed the possibility of fine science, *pace* Kant (CJ, 305, 172). Nature gives the rule to science through genius.

But the power of judgement is not the exclusive domain of natural scientists. So, Reichenbach’s reference to the genius does not only commit him to believing there is fine science, but fine *episteme*\textsuperscript{25}, more generally. Philosophers, mathematicians, social scientists, engineers, every conceivable kind of researcher might produce work destined to be a standard of reference.

### 3.7 Further remarks

It appears that Reichenbach was equally committed to relativized principles and to their a priori status. If my argument is correct, he found a way to reconcile them by evoking the Kantian notion of genius. The protocol sentence debate was irrelevant to Reichenbach because he was willing to permit self-evident empirical mental content throughout his career. At this point we should remember Reichenbach’s casual attitude to verificationism (chapter 2, section 2.5), namely:

> Verification… is an act of comparison between the objects and the symbols. It is, however, not… a comparison which would demand a certain similarity between objects and symbols. It is…

\textsuperscript{25} I mean Aristotelian *episteme*. 
a comparison in which we must apply the rules of language,
understanding their contents (Reichenbach 1938, 32).

A major difference between Kant and Reichenbach, one which can help us analyze the implications of Reichenbach's reliance on the scientific genius, is that in Kant's analysis of the understanding, apriority plays a part in making experience explicit (cognizable) in a subject's consciousness, whereas in his analysis of the role of apriority in judgement what becomes explicit (intelligible) is the whole of nature as a system, a system whose intelligibility is invested with the average subject's endowment—a natural tendency of the human mind—to make sense of it as purposeful. We remember that the objectivity found in Kant's philosophy is untenable in the scientific philosophy of the logical empiricists; determinative judgement is empirical, but neither evolution nor the curvature of spacetime could be found directly in experience. We have also described in some detail how Reichenbach attempted to accommodate this development with the relativization of the a priori. Later Reichenbach stopped developing the relativized a priori but I think that he never abandoned it. If I am correct in my diagnosis that the genius is an element of the base of Reichenbach's empiricism which he did not let go, and, consequently, an element that cannot be eliminated, then Reichenbach overcame the problem of Kant's restrictive objectivity by transferring the emphasis from cognizability to intelligibility. This does not mean that the work of the scientist is subjective, but the commitment to science is a decision. But the subjective is still at work; it gives rise to genius and it also makes an a priori judgement fallible. Further, it leaves the feeling of certainty present in the genius's mind inexplicable; such feelings belong to the context of discovery, and are thus a complicated matter not affording reconstruction. Finally, the apriority in the mature Reichenbach's
work is not the only scaffold which helps scientific theories to develop. As we have seen, Reichenbach -grudgingly- allows that conventions play a part in theories, too, although he denies that they can be found in the foundations.

We can conclude that the quest for apriority during Reichenbach's career lead him to flirt with the Kantian purposiveness of nature from at least the middle of his professional life until his death. I am using the verb flirt, because the affinities with Kant's *Critique of Judgement* become plausible only after reconstruction.

The infrequent use of the word ‘genius’ by Reichenbach, always in the vicinity of the context of discovery/context of justification distinction, or accompanying discussions of historical personages has led me to suspect that he intended it to be more than a habitual passing reference. I thought that it might somehow hint at an explication for the contexts distinction; Reichenbach introduces it rather abruptly both in (Reichenbach 1938) and (Reichenbach 1951), without any defence apart from a masterfully articulated but still vague claim that there can be no logic of discovery. I would expect a philosopher as meticulous as Reichenbach to be able to justify his claim; in this chapter I argue that he does not fail to meet the expectations. According to Reichenbach, I may affirm at this point, there can be no logic of discovery because, following Kant, we can only assert that nature reveals itself to the prepared mind’s judgements, not how it does it.

I should say that my argument for the mature Reichenbach’s neo-Kantianism (apriority of judgement) is an inference to the best explanation. It is the best explanation not only because it explains why Reichenbach was not interested in questions of foundations, but because it also is a perfect match to his moral
behaviourism, based on the will. “Everybody is entitled to set up his own moral imperatives and to demand that everyone follow these imperatives” (1951, 295), he writes. He calls this volition (a volition is an act of the will) the “democratic principle”. He explains further:

I do not derive my principle from pure reason. I do not present it as the result of a philosophy. I merely formulate a principle which is at the basis of all political life in democratic countries, knowing that in adhering to it I reveal myself as a product of my time. But I have found that the principle offers me opportunity to propagate and, in large measure, to follow my volitions: therefore I make it my moral imperative (Reichenbach 1951, 296).

This might read forceful, but it is not intended to be so:

We try to pursue our own volitional ends, not with the fanaticism of the prophet of an absolute truth, but with the firmness of the man who trusts his own will. We do not know that we shall reach our aim. Like the problem of a prediction of the future, the problem of moral action cannot be solved by the construction of rules that guarantee success. There are no such rules (Reichenbach 1951, 301).

So, Reichenbach articulates some kind of faith in following our will in matters moral. He does so in matters epistemic too. The passage that follows was written in 1928:
Rational knowledge in our sense is not tantamount to categorization within the pre-established cubbyholes of a reason that governs *a priori*, but simply amounts to unconditional faith in the power of the human capacity for knowledge—within the framework of a critique of its own goals. Thus the rational element is itself subject to change; and it emerges with increasing clarity that the basic stance of science is a faith more akin to an instinct than to rational insight, to will than to knowledge. Thus the will, the tenacious, malleable, indefatigable, and yet, eternally modifiable will is probably the basic element that truly represents the world view standing behind the scientific investigation of nature (Reichenbach 1978, 244).

Notice that in this passage Reichenbach is not stripping apriority bare of its epistemic authority; he is just not recognizing the authority of reason to be “the origin of certain concepts and principles” (*Critique of Pure Reason*, A299/B355). Reichenbach’s philosophy rests on the meta-epistemic “faith” that you must persist in following the prerogatives of your will. In matters empirical this faith is like an instinct. The reason why is the Kantian blueprint for the apriority of judgement and nature’s intelligibility: nature can be revealed to the willing, that is the creed of the faith. Instincts are compelling. Rational insight might be or it might be not. Reason alone can hardly motivate us. Remember that Kant did not deduce the apriority of judgement, he suggested it. This is what Reichenbach does, too, concerning the “faith akin to instinct”.

The application of the neo-Kantianism of the mature Reichenbach concerns the status of the context of discovery/context of justification distinction. It is obvious
that it did not find its way in Reichenbach’s epistemology because it is an intersubjectively a priori justified judgement: it is not a (part of) representation of nature (i.e. the actual processes of thought in this case), valued by peers, and it is not an empirical fact (Reichenbach 1938, 4-5). The contexts distinction is in fact a maxim imposed by reason on the logical empiricist, in virtue of logical empiricism’s own basic assumptions. Reason is the ability to determine the particular through the universal (CJ, 201’, 391). A maxim is a subjective principle of willing (Groundwork of the Metaphysics of Morals, 400, 29). Maxims are instrumental rules of the form ‘if my aim is x, and x is achieved by means of y, then I have to do y’.

The radical application of Kant’s aesthetics in the field knowledge permits Reichenbach to warrant the epistemic normativity of science by still granting conventions a part in his epistemology. It also serves as testimony that he was genuinely persuaded Schlick had been largely right to object to the relativized a priori of his early career. Most significant of all, the radical application of Kant’s aesthetics shows that Reichenbach could both feel a feeling of epistemic harmony and rationally reconstruct it.

So now we can see that Reichenbach did not quite intend the contexts distinction to be the “hallmark” of the philosophy of science, despite its featuring among the basics of his epistemology. It is just a maxim. So Reichenbach uses it as a first step to support a conclusion like the following: ‘if you are an empiricist, then you can have knowledge of the world’. This brings us back to Reichenbach’s programmatic intent, this intent being no other than to make philosophy immune to fanciful conjecture by modelling it on the (wonderfully no-frills) natural sciences. Reichenbach pursued a scientific philosophy
(Reichenbach 1951). The contexts distinction and the rational reconstructions is just a way to get his formal philosophy going without being forced to engage in arguments even Kant did not attempt to pull through (judgement’s apriority).

I am not alone to think that the contexts distinction has only methodological import in Reichenbach’s work. Clark Glymour and Frederick Eberhardt (2012) argue that:

...the [contexts] distinction is supposed to be between objective relations among premises and conclusions, and subjective ways of discovering those relations. The ‘context of discovery’ is not about search for hypothesizes or about the order in which hypothesizes are considered but about the search for the objective inductive relation between a theory and a body of evidence (Glymour & Eberhardt 2012).

This conclusion is correct to the iota. Then they go on saying:

Reichenbach seems not to have given any thought to questions about how to come up with hypothesizes and about better and worse ways to search through the space of logically possible theories (Glymour & Eberhardt 2012).

This is accurate, too. The benefit of my analysis explains why he did not engage in these two pursuits: the first, how to come up with hypothesizes is hopeless in the setting prescribed by the Critique of Judgement and the second is covered by the “no rules” character of the “faith akin to instinct” that is the requisite of scientific inquiry paired with the faith’s content, namely that nature reveals itself, which, according to Kant, is unjustifiable.
We can now see clearly that the rational reconstructions, for Reichenbach at least, are not different from scientific theories. My claim here is that in Reichenbach’s philosophical system the philosopher should do what the scientist does.

Scientific theories are only representations of the world; they are not the world itself. For instance, Darwin’s theory of evolution is not a detailed narrative of trait changes in individuals in discrete populations that eventually led to the emergence of other species. Similarly, Einstein’s special relativity theory is not a motion picture of the (relativistic) mass augmentation of an object continuously accelerated from within an observer’s frame of reference, but a mathematicized representation, which predicts such a phenomenon.

3.8 Conclusion

Now let us return to Rheinberger and his criticism of the contexts distinction. We do not need Reichenbach’s maxim to remain faithful to the parts of his motivation for scientific philosophy that can withstand criticism today. A major such point is the following:

It is important to follow the concepts by which the theory finds its way step by step and to level criticisms at the theory from the same intellectual path as was used in the creation of the theory. This work derives from such an attitude; indeed to renounce this method would achieve nothing but to promote traditional representations to a status of absolute predominance.

(Reichenbach 2006, 97.)
Of course, now the traditional representations include Reichenbach’s own work and the philosophy of the successors of the logical empiricists who considered the contexts distinction to be the extremely important. But we would definitely be faithful to Reichenbach if we allowed the contexts distinction to rest.

Reichenbach’s affiliation with apriority (we are always talking about Kantian apriority in the setting of contemporary philosophy with respect to apriority’s properties) and his moving in the direction of personal involvement-in-the-world as the source of epistemic normativity are intriguing in the sense that they can direct us towards practice. By involvement-in-the-world I only wish to convey Bernard Williams’s argument that normativity’s compelling character concerning our actions requires our caring about doing or not doing a particular action (chapter 2). The logical empiricism of the mature Reichenbach is a fitting preamble to the conceptual intricacies of a normative philosophy of science which takes into account not scientific thinking alone, but scientific thinking and doing. In Reichenbach’s philosophy, however, we do not see scientific doings featuring much: the protagonist is the will of the individual scientist rather than her reasoning (which we are to understand as thinking and doing). The scientist’s will is committed to the scientific framework, viz. scientific theories, with the use of which she reveals the workings of the world. In Reichenbach the balance is tipped in favour of theories, regarded as representations of the world, not unlike works of art.

This picture excludes the importance of experimentation which is conducted for its own sake, largely or entirely independently of theory. Rheinberger’s polemic tone concerning the contexts distinction is justified, with the qualification that if it is directed against Reichenbach himself, then it is a bit unfair.
The bottom line of Reichenbach’s work is that we philosophers should open ourselves to the possibility of the need to redefine rational knowledge by carefully attending to the way the scientific enterprise is conducted: the philosophy of experiment suggests that “traditional representations” (Reichenbach 2006, 97), in this case the logical empiricist orientation towards scientific theories, had better be overcome. The practice approach does that, and so, it is faithful to the substance of Reichenbach’s legacy. It is time we turn away from scientific theories to practical scientific understanding. We will do so through the notion of skill.
4. From Skill to Apriority

4.1 Talking about slime moulds

In chapter 2 we were introduced to the contemporary conception of apriority from the angle of general epistemology. In chapter 3 we encountered the idea that nature reveals itself to people who approach it in the proper way. In the present chapter we will see how apriority is related with skill through the work of Hubert and Stuart Dreyfus and Maurice Merleau-Ponty.

First we will see scientific skill in action, in order to see how logical empiricist emphasis on theory can lead us to veer too far from actual science. The following quote is from the autobiography of John Tyler Bonner, who is a developmental biologist specializing in the study of the life cycles of slime moulds. Slime moulds are a heterogeneous group of primitive organisms which use spores to reproduce. Slime moulds are eukaryotes; their cells have a nucleus and other intracellular structures like our own cells and unlike bacteria. They are called moulds because some of them have the appearance of moulds, and slime because some of them look like viscous, slippery liquid. Slime moulds feed on other microorganisms, like bacteria, and most species live in the soil. The slime moulds Bonner refers to in the passage below spend most of their life cycle as amoeba-like single cells. They belong to the species *Dictyostelium discoideum* (Bonner 1947). When the bacteria in the small area they inhabit are depleted, a large number of them form a diaphanous “multicellular organism” called a slug (Bonner 2002, 57). The slug looks like one of those snails in shape and fashion of motion. Bonner calls the slug an organism because it has a front and a hind end and it moves in response to light and heat stimuli (Bonner 2002, 57). The slug migrates until it stops to form a thin, tall structure rising up a few
millimetres (Bonner 2002, 58). The structure disseminates spores. Some amoebae shape the structure’s stalk. The cells at the structure’s top become spores.

One of the stages of the *D. discoideum* life cycle is aggregation. At this stage the cells begin to move in concert towards a particular area. Aggregation ultimately leads to the formation of the slug. Bonner found that the amoebae responses are caused by chemicals, a phenomenon called chemotaxis.

I tried hard to keep an open mind and investigated the possibility that the amoebae were oriented by some sort of electrical force or by some interfacial phenomenon happening on the surface between the moving amoebae and the substratum in an attempt to demonstrate... contact guidance [following the research of the day]. I even tested the idea that a center might be giving off some sort of ray because in those days people were still talking, although with considerable skepticism, about ‘mitogenic rays’ that were supposed to stimulate growth. None of these things worked; all my experiments seemed to rule them out. At the same time I could not prove chemical attraction either.

During the course of this work I had developed a way to have aggregation occur on the bottom of a glass dish under a layer of water. One day, to see if a current affected the orientation of the amoebae, I decided to swirl the water very slowly in a circular dish with a bent stirring rod over some aggregates. I left the motor running and after some time glanced through the dissecting scope to see what happened. I was really not
expecting much, and what I saw nearly blew me through the roof. The current had produced an asymmetrical aggregation pattern: there were no oriented amoebae upstream of the center; they seemed to be wandering about aimlessly, while the amoebae downstream were perfectly oriented toward the center and moving against the current. In a flash I realized the attraction had to be by diffusion, and the diffusing agent had been moved downstream by the current, like wind moving the smoke from a pile of leaves in the fall, with no smoke upwind, and the smoke trailing long distances downwind. What surprised me afterwards was how quickly I read the message sent to me through that one glance into the dissecting microscope. Instantly I saw that chemotaxis had been proved, and that I had made the discovery that would get me a satisfactory thesis. I remember dancing about my lab room and punching the air in my excitement.

The experience also taught me a great lesson. I had not carefully designed an experiment that would prove diffusion; I had managed it by accident. That and all the other observations I had made told me that the slime molds were in charge, not I. They would let me know their secrets on their terms, not mine (Bonner 2002, 76-78).

Bonner’s narration of his discovery of chemotaxis is a brief and clear account. You will notice that a possible first-hand description of nature revealing itself to genius might read like Bonner. There is, however, a problem: Bonner’s science
is not about making broad theoretical representations. We need a philosophical framework which will be able to encompass science as *exploration* (experimentation) as well as science as *cartography* (theory). I use ‘cartography’ here as the sedimentation of exploration in easy-to-access forms.

More importantly, try as he might, Bonner was not able to make progress. It took an informed accident to achieve that. It seems that Reichenbach’s belief in the force of the will is hardly the fullest explication possible for Bonner’s doctoral research experience: I think we can do better. Reichenbach’s shortcomings suggest we approach science from a different angle.

The best way to conceptualize Bonner’s experience is not in terms of logical reconstruction or the influence of theoretical considerations on experimentation, but in terms of experimental systems and epistemic things. Bonner was taught that to not be frustrated, he had to follow the material transcendence of the things from then on.

I have spoken about Bonner’s ‘accident’ as an informed accident. What I mean is that in all probability an undergraduate student would not have been able to arrive at such an accident without the guidance of a supervisor. This observation leads us to skill. It is through skill that we will arrive at the role of the subject in the practice approach to the philosophy of science that we have witnessed Rheinberger mentioning. Bonner’s narration sets the tone for the the present and the following chapters.

The notion of skill is no stranger to the philosophy of science. Michael Polanyi builds his philosophy of science on skill. Knowledge begins in the sphere of the personal, Polanyi argues. The “personal” in Polanyi’s epistemology is elucidated further by a concise analysis of the structure of skill (Polanyi 2009, 51). The
notion of skill with its meaning of purposeful doing allows us to make sense of various activities, as well as to learn them, even if the underlying principle is unknown and it cannot be known either via science or through introspection (Polanyi 2009, 51). An example of such an unknown principle given by Polanyi is a cyclist’s ability not to fall (Polanyi, 2009, 51). Polanyi does not offer us a structure of skills as such: To get a closer look at the structure of skills, we will have to see the work of Hubert Dreyfus and Stuart Dreyfus on skilful performance and its acquisition. The connection between Polanyi and Dreyfus & Dreyfus, as we will see in the next section, is the observation that we do not need to know the underlying principles of our conduct in order to act purposefully and to think meaningfully.

4.2 The Dreyfus and Dreyfus model of skill acquisition

Hubert Dreyfus and Stuart Dreyfus have modelled the full range of skill acquisition and skilful performance, from novice to expert (Cf: Dreyfus & Dreyfus 1986. Original version: Dreyfus & Dreyfus 1980. A recent formulation can be found in Dreyfus 2002. The most recent development of the model of skill acquisition is presented in H. Dreyfus 2009). The classic version of the Dreyfus & Dreyfus model describes five stages of expertise: novice, advanced beginner, competence, proficiency and expertise (Dreyfus & Dreyfus 1980, 7-14, Dreyfus & Dreyfus 1986, 21-36, Dreyfus 2002, 368-372). Hubert Dreyfus has recently added a sixth stage in the model, the stage of mastery (H. Dreyfus 2009, 40-44).

The authorship of the model of skill acquisition belongs to both Dreyfus brothers, Hubert and Stuart. The development of the philosophic aspect of the model, i.e. its relation to Merleau-Ponty’s philosophy of being-in-the-world
appears mostly in papers authored by Hubert Dreyfus, who is the philosopher of the pair. Heretofore when I write “Dreyfus” in sentences or citations, I refer to Hubert Dreyfus.

As addressed by Dreyfus, the answers to the question of the structure of skills and skill acquisition, as well as the question of an analysis of expertise make the expert knower tangible. Dreyfus's philosophical method, phenomenology, shares -in fact presupposes- Merleau-Ponty's pre-reflective (Merleau-Ponty 2002, 347) or tacit cogito (Merleau-Ponty 2002, 469-470) which aims to break down the object-consciousness dichotomy.

The novice finds herself in a position where she must begin practicing the skill she intends to learn, being entirely in the dark about what to do, what to expect, about the relevant jargon and the pertaining facts. So, the instruction process usually begins with the presentation of decomposed features of the task to be done. No prior specific knowledge is expected; the features presented to the novice are easy to recognize. The beginner is given rules to follow, triggered by these features (Dreyfus 2009, 27). Dreyfus uses examples of instruction for learning a motor skill and an intellectual skill. He also presents the minutiae of instruction in the lecture hall. A newcomer to automobile driving is told to shift to second gear when the RPM, indicated by the dedicated gauge, reach a certain reading. The novice chess player is told about a numerical value assigned to each piece, accompanied by the rule that in an exchange during a game the value of the lost pieces should be less than the value of the captured ones. In the classroom, the teacher provides the students with the facts and procedures the students will use in their drills and exercises (Dreyfus 2009, 27-28). In the novice stage, the learner absorbs information and is provided with the rules
about how to deal with the newly learnt. Usually, no justification of the rules provided is mentioned; novices do not understand the practice enough to ask for one.

After some time of engagement in the form of practice, the student notices, or is directed by the instructor to notice, additional meaningful aspects in real situations. The learner is now an advanced beginner and is able to interpret the rules in the context of the skill she practices. The purpose of the rules as summaries of a huge variety of possible situations becomes quite apparent at this stage. The few rigid rules become numerous malleable maxims and the importance of the actual situation for rule application increases (Dreyfus 2009, 29). The advanced beginner student driver learns the value of maxims like: shift up when the motor sounds like it is racing, shift down when it sounds like straining. The chess advanced beginner begins to recognize over-extended positions and how not to expose her mock army. She also begins to recognize certain piece layouts as strong or vulnerable, despite the lack of any textbook definition about each possible piece deployment. The player has a grasp of maxims like 'attack a weakened king's side'. In the teaching process, pieces of information are contextualized so that the student can begin to form an appreciation of its significance. The teacher functions as a coach, who adjudicates or provides various maxims for organizing and understanding the material (Dreyfus 2009, 29).

The third stage in the process of skill acquisition is competence. With the augmentation of experience, the number of potentially relevant elements and procedures that can be recognized as pertaining to the situation increases exponentially. At this point a sense of what is important in a situation is missing;
as a result, performance becomes frustrating and exhausting. It is at this stage that the performer realizes or is informed by the tutor that to cope with the multiple manifestations of relevant details in the situations she is called to respond to, she will have to restrict herself in devising a plan or choosing a perspective. The performer attempts to withdraw to rules and maxims like the ones given at the two beginner stages of expertise. At this point, however, objective rules and direction-pointing definitions are hard to come by, because real situations differ greatly from the controlled environment where the drills take place. The learner faces the possibility of failure. Failure at this stage is not perceived as failure in some exercise; the learner is conscious of her part in decision-making. The choice of perspective or plan to tackle the task introduces the learner to responsibility, because the probable insufficiency of the chosen way to address a particular problem is a real prospect. The competent practitioner becomes emotionally involved with what she is doing (Dreyfus 2009, 30-31). It is from this stage onwards that we can think of the learner as practitioner proper and not as student.

When exiting the freeway, the competent driver learns to pay attention to the speed of the vehicle and to forget about shifting gears. Other factors calling for attention here are the dryness of the surface of the road, the steepness of the curve, etc. The competent driver knows that she has to take these factors into account if the car is not to skid. She decides if she will have to let up on the accelerator, or to remove the foot from that pedal, or to step on the brake. The coordination of expectation and action resulting in a smooth vehicle trajectory creates a feeling of elation. Last-moment corrections can lead to embarrassment. The timing becomes a feature of the situation. Similarly, the competent chess player must judge if the opponent has weakened her king
irrevocably and in which turn to attack. She will ignore some opponent advances and lost pieces, perhaps underestimating her own weaknesses. In the classroom the risks and a sense for the right moment for action are not so pronounced. Nevertheless, the emotional involvement is crucial so that the student is provided with incentives for immersion beyond extensive information accumulation (Dreyfus 2009, 31-34).

The fourth stage in the Dreyfus model is proficiency. Emotional involvement is still in the frame (Dreyfus 2009, 34):

As the competent performer becomes more and more emotionally involved in his task, it becomes increasingly difficult for him to draw back and adopt the detached maxim-following stance of the advanced beginner or perspective-choosing behavior of the competent performer. If the detached stance is replaced by involvement, and the learner accepts the anxiety of non-deliberative response, he is set for further skill advancement (Dreyfus & Dreyfus 2008, 4, original emphasis).

The positive and negative emotional experiences inhibit unsuccessful responses to varying situations and reinforce successful ones. The performer's explicit understanding of her skill, like rules and principles, is replaced with "situational discriminations, accompanied by associated responses" (Dreyfus 2009, 34): her “theory of the skill” (Dreyfus 2009, 34) is gradually replaced by intuitive fitting responses to the situation:

Then, the resulting positive and negative emotional experiences will strengthen successful perspectives and inhibit unsuccessful
ones, and the performer's theory of the skill, as represented by rules and principles, will gradually be replaced by situational discriminations. Proficiency seems to develop if, and only if, experience is assimilated in this embodied, atheoretical way (Dreyfus & Dreyfus 2008, 4).

Proficiency is developed only after the emotional involvement takes place, which allows for the intuitive, rather than the, usually ineffective, explicitly understood, "theoretical" responses (Dreyfus 2009, 34). Approaching a situation with involvement the performer is able to recognize some aspects which stand out as important. In the stage of the proficient performer there can still be doubt about which of the important aspects is the best candidate to be adopted or pursued, but the performer takes the plunge (if she does not she remains stuck at the stage of competence). In some cases the appropriate course of action can be obvious, but this is not always the case (Dreyfus 2009, 34):

…this can be seen most clearly in cases of action. As the performer acquires the ability to discriminate among a variety of situations, each entered into with involvement, plans are evoked and certain aspects stand out as important without the learner standing back and deciding to adopt that perspective. When the perspective is simply obvious, rather than the winner of a complex competition, there is less doubt as to whether what one is trying to accomplish is appropriate (Dreyfus 2009, 34).

The intuitive –i.e. proficient- performer can often end up being at a loss about what to do. She plainly does not know what to do (Dreyfus 2009, 34). This puzzlement is the result of the proficient performer's limited experience and the
fact that there are limited ways to see a situation, but many more possible reactions to it (Dreyfus 2009, 34). The proficient performer exposes herself to outcomes she has not encountered before. The proficient performer must still decide her way out of a situation, and explicit rules and maxims are still handy in permitting her to reach a decision (Dreyfus 2009, 35):

At this stage [of proficiency], the involved, experienced performer sees each situation from an intuitive perspective, but hasn’t yet learned what to do. This is inevitable since there are far fewer ways of seeing situations than there are ways of reacting. The proficient performer simply has not yet had enough experience with the outcomes of the wide variety of possible responses to each of the situations he can now discriminate to react automatically. Thus, the proficient performer, after spontaneously seeing the salient components of the current situation, must still decide what to do on the bases of highly salient and less salient, but relevant, components of the situation. And to decide, he must fall back on detached rule- and maxim-following (Dreyfus 2009, 34-35, original emphasis).

A proficient driver feels "in the seat of his pants" (Dreyfus 2009, 35) that he is approaching fast a curve on a rainy day. Realizing that he must reduce speed, he must decide if he is going to brake or she is going to release the accelerator. The proficient driver feels that she has to decelerate sooner than the competent driver. The chess player recognizes immediately the nature of the situation, but still has to consider the best strategy to address it. For instance, she recognizes that she has to attack at this point, but she must weigh how to proceed. The
proficient student grasps the problem, but she still has to think about possible solution courses (Dreyfus 2009, 35). In short, the proficient performer has the ability to intuitively discern how to handle a situation (albeit with more optimism than certainty from time to time), but she often ends up a bit overwhelmed by how her chosen course of action played out. To deal with overwhelming developments of situations she must resort to the basics.

With accumulated experience, the proficient performer proceeds to become an expert. The expert is able to make finer discriminations and to respond immediately to the situations she faces (Dreyfus 2009, 35). The expert’s brain compartmentalizes subclasses of problems within a broader category of problems, for each of which there is an appropriate solution in her extensive repertoire of responses (Dreyfus 2009, 36). The expert student has a full grasp of the question at hand and the discernment of its solution (Dreyfus 2009, 36).

The expert need not think her responses. Increased experience “usually” leads to emotionally “rewarding” behaviour “without the need for any detached, effortful, time-consuming deliberation about perspective or action” (Dreyfus & Dreyfus 2008, 7). Humans are not different from non-human animals in reacting without explicit thinking:

Obviously, an animal, incapable of deliberation, can, nevertheless, learn not only how to intercept a running prey, but also when to switch to the perspective required for blocking an escape route in circumstances when that is a better strategy. The animal does not ‘change its goal’ since it is incapable of thinking ‘block its escape’, it merely responds, on the basis of past experience, to new stimuli or saliencies which might include...
a tree that the prey might climb. It should come as no surprise that people can do likewise in their skill domain without deliberation and without thinking that they should change their goal. For example, an expert baseball outfielder, if a fly ball is hit in his general direction, will initially see as salient the angle of ascent of the ball, perhaps the location of nearby fielders and maybe the location of the sun if he has learned to take account of this so as to move in a way that avoids looking directly at it. If the fly ball is well hit by a strong batter, the location of the ball as it goes over his head, the location of the outfield wall that it might strike, and the known running speed of the batter become salient as he turns to field the ball after it hits the wall. He never needs to think ‘I can’t catch the ball and my new goal should be to field it off the wall and throw it to the third baseman’. He merely acts, on the bases of experience, in a way that accomplishes this (Dreyfus & Dreyfus 2008, 7).

Deliberation is not useless for an expert performer. Sometimes a situation that presents itself is novel or more than one compelling courses of action appear to be appropriate responses (Dreyfus 2009, 36-37): “as when more than one compelling perspective or action intuitively presents itself, or when the situation is recognized as sufficiently novel as to put in doubt an intuitive behavior learned through only very limited experience” (Dreyfus & Dreyfus 2008, 8). Expertise, apart from extensive exposure to performance opportunities or repeated drills, is acquired if the performer is absorbed in the situations, feeling the risks, the gratification of success and the frustration of failure (Dreyfus 2009, 38). Apprenticeship offers the most opportunity for sharpening one’s skills
Apprenticeship under a variety of teachers is the key to the accumulation of a wide repertoire of approaches and treating strategies, and, consequently the path to creativity (Dreyfus 2009, 39-40).

The expert driver entering a curve too fast knows exactly what must be done: to release the pressure on the accelerator at first, and then to brake as required. "What must be done, simply is done" (Dreyfus 2009, 36). The expert chess player, a Grandmaster, experiences a "compelling intuitive perspective" as well as an inclination to execute the best move (Dreyfus 2009, 36). Chess experts play a move in a matter of seconds, without any adverse effects on their performance. Such fast playing does not rely on analysis and comparisons of alternatives (Dreyfus 2009, 36). Graduate students in the laboratory, the field or the library are good representatives of the involvement and dedication manifest at the expert level (Dreyfus 2009, 38-39).

The sixth stage of skill acquisition is mastery. The master's performance is characterized by deliberation, but a deliberation different in kind from rule-using; viz. it is different than the deliberation that characterizes the competent performer. It also differs from the deliberation after having intuitively a spherical view of the situation, which characterizes the expert (Dreyfus 2009, 40). The future master is willing to abandon the intuitive perspective of the expert (Dreyfus 2009, 41): “The budding master forsakes the available ‘appropriate perspective’ with its learned accompanying action and deliberately chooses a new one. This new perspective lacks an accompanying action, so that too must be chosen…” (Dreyfus 2009, 41). Why is this so? The answer is that the future master is after excellence:
A very different sort of deliberation from that of a rule-using competent performer or of a deliberating expert characterizes the master. At one level of explanation one can say that the future master consciously decides that expertise isn’t good enough. Such a person must be dedicated to what counts as excellence in her profession and therefore dissatisfied with merely engaging in what is accepted as expert behavior. Master learners, then, must be strongly motivated to look for opportunities to excel that are invisible to experts and must be willing to accept the risk of temporarily degraded performance while further developing their skill (Dreyfus & Dreyfus 2008, 8).

With enough accumulated experience, we can all potentially become experts. This is demonstrated by non-human animals, which become experts in the skills needed for their survival. Human beings are different from animals in that they can become attached to rule following and be so averse to risk, that they may end up stuck at the level of competence. On the other hand, humans can move beyond expertise to become masters of skills (Dreyfus 2009, 40). Dreyfus asserts that non-human animals are condemned to be experts:

Paradoxically, it seems that only a human being can be so attached to the deliberative rule-based thinking typical of the first three stages of instructed skill acquisition and so afraid of taking any risk, that vast experience produces only enhanced competence within a skill domain. Also, however, only human beings can become masters (Dreyfus 2009, 40).
Dreyfus reminds us that the proficient performer’s and the expert’s perspectives over how to appropriately address a situation are states of discernment of the crucial aspects of a problem, with the addition of the discernment of appropriate treatment in the case of the expert. These crucial aspects and the appropriate treatment cannot be expressed in explicit terms in their full complexity (Dreyfus 2009, 41). The future master chooses to abandon the knowledge afforded by her expertise and opens herself to new approaches. By abandoning the safe ground, the master-to-be recedes to the state of the proficient performer, who must decide the course of action she is going to follow (Dreyfus 2009, 40-41). The master-to-be conditions herself, once more through her emotional involvement, to repeat the response of fortuitous overriding the tested armamentarium of approaches available to the expert (Dreyfus 2009, 42):

Sometimes a coach, who is himself a master or who has learned to become a masterful coach, will suggest or demonstrate a new way of experiencing a situation, but a new perspective can also be chosen experimentally without coaching by a highly motivated expert. When conscious overriding of conventional expertise happens to yield improved performance, the resulting emotionally rewarding experience reinforces the likelihood that, when in a similar situation in the future, the newly established perspective and action will recur without conscious effort, and what might be called ‘enhanced expertise’ results. The strongly motivated aspiring master generally will replay the memory of the rewarding experience many times and do so with the same emotional involvement as accompanied it in the first place. This
will help solidify the perspective and behavior in the learner’s repertoire (Dreyfus & Dreyfus 2008, 9).

There is a second path to mastery apart from the conscious pursuit of excellence: the future master may be presented with situations not lending themselves to deliberation. On such occasions, a performer motivated by her will to excel will follow the memory of past successful and failed experimentations, like the future-master-by-choice, on to mastery:

A related alternative road to mastery presents itself to experts whose skill demands that they sometimes must respond to novel situations without time for deliberation. Such an expert, if motivated to excel, not only will assess the situation spontaneously and respond immediately, but will experience elation if the assessment and response is successful and dissatisfaction if it seems to him disappointing. But, unlike ordinary satisfied experts, if the developing master is dedicated to his profession and if time permits, he will recall and savour successes (Dreyfus 2009, 42).

The prospective master of the second path to mastery may resort to some deliberating on her successes and failures, trying to make rules of thumb out of them about what to repeat and what to avoid, regressing temporarily to the level of competence (Dreyfus 2009, 42-43). There is another possibility for the future master of the second path; pleasure and pain conditioning, without any effort to make rules of thumb to follow (Dreyfus 2009, 43). Continuing from the passage last quoted, Dreyfus writes:
Alternatively, in case of dissatisfaction, there seems to be two possible ways to respond. He may *deliberate* about what should have been done and make a rule to do things a different way if a similar situation arises in the future. He then risks the temporary regression to competence that comes with resisting an intuitive response, but this new way of acting will, hopefully, become intuitive with more experience. Or, rather than analysing what went wrong and making a rule for avoiding the mistake in the future, he may just dwell on the past events, feeling sad about what happened when things went wrong and joy when recalling the times when they went well. Then simple pleasure and pain conditioning will rewire his neurons in a way that will lead him to repeat the successful types of performance and prevent him from acting in the unsatisfactory way in the future. In either case, the new behaviour will become part of the master’s ever-growing intuitive repertoire that is activated immediately if a similar situation occurs in the future (Dreyfus 2009, 42-43, original emphasis).

In sum, the master is a person motivated to not confine herself to the appropriate solutions which determine the choices of the proficient and the expert. The master is not only creative, she is original:

…when an *expert* learns, she must either create a new perspective in a situation when a learned perspective has failed, or improve the action guided by a particular intuitive perspective when the intuitive action proves inadequate. A *master* will not
only continue to do this, but will also, in situations where she is already capable of what is considered adequate expert performance, be open to a new intuitive perspective and accompanying action that will lead to performance that exceeds conventional expertise (Dreyfus & Dreyfus 2008, 11, original emphasis).

This completes the presentation of the Dreyfus model of skill acquisition. We have seen the terms in which to make sense of skill. We will return to experimentation in the next chapter.

The presentation allows us to conceive the content of the Dreyfusian notion of skill. For Dreyfus, a skill is an acquired ability or aptitude, which is learned formally or informally by simply participating in a community, and which requires practice to be perfected. The definition of Dreyfusian skill coincides with the definition of the natural language concept of skill. If we need a definition for the concept of skill in Dreyfus's works, we only have to look it up in a dictionary.

4.3 Maurice Merleau-Ponty’s A Priori

The background of the model of skill acquisition concerning its workings in an individual’s mind is Merleau-Ponty’s notion of the intentional arc (Dreyfus 2002, 372-373). So an acquaintance with Merleau-Ponty’s thought is due. I use apriority as the focal point. I arrive to the notion of the intentional arc through that focal point.

Merleau-Ponty’s philosophy is a philosophy of perception. Merleau-Ponty stresses the fact that perceptual consciousness is always embodied (2002, 61). On one occasion he puts it thus: "...our own body is in the world as the heart is
in the organism: it keeps the visible spectacle constantly alive, it breathes life into it and sustains it inwardly, and with it forms a system" (Merleau-Ponty 2002, 235).

It is in the *Structure of Behavior* (Merleau-Ponty 1983) where he establishes that individual consciousness is connected with the reality of the external world as a result of the nature of perception. What we perceive are indecomposable sets of existing things\(^{26}\) (Merleau-Ponty 1983, 171) which include their own latent meaning and nascent intelligibility (Merleau-Ponty 1983, 206-207). The contingent sets of materials present in our field of perception are inherently invested with an array of possible fitting meanings. Reason is an integral part of the world:

The world is inseparable from the subject, but from a subject which is nothing but a project of the world, and the subject is inseparable from the world, but from a world which the subject itself projects... The world as we have tried to show it, as standing on the horizon of our life as the primordial unity of all our experiences, and one goal of all our projects, is no longer the visible unfolding of a constituting Thought, not a chance conglomeration of parts, nor, of course, the working of a controlling Thought on an indifferent matter, but the native abode of all rationality (Merleau-Ponty 2002, 499-500).

The possibility of knowledge rests on the interplay between a subject's perceptual and intellectual capacities and an external world which is intelligible through its varied manifestations, manifestations which are concrete situations

\(^{26}\) I.e. physical objects and events.
Merleau-Ponty (2002, 425) states that the world is meaningful for any of its inhabitants that can make some sense of it, depending on their natural endowments. We have found ourselves in the territory of apriority.

Merleau-Ponty talks about the "human a priori" when discussing sexuality (Merleau-Ponty 2002, 197). He explains that it is impossible to separate human sexuality from, say, intelligence, and treat one or the other as contingent facts. "Everything in man is a necessity", which necessity, of course, is not "any backward-looking illusion, any essential necessity" (Merleau-Ponty 2002, 197). The mention of essence here refers primarily to Edmund Husserl’s philosophy, which is about searching for essences, but Merleau-Ponty’s point is valid for essentialism all the way back to Aristotle.

Necessity is not the end of the story. Explanatory narratives about sexuality or intelligence are not problematic because they isolate functions which can make better sense in the integrated whole, but because everything, i.e. the integrated whole, the individual organism, is also contingency:

On the other hand everything in man is contingency in the sense that this human manner of existence is not guaranteed to every human child through some essence acquired at birth, and in the sense that it must be constantly reforged in him through the hazards encountered by the objective body (Merleau-Ponty 2002, 197-198).

Man has an extensive ability to engage in a kind of dialogue with the world: "Human existence will force us to revise our usual notion of necessity and contingency, because it is the transformation of contingency into necessity by
the act of taking in hand" (Merleau-Ponty 2002, 198). In addition, man has the ability to attempt to define himself. This brings a historical aspect - a specific spatiotemporal component - into the "everything" in man: "Man is a historical idea and not a natural species" (Merleau-Ponty 2002, 198).

Merleau-Ponty discusses briefly the a priori _simpliciter_, not human or otherwise, in relation with the perception of space. The central idea here is one permeating his work, namely the bringing together of "intellectualism", the view that mind is an active co-creator of our perception together with unknowable things-in-themselves, and empiricism, the view that the mind is passive in perceiving objects. We have encountered Merleau-Ponty's guiding idea before as the communion between the situated individual and the setting she finds herself in. Merleau-Ponty begins his discussion of the a priori by distinguishing his views from those of Kant: "From the moment that experience - that is, the opening on to our de facto world - is recognized as the beginning of knowledge, there is no longer any way of distinguishing a level of a priori truths and one of factual ones, what the world must necessarily be and what it actually is" (Merleau-Ponty 2002, 256). To show why this is the case, Merleau-Ponty asserts that every sensation is spatial as a result of its being a comprehensive configuration between a sentient and a sensible.

Every sensation is a co-existence in a field of co-existences (various objects and events that can be felt, draw our attention, be understood etc.) and, as such, necessarily constitutes "a setting of co-existence", i.e. a space (Merleau-Ponty 2002, 256-257). This inalienability of existence allows Merleau-Ponty to redefine (2002, 256) the a priori: "The a priori is the fact understood, made explicit, and followed through into all the consequences of its latent logic; the a
It would be contradictory to assert that the sense of touch is devoid of spatiality, and it is a priori impossible to touch without touching in space, since our experience is the experience of a world. But this insertion of the tactile perspective into a universal being does not represent any necessity external to touch, it comes about spontaneously in the experience of touching itself, in accordance with its own distinctive mode. Sensation as it is brought to use by experience is no longer some inert substance or abstract moment, but one of our surfaces of contact with being, a structure of consciousness, and in place of one single space, as the universal condition of all qualities, we have with each one of the latter, a particular manner of being in space and, in a sense, of making space (Merleau-Ponty 2002, 257).

It will be noticed that Merleau-Ponty's new definition of the a priori remains faithful to apriority's normative prerogative, which is recognisably Kantian, despite that he dispenses with "the form and content" distinction (Merleau-Ponty 2002, 257); form is not something external to the content. It follows that the justificatory characteristics of apriority are retained. This becomes apparent if we reflect on Merleau-Ponty's assertion that "it is a priori impossible to touch without touching in space" (2002, 257), quoted above. It is not just unintelligible, it is entirely unthinkable to doubt that some notion of space is implied in being-in-the-world. The blind man has an understanding of what space is (Merleau-Ponty 2002, 257), although Kant's formal intricacies about space being
necessarily understood in Euclidean terms would be lost on him. Another instance where the justificatory nature of the redefined a priori is manifest, is Merleau-Ponty’s explication of how intersubjectivity is possible. The notions of the intentional arc and the habit-body play a major part here. Let us examine these two notions.

Merleau-Ponty suggests that agents are in full possession of their bodies and do not need to discover the appropriate body part in order to be able to act. This is the work of the habit-body, a facet of embodiment, which can be best understood as hard-wired predispositions of ability for action:

How can I perceive objects as manipulatable when I can no longer manipulate them [e.g. when one of my limbs has been amputated]? The manipulatable must have ceased to be what I am now manipulating, and become what one can manipulate; it must have ceased to be a thing *manipulatable for me* and become a thing *manipulatable in itself*. Correspondingly, my body must be apprehended not only in an experience which is instantaneous, peculiar to itself and complete in itself, but also in some general aspect and in the light of an impersonal being (Merleau-Ponty 2002, 95, original emphasis).

For instance, when a baby is after an object, it is the object that she attends to, and not her hand. The hand is what the baby is in intimate possession of and does not have to consciously find it before she is able to use it for reaching and grasping. The child’s (and anybody else’s for that matter) movement is "not thought-about movement" (Merleau-Ponty 2002, 159). Moreover, the fact that we can indisputably agree that the baby is indeed reaching seems to suggest
that the object sought has already been invested with meaning on the baby's part. The object has an intimate significance for her. Such an intimate significance, which also happens to be pre-theoretical, is also attributed to objects by younger or older grown-ups (Merleau-Ponty 2002, 157).

[T]he nuclear [i.e. core] function to which we refer, before bringing objects to our sight or knowledge, makes them exist in a more intimate sense, for us. Let us therefore say... that the life of consciousness -cognitive life, the life of desire or perceptual life- is subtended by an 'intentional arc' which projects round about us our past, our future, our human setting, our physical, ideological and moral situation, or rather which results in our being situated in all these respects. It is this intentional arc which brings about the unity of the senses, of intelligence, of sensibility and motility (Merleau-Ponty 2002, 157).

Brian Mooney and Damien Norris summarize well what the habit-body and the intentional arc culminate in: "...the object sought is already understood as a thing-to-be-touched, a-thing-that-can-be-grasped, and the hand already as that-which-can-grasp. This knowledge has thus withdrawn from reflective consciousness into the domain of the intentional arc" (Mooney & Norris 2007, 5).

A telling passage from the *Phenomenology of Perception* makes clear how the self-evidence of apriority is a manifestation of the habit-body-connected and context-infused intentional arc, bringing about the phenomenon of intersubjectivity. Merleau-Ponty has in mind the fact that something which is of smaller dimensions relative to another object in our visual field is interpreted as
distance from the viewer, something that is used in painting to create the illusion of depth on a two-dimensional surface:

For God, who is everywhere, breadth is immediately equivalent to depth. Intellectualism and empiricism do not give us any account of the human experience of the world; they tell us what God might think about it. And indeed it is the world itself which suggests to us that we substitute one dimension for another and conceive it from no point of view. All men accept without any speculation the equivalence of depth and breadth; this equivalence is part and parcel of the self-evidence of an intersubjective world, which is what makes philosophers as forgetful as anyone else of the originality of depth. But prior to this [note that we can substitute the expression 'prior to this' with 'a priori'] we know nothing of the world and of space as objective... (Merleau-Ponty 2002, 298).

The intersubjective world is a field of possibilities which can be meaningful for everyone: "It is quite possible that, on the basis of his nervous weaknesses, [the painter Paul] Cézanne conceived a form of art which is valid for everyone" (Merleau-Ponty 1964, 11). In Cézanne's case what is "valid for everyone" is the impression, explicated by Merleau-Ponty, that "The object is no longer covered by reflections and lost in its relationships to the atmosphere and to other objects [as in impressionistic painting]: it seems subtly illuminated from within, light emanates from it, and the result is an impression of solidity and material substance" (Merleau-Ponty 1964, 12). This solidity and material substance is a priori in this case, simply because it is rooted in perception. Objects can appear
to possess a commanding materiality, to preside over their context. Notice that the impressionistic emphasis on relationships between objects is equally "valid for everyone", and, following Merleau-Ponty's new definition of apriority, after explication and analysis, also self-justified.

In Merleau-Pontean phenomenology, apriority looks like the picture that has been drawn about it from the point of view of general epistemology; there is no warrant that an a priori justification grants immutable knowledge, although knowledge based on self-evidence retains all its Kantian qualities of communicable compelling appeal. Merleau-Ponty goes a step beyond the analytic philosophers' conception of apriority (Reichenbach counts among the analytic philosophers). For Merleau-Ponty apriority is simply an appendage of reflecting about what it is to-be simpliciter. For Merleau-Ponty, it makes sense to say that propositions like "Red is a colour" and "No object can be round and square all over at the same time" are known a priori solely on the basis of our imperfect experience of the world, and not as a result of understanding the meaning of the words comprising each sentence -although apriority on the basis of analyticity is not excluded, naturally. In effect, for Merleau-Ponty, such propositions are like "I know that the wardrobe has a back side" although the wardrobe in question is in my grandmother's house and I have no memory of its back side. Moreover, based on knowing that this wardrobe is really a big box (I can see that! - but I can never see it all at once) I can form in my head an approximate sense of its volume to begin planning where to move it in the room so that the space feels less cluttered. The wardrobe story is a nice example of reflecting on direct perception. The beliefs formed after reflecting a little bit about the wardrobe's back side, the space it occupies that the room feels cluttered are all self-evident; they are a priori.
The Merleau-Pontean phenomenological a priori brings together the mental and the empirical in the shape of situatedness. Situatedness refers to the actual whereabouts of our body, our habit-body, and the multifaceted projections of the intentional arc. The intentional arc is the cause of our being situated in a variety of respects, Merleau-Ponty asserts (2002, 157). Some of these respects depend on the opinions of others.

The communal aspects of one's life are presented in a forceful, dramatic style in the concluding paragraph of Cézanne's *Doubt*. There the painter's doubt is undisclosed to be his freedom, his entire life hanging by a thread over the abyss of attempting to represent instances of nature in the fullness of their complexity, their "latent logic". The tools of his trade, colours, and the observers of his work were the only means at Cézanne's disposal that could acquiesce his concern if he had achieved a non-mundane collapse of the distinction between form and content, if he had managed to make the particular and contingent to emanate some new self-evident understanding:

> Just as we may observe the movements of an unknown animal without understanding the law which inhabits and controls them, so Cézanne's observers did not guess the transmutations which he imposed on events and experiences; they were blind to his significance, to that glow from out of nowhere which surrounded him from time to time. But he himself was never at the center of himself: nine days out of ten all he saw around him was the wretchedness of his empirical life and of his unsuccessful attempts, the leftovers of an unknown party. Yet it was in the world that he had to realize his freedom, with colors upon a
canvas. It was on the approval of others that he had to wait for the proof of his worth. That is the reason he questioned the picture emerging beneath his hand, why he hung on the glances other people directed toward his canvas. That is the reason he never finished working. We never get away from our life. We never see our ideas or our freedom face to face (Merleau-Ponty 1964, 25).

The coda in our discussion of the Merleau-Pontean a priori is that despite the strong dependence on experience, it is a priori properly speaking, i.e. it retains its independence from experience as a result of the pre-reflective character of our inherence in the world.

4.4 Final concerns

We might wonder about the implications of my discussion of Merleau-Ponty for the concept of skills: when we try to understand a skill, will we invariably encounter some a priori propositions? Based on the points I have presented and made so far in this chapter, the answer is affirmative. To quote Dreyfus: "One does not need to know, nor can one normally express, what [the] optimum [for the equilibrium due to the intentional arc] is" (2002, 378). Explication has its limits.

A question arises if we conceive Bonner’s narrative through Merleau-Ponty’s philosophy: The philosophy of perception can account for Bonner’s having learnt to approach his slime moulds on their own terms, it can account for his decision to see how water flow would affect the amoebae and it can account for Bonner’s punching the air after he saw the effect of the current on the amoebae.
But how about Bonner’s realization that what he saw through the instrument’s lens was *proof* of chemotaxis? Bonner, unlike Cèzanne, did not do art. Merleau-Ponty drew heavily on the developments of the empirical sciences, but he was not doing philosophy of science (Merleau-Ponty 2002, ix). As a result of that we will now turn to Hacking’s account of scientific practice. Hacking’s answer to the proof question is that having engaged in the very scientific thinking and doing encompasses proof.

From our discussion in this chapter we are to retain Merleau-Ponty’s conclusion that our embodied inherence in the world is the horizon of apriority and of the necessity associated with it. This conclusion is instrumental in helping us grasp Hacking’s mention of embodiment in the context of a recent clarification of his line of thought (Hacking 2012, 600), which we will do in chapter 6. In chapter 6 we will encounter skills again.

5.1 A different kind of realism

In this chapter I will be reconstructing Hacking’s entity realism (Hacking 1982; 1983). Entity realism is an alternative variant for scientific realism. Entity realism is not based on the success of the theories postulating the entities, but on our ability to manipulate the entities in question. The entity realist is not concerned with the truth of theories; she argues that we are justified in believing that the entities we use regularly in our quest for expanding knowledge exist. The entity realist’s position about the existence of unobservable entities postulated by theories entails her regarding ontological debates like those the scientific realist and the scientific anti-realist engage in as necessarily inconclusive.

My argument in this chapter is that Hacking’s entity realism is sound because it provides us with self-justified knowledge claims on the basis of interaction with the material world according to well-established reasoning patterns. I need to digress slightly at this point to clarify the difference between justification and self-justification. Building on the description of justification I have provided in chapter 2, namely that justification is the provision of evidence in both discourse and reflection, by self-justification I mean a mental occurrence the evidence of which is its own content. In contrast, a justified mental occurrence is justified by evidence other than its own content. The word ‘occurrence’ stands for the process of arriving at a justification as well as for the outcome of such a process, the justified or not-justified mental content.

Now we can return to entity realism and to the interactions with the material world. The interactions with the material world should not be haphazard; good
practical understanding of the use of the entities is a requisite. As we will see, this is not a very pressing demand: scientists only have to use the entities in their laboratories to investigate other phenomena or to engineer technical applications in a routine fashion. This is why Hacking refers to them as manipulations.

The reasoning patterns I mentioned in tandem with the interactions with the material world are historically identifiable, they pertain to western science, and Hacking intends them to function as Kantian reason does: employing them in our scientific thinking and doing comes inescapably with connotations of normative warrant. These patterns of thinking and doing are known as the styles of reasoning.

The entities we will be talking about are putative or unobservable entities (unobservables for short). The entity realist agrees with the antirealist that the old-school scientific realist’s position of the entailment of truth for scientific theories on the grounds of their explanatory success, or, at least, that the truth of the scientific theories is the best explanation for their explanatory success, is misguided (Elsamahi 1994, 173).

Entity realism has been adopted by Nancy Cartwright (1983, chapter 5), Ronald Giere (1988, chapter 5). Rom Harré (1986) is sympathetic to it.

Hacking's argument for realism is deployed in the second part of Representing and Intervening (Hacking 1983), unsurprisingly called "Intervening", after the rich chapter bearing the title "Break". The whole case about intervening is a demonstration of the importance of experimentation in science. Hacking’s favourite phrase to illustrate that importance is "Experiment has a life of its own" (present, for instance, in p. 604 of Hacking, 2012). Chapter 12 of the
(1983) book is the culmination of Hacking’s case for entity realism. The chapter includes the so-called manipulation criterion for realism, which has attracted much attention:

...entities that in principle cannot be ‘observed’ are regularly manipulated to produce a new phenomenon and to investigate other aspects of nature. They are tools, instruments not for thinking but for doing (Hacking 1983, 262).

My purpose in this chapter is to contribute to the discussion on Hacking’s main argument for entity realism, arguing that it is a transcendental argument. We remember that transcendental arguments are deductions linking the world with our perception of it in a self-evident fashion.

The validity of a transcendental argument is appraised against a background, and this background is reasoning. In Hacking’s philosophy we encounter such a background, the styles of reasoning. There are a number of them, six to be precise; I discuss the styles in detail in the next section (section 5.2). I also discuss how the styles of reasoning are coherent with the practice approach in chapter 6. Here (chapter 5) we will also have the opportunity to revisit the questions of representation and reference, which have been left open after our discussion of Rheinberger’s practice approach for the history and philosophy of science in chapter 1.

Second, transcendental arguments involve a notion of presupposition. The notion of presupposition relevant to our purposes can be defined thus: we will say that a judgement, a belief, or any mental content that can be regarded as expressible as a proposition is presupposed if and only if it motivates us to think and act as if we possessed practical and/or theoretical understanding of certain
basic (“ground floor” (Dreyfus 2005, 61)) understandings the world lends itself to. In preparation for the premises of my argument in support of the styles of reasoning, which is to follow in the next chapter, we will dub my line of thought ‘the Kantian-Aristotelian line of thought’. In this line of thought the substance is Aristotelian and the logical way of the organization of the substance is Kantian. This line of thought is the necessary outcome of Hacking’s arguments.

Finally, transcendental arguments target scepticism. We remember that for a transcendental argument to be valid some sort of verificationism is assumed. Hacking’s argument for entity realism is known as the experimental argument for realism.

5.1.1 The position of entity realism in the realist-anti-realist spectrum

Hacking stresses that we are still finding how to find out. Hacking in effect applies Kant’s basic insight that “...although all our cognition commences with experience, yet it does not on that account all arise from experience” (Critique of Pure Reason, B1) in a new sense. In Hacking it is the historical setting in which we make sense of our experience that provides the background for understanding.

Our theoretical and experimental approaches to the world are the conditions of possibility of our knowledge. There would be no knowledge of the world but for the means we use to acquire such knowledge. Moreover, in Hacking's understanding, this knowledge is revealing the world as it is. The questions of warrant either for our approaches per se, like scientific theories and models, or about success in disclosing the world become now a superficial exercise in seeking truth with substantive import. Technically, this superficiality is reached by the demonstration that aprioristic justification is the kind of justification
scientific research relies heavily on. An a priori justified belief is self-justified; if our research practices are shown to depend on self-justified beliefs, then there remains no logical room either for the automatic justification of scientific theories presumed by the usual scientific realist or for the additional, but unattainable, substantive justification demanded by the anti-realist of either variety. With Hacking we break free from the conundrum\textsuperscript{27} of the discussions on the correspondence of scientific theories to the natural world. With Hacking we move from the realm of scientific theories to a conception of science as practice where theory recedes from the foreground, giving the prominent role it possessed so far in philosophical accounts to thinking more generally, which itself is on a par with doing. Hacking’s entity realism is a position which counters the scepticism of the sceptic anti-realist that we can access the world, and presents the anti-realist who doubts that the world is independent from us with the thesis that it does not matter after all that our understanding of the world is not independent from our ways of accessing it, since we in fact access it practically, e.g. with experimentation.

5.2 The styles of reasoning

5.2.1 The styles of reasoning in the history of science

Hacking introduces the styles of reasoning as a historical fact: “I start from the fact that there have been different styles of scientific reasoning” (Hacking

\textsuperscript{27} In chapter 3 I have argued that Reichenbach had thought about an elegant solution to the problem of the doubts about our ability to disclose the workings of the world, applying Kant’s arguments about the creation of artistic masterpieces found in the \textit{Critique of Judgement} (Kant 1987) in matters epistemic. However, his solution to this problem was never pursued in detail – probably because of its radical character. In addition Kant’s own account for masterpiece production in the third critique is not without its own problems (see Guyer 1979, 297; Allison 2001, 184–192). The conundrum remains even after the application of Reichenbach’s solution.
He then provides two examples, that the Greeks back in antiquity admired Euclidean thought and that the brightest of the eighteenth century agreed that experimentation was paramount for knowledge (Hacking 2002b, 160). Alistair Crombie (1994) is the historian who first described the styles of reasoning. The very word ‘style’, Hacking informs us (2002b, 161), is borrowed from the title of Crombie’s (1994) book: *Styles of Scientific Thinking in the European Tradition*. It should be noted that we are talking about styles of reasoning which originated and began their development in a particular setting, that of Europe.

Hacking (2002b, 161) quotes Crombie’s summary of the styles, a list of them accompanied by a short description. I follow Hacking’s example here:

The active promotion and diversification of the scientific methods of late medieval and early modern Europe reflected the general growth of a research mentality in European society, a mentality conditioned and increasingly committed by its circumstances to expect and to look actively for problems to formulate and solve, rather than for an accepted consensus without argument. The varieties of scientific method so brought in to play may be distinguished as,

a) the simple postulation established in the mathematical sciences,

b) the experimental exploration and measurement of more complex observable relations,

c) the hypothetical construction of analogical models,

d) the ordering of variety by comparison and taxonomy,
e) the statistical analysis of regularities of populations and the calculus of probabilities, and,
f) the historical derivation of genetic development.

The first three of these methods concern essentially the science of individual regularities, and the second three the science of the regularities of populations ordered in space and time (Crombie 1981, 284).

Although Crombie’s description is to the point, questions might be asked about the third style’s content, the “hypothetical construction of analogical models”.

Crombie keeps the same words later on (1994, vol. 1, 431). A good example for the third style comes from Hacking: “Galileo, in my view, ‘mathematized’ the world” (Hacking 2014, 189). I tend to have the same view with Hacking on this one: the example is a good indication of Crombie’s meaning. In (Hacking 2002a, 182) style b) becomes better articulated: “The deployment of experiment both to control postulation and to explore by observation and measurement”.

Style f) is about writing the histories of the origins of things.

Hacking discusses his and Crombie’s usage of the word ‘style’ in relation to Ludwig Fleck’s ‘thought style’ in science. Fleck (1979) defined thought styles as belonging to distinct social units, the thought collectives. A thought collective is:

…a community of persons mutually exchanging ideas or maintaining intellectual interaction[,] we will find by implication that it also provides the special “carrier” for the historical development of any field of thought, as well as for the given stock of knowledge and level of culture. This we have
designated thought style. The thought collective thus supplies the missing component (Fleck 1979, 39).

Hacking’s styles are broader than Fleck’s. As we will see in the following quotation, Hacking reads Fleck’s philosophy to be an exhaustive theory of the establishment of scientific knowledge. The point Hacking wishes to make is that Fleck’s account of knowledge establishment is a description made from a vantage point *within* science.

Fleck intended to limn what it was possible to think; a *Denkstil* [a thought style] makes possible certain ideas and renders others unthinkable. Crombie and I fix on an extreme end of the spectrum of such permissible uses [of the word style], and accordingly enumerate very few styles of thinking or reasoning. This is partly because our unit of analysis is very large in scope. There are many other units of analysis comparable to Fleck’s, and which also deal with what it is possible to say (Hacking 2002a, 180).

Fleck’s “‘carrier’ of the historical development of any field of thought” (1979, 39) in Hacking’s philosophy is the discursive character of practices. Let us start unpacking this assertion. We should begin with Hacking’s explanation why he preferred to call his styles the ‘styles of reasoning’ rather than Crombie’s ‘styles of thinking’.

I prefer to speak of styles of (scientific) ‘reasoning’… This is partly because thinking is too much in the head for my liking. Reasoning is done in public as well as in private: by thinking, yes, but also by talking and arguing and showing. This
difference between Crombie and myself is only one of emphasis. He writes that ‘the history of science has been the history of argument’—and not just thinking. We agree that there are many doings in both inferring and arguing. Crombie’s book [(Crombie 1994)] describes a lot of them, and his very title happily ends not with science but with ‘Sciences and Arts’. He has a lot to say about architecture, clock making, and the doctrine that ‘knowing is making’. Nevertheless, there may still be a touch too much thinking for my pleasure… Even my word "reasoning" has too much to do with mind and mouth and keyboard; it does not, I regret, sufficiently invoke the manipulative hand and the attentive eye. Crombie’s last word in the title of his book is ‘Arts’; mine would be ‘Artisan’ (Hacking 2002a, 180-181).

Hacking’s vantage point is what people do, or what they had done many years ago; his vantage point is what in chapter 1 I called practices-at-large. Thus the ‘carrier’ of the historical development of knowledge is people’s practices-at-large, i.e. history-in-the-making itself. We should also notice Hacking’s reliance on the historically socialized subject. The reliance I speak about is not just on the subject as agent, but on the subject as doer.

5.2.2 Discourse and Reality

In Hacking’s philosophy the relation between the objectual, the personal, and the communal, the ingredients of the anthropology Rheinberger envisages, is best portrayed by considering how people come to represent; the relation, according to Hacking, is discourse. The structure of Representing and
Intervening (Hacking 1983) is separated between “representing”, where Hacking discusses the merits and drawbacks of theory-oriented philosophy of science, and “intervening”, where the discussion on the significance of experimentation takes place. Between these two major parts, there is a chapter entitled “Break” (Hacking 1983, 130-146), where Hacking introduces his notion of representation using an anthropological fable. In the beginning, people created representations around the campfire and then they began to appraise their own creations (Hacking 1983, 139). Hacking presents highly abstract concepts to have evolved in casual chatter among equals around the campfire. This is his way of limning the cooperation between the communal and the personal elements of knowledge. The best word to describe what Hacking wishes to convey is that representations are public (Hacking 1983, 142).

Hacking’s notion of public representations in its setting of the anthropological myth makes us imagine a community of hunter-gatherers with a simple social structure, using their unencumbered (by our standards) discursive practices to root the concept of the real in a communal exercise of agreement and disagreement over exchanges of their personal points of view and their thoughts of the natural world they inhabit. Hacking’s anthropological fable is an exquisite illustration of the actual-life-outlook of the field of practices. This actual-life-outlook illuminates the chains of reasoning connecting Dreyfus with Hacking, Hacking with Rheinberger, Rheinberger with Daston and beyond. In this thesis I am concerned with the person and her implementation of her socially mediated skills for her explicit understanding of the material things she encounters by being-in-the-world, thus I will be concerned with establishing a Dreyfus-Hacking-Rheinberger-inspired philosophy, centred on the concept of epistemic justification, for the purpose of answering the question raised by
Uljana Feest and Thomas Sturm (2011): “[The] divergent accounts of the status and nature of scientific practices [by the historical epistemologists] draw our attention to the need to systematically analyze a question not addressed by historical epistemologists so far: what exactly is meant by the word ‘practice’ when we talk about scientific practices or research practices?” (Feest & Sturm 2011, 299-300). To further depict my intentions in this thesis, we will have to use once more the onion metaphor I used about the three variants of doing historical epistemology: Dreyfusian skills are the core, followed by Hacking’s epistemic conclusions relative to scientific things, leading ultimately to the outer—but no less significant—layers of Rheinberger’s historical epistemology and his historical descriptions of the acquisition of knowledge. The onion, of course, is scientific practices concerning scientific things (i.e. physical objects with their motions, actions and interactions, along with a number of objects of the understanding, like, e.g., an organism’s development), expanded in chapter 6 to a variety of Daston-esque scientific objects (we recall that these kinds of things, in Rheinberger’s sense of things, seem to be located at the conceptual end of the spectrum rather than at the material end, like dreams as examined by psychology), a move which comes as a result of Hacking’s work.

Hacking’s reformulation of representation is not his most far-reaching contribution to a conceptual reorientation in the philosophy of science. His most influential legacy lays in the dethronement of the Popperian-style view of the role of experiments: Hacking demonstrated that the grand, all-penetrating issues in the philosophy of science must be analyzed with a view to experiments as self-constituted instances of inquiry; experiments are not

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28 Popper is to blame only because he paid some attention to experimentation. The logical empiricists did not pay very much attention to it.
subordinate to theories. As Hacking put it: “experimentation has a life of its own” (1983, 149-150). This autonomy of experimentation constitutes “no claim that experimental work could exist independently of theory”, but that the relations between theory and experiment are numerous and unpredictable; “some theory precedes some experiment, some experiment and some observation precedes theory, and may for long have a life of its own” (Hacking, 1983, 158-160). The appropriateness of Rheinberger’s gesture to Hacking is revealed: Rheinberger has shown that experiments are far from routine, and that a variety of inferential transformations take place during knowledge acquisition. Rheinberger’s work provides independent support to Hacking’s conclusions.

Hacking begins by an assertion: “reality is just a byproduct of an anthropological fact” (Hacking 1983, 131). He then explains that the anthropology he evokes on the issue of reality is Kant’s philosophical anthropology.

Realism is not to be considered part of pure reason, nor judgement, nor the metaphysics of morals, nor even the metaphysics of natural science. If we are to give it a classification according to the titles of Kant’s great books, realism shall be studied as part of Anthropologie itself (Hacking 1983, 132).

A philosophical anthropology can be a precarious undertaking (Hacking 1983, 132), and so can be speculation on the essential nature of human beings (Hacking 1983, 132), but these are no reasons not to propose another account of what it is to be human: "Human beings are representers. Not homo faber, I say, but homo depictor. People make likenesses” (Hacking 1983, 132, original
emphasis). This proposition is so basic that: “Should the ethnographer tell me of a race that makes no image (not because that is tabu [sic] but because no one has thought of representing anything) then I would have to say that those are not people…” (Hacking 1983, 134).

The word ‘representation’ has been used to translate Kant’s term Vorstellung, a mental presence of images and more abstract things before the mind (Hacking 1983, 132). Hacking warns us: “This is exactly what I do not mean by representation” (Hacking 1983, 132, original emphasis). What is not to be included in the content we get when we read ‘representation’ in Hacking is John Locke’s internal ideas, too, a thing Kant intended to capture in Vorstellung (Hacking 1983, 133). Finally, ordinary public sentences are also to be excluded (Hacking 1983, 133-134): “A single sentence will in general not represent” (Hacking 1983, 134, original emphasis).

So what is included in Hacking’s concept of representation? Physical things, first and foremost (Hacking 1983, 133), as well as the imitations of bird whistles (Hacking 1983, 133). A representation according to Hacking is any public likeness (Hacking 1983, 133). For him, reality may be “parasitic upon representation” but the world has a firm place in what people represent: the world has always been there before we humans represented it (Hacking 1983, 136). It is the conceptualizing of the world as reality that does not come along with the direct perception of the world; the thinking of stuff as real or not real is "secondary" (Hacking 1983, 136).

So, according to Hacking, a representation is a likeness which is not a private copy of features of the world in a person’s mind. The public character of representation requires some further discussion: “…homo depictor did not
always deserve Aristotle’s accolade of rationality, but only earned it as we smartened up and began to talk” (Hacking 1983, 134). Hacking offers a fable on the origins of talking. It was not invented to co-ordinate hunting, neither to warn for danger (Hacking 1983, 135): “The [general] idea is that people invented language out of boredom. Once we had fire, we had nothing to do to pass the long evenings, so we started telling jokes” (Hacking 1983, 135). It was in this setting that exchange of opinions and argumentation on representations began. The “real” was a sound invented to express the thought that a particular figurine represents accurately the model it is made after in a certain fashion (Hacking 1983, 135). Then people started to make comparisons and to think like "this real, then that real" (Hacking 1983, 135). Soon sounds expressing disagreement about the reality of stuff emerged, too (Hacking 1983, 135).

Hacking’s fable is not an attempt to trace the origins of language (Hacking 1983, 136-137); it is also not an account of the origins of representation. Hacking’s point is that representing is part of being human (Hacking 1983, 136).

Our imaginary argumentative ancestors in Hacking's story do not restrict their representations to distinct objects. They, like us moderns, use their language to express an array of meanings, the content of their utterances depending on the context (Hacking 1983, 136).

Hacking’s central position is that representing aspects of the world is the making of likenesses. The interesting thing about likenesses is not just that they resemble somehow the things or aspects of things they are meant to represent, but they do so by people and for people. When competing representations of the same thing develop, discussions about which
representation is the ‘real’ one follow (Hacking 1983, 139-142). Scientific realism and anti-realism can be explained by Hacking as the natural outcomes of competing representations (Hacking 1983, 139).

What role does the world play in all this? We already can surmise that it must play quite an important one, since Hacking’s fable is designed to not only invoke ancestral discussions about abstract immortal gods and kind or maleficent spirits, but also about tangible stuff directly accessible to the senses. In Hacking’s philosophy the world is always there, present, often tangible and solid, familiar; sometimes it is less familiar, including mysterious entities and unexpected phenomena. The world is all around us able to be understood, but also offering no easy access to its inner workings. It is knowable and elusive at the same time. This entails that no single metaphysics, i.e. a theory about how the world is, is correct. There are many ways to understand the world (Hacking 1983, 143-144).

More specifically, as far as the world issue is at stake, Hacking’s preferred formulation of realism is "if you can spray them, then they are real" referring to electrons in the context of an experiment where they were shot at a ball of niobium. Hacking is clear that by his dictum he meant just what he said, and not "they are real only if you can spray them" (Hacking 2009a, 8, emphasis added). The implication of the world does not mean that it is impossible to find mistakes in knowledge or illusory accounts of reality; metaphysics, Hacking asserts, developed as a way to “sort representations when the only criteria for representations are supposed to be internal to representation itself” (Hacking 1983, 142). Then, metaphysics was superceded by the modern scientific attitude, until “people realized that there might be several ways to represent the
same facts” (Hacking 1983, 143, original emphasized). This is the point where we are today; the fact that there are many actual and many more possible systems of representation is one of Hacking’s points of departure.

We suspect that for Hacking the world is. This inference is correct; when he discusses the introduction of objects by our ways of inquiry, Hacking makes the following remark: “[Introduction of objects] does not mean the objects of the class did not exist before there was a way to investigate them. That is nonsense” (Hacking 2012, 606). The world is, although the ‘how it is’ is more a matter of our ways of understanding rather than a matter of getting to the uniquely correct representation of the world. Competing representations do not only lead to agreements and disagreements about which representation is really real, they also lead to scepticism. Using Democritus’s atomism, one of the metaphysical ways attempting to sort out what is real and what is not, Hacking recounts the sorts of scepticism that ensue from the representation chain:

Scepticism is inevitable, for if the atoms and the void comprise the real, how can we ever know that? As Plato records in the Gorgias, this scepticism is three-pronged. All scepticism had had three prongs since Democritus formulated atomism. There is first of all the doubt that we could check out any particular version of the Democritean dream. If much later Lucretius adds hooks to the atoms, how can we know if he or another speculator is correct? Secondly, there is a fear that this dream is only a dream; there are no atoms, no void, just stones, about which we can, for various purposes, construct certain models,
whose only touchstone, whose only basis of comparison, whose only reality, is the stone itself. Thirdly, there is the doubt that, although we cannot possibly believe Democritus, the very possibility of his story shows that we cannot credit what we see for sure, and so perhaps we had better not aim at knowledge but at the contemplative ignorance of the tub (Hacking 1983, 141).

Hacking thinks that scepticism is the philosophical progeny of knowledge (Hacking 1983, 141). To be more precise, it is the progeny of some knowledge, however incomplete or nascent (Hacking 1983, 141). All three prongs of scepticism Hacking brings forward following Plato are serious. The first concerns methods of verification, the second competing schemas of representation and the third is a sort of melancholy epistemic stoicism. What they have in common, apart from the fact that an answer to questions stemming from one of them will in all probability have logical consequences for the other two, is that none of the Platonic skeptics doubts there is something in front of her, viz. the stone of Hacking’s example, which she sees and touches:

Scepticism of the sort ‘do I know this is a hand before me’ is called ‘naive’ when it would be better described as degenerate. The serious scepticism which is associated with it is not, ‘is this a hand rather than a goat or an hallucination?’ but one that originates with the more challenging worry that the hand represented as flesh and bone is false, while the hand represented as atoms and the void is more correct. Scepticism is the product of atomism and other nascent knowledge. So is the philosophical split between appearance and reality.
According to the Democritean dream, the atoms must be like the inner constitution of the stone. If ‘real’ is an attribute of depiction, then in asserting his doctrine, Democritus can only say that his picture of particles pictures reality. What then of the depiction of the stone as brown, encrusted, juggled, held in the hand? That, says the atomist, must be appearance. Unlike its opposite, reality, ‘appearance’ is a thoroughly philosophical concept. It imposes itself on top of the initial two tiers of representation and reality. Much philosophy misorders this triad (Hacking 1983, 141).

So far Hacking has left us with a world which is mute about the explanations of the occurrences in it, with a reality which is largely the product of those understanding this very reality, and with no deep-seated metaphysics as the final arbiter.

How can we say that we know, then? Hacking’s answer is that we know because representations are made according to a style: “There is, we all know, no representation without style. Even the most untutored of cultures must have a system of representation if it is to represent at all” (Hacking 1983, 137). This ‘style’ Hacking refers to is just artistic style, like in the proposition ‘Cycladic statuettes are all made in a minimalist style’, but he does not stay there:

I am too brainwashed by philosophy to hold that thing in general can be simply, or unqualifiedly alike. They must be like or unlike in this or that respect. However a particular kind of thing, namely a human-made representation, can unqualifiedly be like what it is intended to represent. Our generalized notion
of likeness is, like our idea of reality, parasitic upon our practices of representation. There may be some initial way in which representations are like what they represent. There is no doubt that some human artifacts of very foreign and very ancient peoples are immediately recognized as likenesses, even when we do not quite know what they are likenesses of (Hacking 1983, 137).

But we have not the whole story about likeness yet. Hacking goes on:

…there is a core to representation that enables archaeologists millennia later to pick out certain objects in the debris of an ancient site, and to see them as likenesses. Doubtless ‘likeness’ is the wrong word, because the ‘art’ objects will surely include products of the imagination, pretties and uglies made for their own sake, for the sake of revenge, wealth, understanding, courtship or terror. But within them all there is a notion of representation that harks back to likeness. Likeness stands alone. It is not a relation. It creates the terms in a relation. [L]ikeness can stand on its own without any need of some concepts… There is no absurdity in thinking that there is a raw and unrefined notion of likeness springing up with the making of representations, and which, as people become more skilful in working with materials, engenders all sorts of different ways of noticing what is like what (Hacking 1983, 138-139).

The quoted passage illustrates how Hacking takes care of the complexities introduced by people’s array of possible motivations in his understanding of
likeness and representation. They are present, all important if we want to make absolute sense of a representation, but they can be set aside for the philosopher to arrive at a useful notion. Its use is that it makes the styles of reasoning sensible. The styles of reasoning are styles of representation, constrained in the field of science. Hacking mentions again the central concerns behind the composition of the ‘Break’ in a later text:

My fundamental observation is that reasoning, finding out, and techniques of discovery have a history. It is not just the history of facts discovered, theories proposed, and technologies invented… We have also had to learn how to find out (Hacking 2009b, 3, emphasis added).

In other words, a history of the establishment of knowledge is incomplete if it ignores the strata of reasoning that made the “facts discovered, theories proposed, and technologies invented” possible. The primacy of the notion of representation over the notion of reality and the philosophical concept of appearance entails that no stratum of scientific reasoning, speculative or technical, would be possible unless it sprang from a style of reasoning.

At the beginning of this chapter I described that entity realism is about unobservables. This stance is the outcome of Hacking towards material objects; for him it is the unobservables that require justification, not meso- or macro-sized objects that can be felt. He writes:

We should learn this: When there is a final truth on the matter – say, the truth that my typewriter is on the table- then what we say is either true or false. It is not a matter of representation… The representations of physics are entirely different from simple,
non-representational assertions about the location of my typewriter. There is a truth of the matter about the typewriter. In physics there is no final truth of the matter, only a barrage of more or less instructive representations (Hacking 1983, 144-145).

The ‘Break’ ends with a brief explanation why doing is important in yielding justified true belief that the unobservables the scientists use regularly in their experiments to unveil other phenomena do exist:

Realism and anti-realism scurry about, trying to latch on to something in the nature of representation that will vanquish the other. There is nothing there. That is why I turn from representing to intervening (Hacking 1983, 145).

Hacking's motivation to enter the realism debate with Representing and Intervening (1983) has been the conviction that philosophy of science should not just be concerned with theories, paradigms or research programmes, but with experiments as well: "I used the raging controversy about scientific realism as a peg on which to hang my plea for experiments" (Hacking 2009a, 8, the whole sentence is emphasized in the original). Science is not only thinking, but doing, too; that is to be understood emphatically.

Using Hacking’s theory of the nature of representation we can answer a question implicit in chapter 1, namely ‘why does experimentation matter for the philosopher of science?’ The answer is: because justification for an important part of our knowledge is to be found in doing. The rest of the chapter is dedicated to show this. The ‘Break’ has prepared us for the conclusion that
epistemic normativity is to be found in the meeting point of representation and intervention, viz. intervening according to a style of representation.

5.2.3 Propositions according to a style of reasoning are compelling

The styles of reasoning are reason: they shape the background against which meaning and discourse acquire their possibility for intelligibility. Hacking asserts us that he has “no doubt that our discoveries are ‘objective’ simply because the styles of reasoning that we employ determine what counts as objectivity” (Hacking 2002b, 160-161). The styles of reasoning are constitutive of what counts as compelling.

So what about the world, which cast its shadow over Hacking’s discussion of representation? Hacking incorporates the empirical in his styles of reasoning as a worry (Hacking 2002b, 160, 161). The “worry” is about the existence of propositions independent of the styles of reasoning that settle “what it is to be true or false in their [i.e. the styles’] domain” (Hacking 2002b, 161). More precisely, Hacking wishes to address the issue that the historical account which led us to the styles opens the door to: “…the sense of a proposition p, the way in which it points to truth or falsehood, [hinging] on the style of reasoning appropriate to p. Hence we cannot criticize that style of reasoning as a way of getting to p or to not-p, because p simply is that proposition whose truth value is determined in this way” (Hacking 2002b, 160). This is an elaborate way to say that people will object that the styles of reasoning pave the way for relativism. The worry is addressed by the very facts: “It is not the case that nothing’s either true or false but thinking makes it so. Plenty of things that we say need no reasons” (Hacking 2002b, 161, original emphasis). So, relativism is excluded by
the basic assumption that there are some propositions which are definitively true or false, like the typewriter example from Representing and Intervening.

Hacking clarifies (Hacking 2002b, 160-161) that his concern with propositions that stem from a style of reasoning is not whether they are true, but whether they are true-or-false. The focus in this part of Hacking’s philosophy is not on the correspondence of our mental contents with the world. This issue is addressed at the level below the styles of reasoning; the lower level is addressed in his thought about scientific realism. He explains that the style of thinking that “befits the sentence” (Hacking 2002b, 160) assists in determining its meaning (so that the sentence is now a proposition) and it also determines in what fashion the sentence is a candidate for truth rather than falsehood or vice versa (Hacking 2002b, 160). A sentence can express a number of different propositions. What is entailed in this assertion is that meanings change over time (Hacking 2002b, 165). He also introduces the idea of meaning changing over time by stating the fact that renaissance medicine is almost incomprehensible (2002b, 170). Hacking’s purpose is not to argue for the historicality of propositions only, but for the historicality of whole “bodies of thought” (2002b, 170). The latter concern is admittedly broader: it entails propositions being potentially totally incomprehensible –without effort at least—or being misunderstood by readers not familiar with the background that produced the text in front of their eyes.

5.2.4 Positivity

The existence of the styles of reasoning does not immediately make us think of epistemic relativism, Hacking writes (2002b, 162). What raises the spectre of relativism is the existence of the world, in which we have found ourselves,
paired with the styles of reasoning (Hacking 2002b, 167). I do not wish to restrict the meaning of the word ‘world’ to the natural world only, but as far as the natural world is concerned it is its material aspect that we should stress. Objects are and events happen, possessing an inescapable brute force. As Hacking puts it, some sentences have a “positive” character (2002b, 166). Here follows an example of positivity in action:

At the time of Pierre-Simon de Laplace it was very sensible to think that there are particles of caloric, the substance of heat, that have repulsive forces that decay rapidly with distance. Relying on this hypothesis, Laplace solved many of the outstanding problems about sound. Propositions about the rate of extinction of the repulsive force of caloric were up for grabs as true or false, and one knew how to obtain information bearing on the question. Laplace had an excellent estimate of the rate of extinction of the repulsive force, yet it turns out that the whole idea is wrongheaded. I would say that Laplace’s sentences once were ‘positive’. (Hacking 2002b, 166)

A positive sentence is one that comes about from cycles of observation of the empirical world, and then comes some thinking about it before we finally go back to observation, starting another cycle. Hacking is influenced by Auguste Comte (2002b, 165, 167). Positivity comes together with verificationism (Hacking 2002a, 191; 2002b, 165). If it did not, Hacking’s “worry” would be the norm: we would not regard empirical knowledge as mind-independent.

5.2.5 Additional characteristics of the styles of reasoning
The characteristics of the styles of reasoning are more like the traits of an organism as the biologists use the word. First, Hacking clarifies that there is no one-style-per-discipline. Each one of them is used by many disciplines and a single inquiry will usually require more than one of them (Hacking 2009a, 182). Second, Hacking acknowledges that Crombie’s list of styles might be incomplete (Hacking 2002a, 183). In all probability it is not exhaustive (Hacking 2002a, 183).

Styles are not private (Hacking 2002a, 180). They pervade the way of thinking and doing of many individuals over large periods of time.

Crombie’s six styles of reasoning emerge contingently, “by little microsocial interactions and negotiations” (Hacking 2002a, 188). Their origins, now largely forgotten or known only as myths, are to be discovered by the historian (Hacking 2002a, 188). The styles have outgrown their original settings (Hacking 2002a, 188). In the present day,

Each style has become what we think of as a rather timeless canon of objectivity, a standard or model of what it is to be reasonable about this or that type of subject matter. We do not check to see whether mathematical proof or laboratory investigation or statistical studies are the right way to reason: they have become (after fierce struggles) what it is to reason rightly, to be reasonable in this or that domain (Hacking 2002a, 188).

The assertion that the styles of reasoning are reason proper (in their domain only) comes with a warning: “I assert neither that people have decided what shall count as objectivity, nor that we have discovered what does the trick. I am
[just] concerned with the way in which objectivity comes into being…” (Hacking 2002a, 188). Objectivity is not a matter of decision because, as we have seen, all representation is done according to a style. There is no standard of being correct about a sentence or about an object’s existence without a style (Hacking 2002a, 188-189).

Styles introduce “novelties” (Hacking 2002a, 190). These novelties might be new objects, new types of evidence, new sentences, i.e. new ways of being a candidate for truth-or-falsehood, new laws —or, at least, new modalities, new possibilities (Hacking 2002a, 189). A style typically will introduce more than one type of novelty (Hacking 2002a, 190).

We should not forget the positivity of sentences introduced by styles of reasoning (Hacking 2002a, 190-191). The only measure of the truth-or-falsehood of such sentences is the style of reasoning to which they belong (Hacking 2002a, 191). There is an “unsettling feeling of circularity” (Hacking 2002a, 191) in this conception, but it is welcome (Hacking 2002a, 192), because it can assist us explain why:

…although styles may evolve or be abandoned, they are curiously immune to anything akin to refutation. There is no higher standard to which they directly answer. The remarkable thing about styles is that they are stable, enduring, accumulating over the long haul. Moreover, in a shorter time frame, the knowledge that we acquire using them is moderately stable. It is our knowledges that are subject to revolution, to mutation, and to several kinds of oblivion; it is the content of what we find out,
not how we find out, that is refuted. Here lies the source of a certain kind of stability (Hacking 2002a, 192).

The positivity cycle of finding the truth of propositions is called the self-authentication of the styles by Hacking (2002a, 191). The self-authentication of the styles is related by Hacking with the “certain kind of stability” that the styles possess, namely self-stabilizing techniques (Hacking 2002a, 193). There are many of them, some identified by other scholars (Hacking 2002a, 193). Each style has its own self-stabilizing techniques and the only thing these techniques have in common is that they enable the style to persist for extended periods of time (Hacking 2002a, 193, 194). Some stabilizing techniques are more effective than others (Hacking 2002a, 194): mathematics (style a) enjoys rather universal endorsement of (and acclaim for) its standards of objectivity. On the other hand, in the taxonomic and historic-genetic styles there are debates on how to go about selecting premium vantage points.

Styles may have life cycles: they might die out (Hacking 2002a, 194). Like their contingent origins, a style’s death is not due to “internal” causes only, but it depends on the circumstances during the era the style was abandoned (Hacking 2002a, 195).

Alexandra Bradner (2009, 3-4) summarizes in a neat list everything I have said so far about the traits of the styles of reasoning. The styles are:

1. general, not personal. They also are not discipline specific, like the narrower “ways of seeing" that belong to Ludwig Fleck's thought collectives (Hacking 2002a, 180). “...styles do not determine a content, a specific science” (Hacking 2002a, 182). Many different disciplines employ the style of statistical reasoning, for instance.
2. not in the head, but ways of working through worldly stuff

3. ahistorical, in that they outlive their original historical instances

4. not predictable or (in any sense) derivable, styles emerge contingently

5. dynamic, styles can change or evolve

6. immune to refutation, but may become invisible or "extinct"

7. they are not accidental, haphazard or one-time approaches, styles have form, recurring structure.

8. must introduce novelties, like objects, evidence, laws, possibilities, "new ways of being a candidate for truth and falsehood" (Hacking 2002a, 189)

9. they are self-authenticating or self-stabilizing.

We can modify the trait number 9 according to Bradner that the styles are self-authenticating and self-stabilizing. It is the trait number 9 that creates problems for the styles of reasoning, as we will see in the next chapter.

A final note concerns the name of the styles. As a result of the proliferation of ‘styles of reasoning’ in the literature due to his work, Hacking now prefers to refer to them with their full Crombiean label, *styles of scientific thinking and doing in the European tradition* (Hacking 2012, 600). I stick with the ‘styles of reasoning’ name for the reason that it conveys better the meaning that they are the standards of sound thinking and correct action in their domains.

Talking about styles, i.e. being squarely in the space of broad schematizing concepts about science, we should spend some time discussing John Pickstone’s ‘ways of knowing’ (Pickstone 1993; 2000; 2007; 2011). Ways of knowing are a “map” (Pickstone 2000, 22) for the historian and “other analysts
of social and intellectual change” (Pickstone 2000, 22). The ways of knowing have been compared with Hacking’s and Crombie’s styles on the basis of their broad scope: both the ways of knowing and the styles “are cognitive practices but include more than simple rules of inference” (Strasser & de Chadarevian 2011, 319), they both “produce specific scientific objects” (Strasser & de Chadarevian 2011, 319), and both outlast their specific historical origins (Strasser & de Chadarevian 2011, 319). Both are about western science, too.

The general description of the ways of knowing by Pickstone is the following:

…each of these ways of knowing has a history, and these histories differ; new ways of knowing are created, but they rarely disappear. As Western society has grown more complex, so ways of knowing and doing have been built up. These ‘ways’ or projects interact in various ways and their ‘coverages’ vary over time. All my categories could be used, in principle, for any time and place, but as a matter of historical fact they became important at different times and in different combinations. In this view, history of STM [i.e. science, technology, medicine] is not a matter of successions, or the replacements of one kind of knowledge by another; rather it is a matter of complex cumulation and of simultaneous variety, contested over time, not least when new forms of knowledge partially displace old forms (Pickstone 2000, 9, original emphasis).

As we will see later in this chapter in detail about the styles of reasoning, there indeed are a number of similarities between the ways of knowing and the styles of reasoning. Pickstone has composed a history of the various ways people use
now, and ways people have used in the past, to find out (Pickstone 2000, 6). He has offered us a history of epistemology and a historical sociology. Pickstone prefers to describe his work as historical sociology (e.g. Pickstone 1993).

The ways of knowing are the product of analyses of instances of ‘finding out’ in science, technology and medicine (Pickstone 2000, 7; 31, note 2). The ‘Ways of Knowing’ are the “elements” of science, technology, and medicine (Pickstone 2000, 7). Pickstone has placed the word ‘elements’ in quotation marks (Pickstone 2000, 7); in the cited page it appears exactly as I have just presented it in the previous sentence. We will now begin to unravel gradually Pickstone’s exact conception of ways as elements.

These ‘elements’ are not taxonomical categories to which particular instances of ‘finding out’ can be classified under: such instances “are not to be ‘dropped’ into single ways of knowing, like specimens into boxes” (Pickstone 2000, 9).

Pickstone explains further: “rather, ways of knowing are to be used in analysing the components of projects and the relations between them” (2000, 9, original emphasis).

The ‘projects’ Pickstone refers to are what I have called ‘instances of finding out’. They are episodes in the process of knowledge acquisition and technology development. The method for their analysis is historical; Pickstone suggests that “this analysis cuts through some of the usual ‘science and technology’ problems by dissecting unfortunate reifications into elements that are at once more historically accurate and more flexible” (2007, 515). Pickstone speaks of “STM projects” (Pickstone 2000, 9); the acronym STM stands for ‘science, technology, medicine’. It is indicative of Pickstone’s conception of the endeavour for practice and knowledge (or the enterprise of scientific practice...
and knowledge, with and without the business connotations, as we will soon see).

Pickstone conceives ‘science’ in “a very broad” sense (Pickstone 2000, 6), he observes that ‘technology’ is ill-defined, and he also remarks that ‘medicine’ fares only slightly better than ‘technology’ (Pickstone 2000, 6). The broad conception of science, the great pervasiveness of technology in the contemporary world, and the fact that the current notion of ‘medicine’ entails sciences’ and technologies’ being used in treatment and therapy, make Pickstone struggle to find a word that “would encompass all… parallel science-technology fields” (Pickstone 2000, 6). He has settled for the acronym STM (Pickstone 2000, 6) to stand for the web of influences between practices, knowledges, and technologies. Pickstone’s ways of knowing are elements which are uncovered by analysis after the assumption of the synthetic starting point of STM.

The early ways of knowing which Pickstone identified are natural history, analysis, experimentalism, technoscience, and world-readings (Pickstone 2000, 7-8).

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29 Pickstone’s early work on the ways of knowing helps us grasp how he brings analysis and synthesis together. Let us take a look at a mode of analysis, which Pickstone uses, and which happens to be a very old one: “The notion of biographical medicine is largely derived from scholarship on ancient Greek and Roman medicine which sought to understand its intellectual form and content, and especially its relation to philosophy, in terms of social relations” (Pickstone 1993, 435). Then, he brings this ancient mode of codification of medical knowledge, practice and information up to-date: “At the level of approximation at which we are operating here, we can merge the model of biographical… medicine with the account of eighteenth-century medicine in [Michel] Foucault's *Birth of the Clinic*. And that account of medicine’s intellectual structure can be regarded as a special case of the classical *episteme*, or structure of knowledge, which Foucault described in *The Order of Things*, where classical natural history was discussed alongside general grammar and accounts of economic exchange” (Pickstone 2000, 439).
Natural history is the cataloguing of the variety of things that there are and/or a cataloguing of properties of things (Pickstone 2000, 10). Natural history is about taxonomy and classification. It encompasses the various taxonomies and classifications that exist or have existed (Pickstone 2000, 10). The ‘natural’ part does not refer to natural objects only, but also to artefacts and other human creations (Pickstone 2000, 10); all aspects of the environments in which we live in are ‘natural’. The ‘natural’ includes physical stuff and conceptual stuff, stuff which can be man-made or it can exist by its own accord. The ‘history’ part is about explicatory narrations and about change. Pickstone’s ‘natural history’ is also about information, ‘what we’ve got’, ‘facts’ in our disposal, and ‘experience’ (Pickstone 2000, 10-11).

Analysis “seeks order by dissection” (Pickstone 2000, 11). Pickstone argues that analytic science develops around a central ‘element’ (Pickstone 2000, 106-112, 115-119, 122-123, 125-126), or rather, having the historical aspect of development in mind, analytic science flows from a central ‘element’ (Pickstone 2000, 11). The elements were not readily available out there; “in some sense they did not exist before 1750” (Pickstone 2000, 12) The word ‘element’ here has the same scope as when Pickstone uses it to describe the ways of knowing, but the content is not the same. Here we should think of a central organizing element for many projects. An element is something many practitioners of STM organize their work around (i.e. a number of people agree it is significant), either to explore or to exploit it (or both). There are many types of analysis (Pickstone 2000, 11). Common elements offer opportunities for comparisons, so analysis is associated with comparative work (Pickstone 2000, 12).
Experimentalism is about “the systematic production of novelty” (Pickstone 2000, 13). Experimentalism “builds on analysis” (Pickstone 2000, 13).

Pickstone's definition of experimentalism is the following: “If analysis is about taking things apart, experimentalism is about setting them up. The former is about specifying the composition of the ‘known’, the latter about putting together elements and controlling them to create new phenomena (or old phenomena in new ways)” (Pickstone 2000, 12).

The fourth way of knowing is technoscience: “Technoscience refers to ways of making knowledge that are also ways of making commodities, or such quasi-commodities as state-produced weapons” (Pickstone 2000, 13-14, original emphasis). Technoscience is the association of knowledge projects with governments, institutions, or corporations (Pickstone 2000, 14-15).

Technoscience began with the utilization of natural history as the way of knowing for achieving various institutional ends; sometimes there were interconnections of the analytical-way type between the practice of science and government, universities and industrial companies (Pickstone 2000, 14). After the 1870s the interests of government, universities and industrial companies developed in “more inventive, intense and self-perpetuating synergies” (Pickstone 2000, 14). Technoscience from the 1870s onwards can be called ‘synthetic technoscience’ (Pickstone 2000, 14).

The final way of knowing in Pickstone’s early account of the ways of knowing is ‘world-readings’. World-readings are about the meanings of things; Pickstone calls them ‘natural philosophies’, too (Pickstone 2000, 8; 2011, 238). The sense of the adjective ‘natural’ is the same as in natural history; man-made stuff is included. World-readings for Pickstone are like hermeneutics (2000, 15).
Hermeneutics is the deciphering of meanings. “Understanding the world in terms of meanings is an activity I refer to as ‘reading’, here drawing on the now general understanding that all aspects of life can be ‘read’ as if they were texts” (Pickstone 2011, 238). World-readings persist through time; they also are still important today, despite their being a very old fashion of knowing (Pickstone 2011, 238). World-readings are significant ways of knowing, because they were the first ways of human getting-to-know in historical terms, and because we are still affected by world-readings to this day:

Our age lacks a simple term for the study of the meanings of the natural world, but there used to be one. For our early modern predecessors, this was natural philosophy — understood in its general rather than technical aspects, as a branch of philosophy (or theology), rather than a branch of mathematics or physics. Meanings were sought in general principles, such as those of Aristotle, Plato or Paracelsus… (Pickstone 2011, 238).

In a sense, world-reading as an activity and world-readings as abstract entities subject to study by science are central to Pickstone’s approach to scientific practice:

By stressing world-readings or hermeneutics in this book I hope to open up the debate around STM by emphasising an obvious fact, too easily ignored: that our primary relationship to nature, as to each other, is one of meaning – of morals and aesthetics, or of religion (for some). Questions of meaning underpin all our relationships with the world, including our appreciation and use
of other ways of knowing (Pickstone 2000, 216, original emphasis).

The sense in which world-reading is significant is the following: “The discussions on the ways of knowing] presume cultures which recognize ‘natural kinds’ – as distinguishable, though not separate, from social and cultural categories” (Pickstone 2011, 237).

A comment in passing: We have just witnessed that the practice turn in theorizing about science forces Pickstone to point in the direction of ethics and aesthetics. As we have seen, this logically necessary move towards ethics and aesthetics can be traced at the beginning of the philosophy of science, to Reichenbach. So, we will not be too far off if we say that the practice approach has been brewing in the theoretical study of science from that study’s very beginnings. Let us return to the ways of knowing.

There is some ambivalence on Pickstone’s part about whether experimentalism and technoscience count as distinct ways of knowing. In Pickstone (2007, 494) we are informed that the ways of knowing were already four, not five. In the same paper we find these two ways merged into a fourth and final way of knowing, called ‘synthetic experimentation’ (Pickstone 2007, 495). The ‘technics’ part of the technoscience has been allocated to Pickstone’s ‘ways of working’ (Pickstone 2007, 495; cf. Pickstone 2005), about which we will speak later on.

Recently, Pickstone has offered four categories slightly different categories as ways of knowing. The first is called ‘sorting kinds’ and it covers ‘natural history’ precisely and entirely. The others are ‘mathematical analysis by elements’ (a post-enlightenment example of which is applied mathematics), another is
‘mathematical synthesis from elements’ (the post-enlightenment example is simulations, ‘substantive analysis’ (post-enlightenment examples include analytic sciences like chemistry or histology), and ‘substantive synthesis’ (post-enlightenment examples of which are synthetic chemistry and genetic engineering) (Pickstone 2011, table 1, 236; cf. Pickstone 2007, 496-497). The new categorization of the ways of knowing is due to historical motivations. There are no early modern examples of substantive analysis or synthesis. These two ways of knowing developed after 1800. The mathematical analysis and the mathematical synthesis, along with the world-readings, which now Pickstone calls ‘readings of meanings’ (Pickstone 2011, table 1, 236), have existed before 1750. We will see in a following quotation how these late ways of knowing are to be conceived in detail.

The ways of knowing, early and late, are associated with ways of performing, which Pickstone calls ‘ways of working’. In the earlier terminology (Pickstone 2000), the ways of working are called ‘ways of making’ (Pickstone 2000, 17-19).

Pickstone has found out that “Scientific change involves changes of work patterns, not just of ideas” (2000, 18). According to Pickstone, there are “close, systematic linkages” (2000, 19) between ways of knowing and ways of working. Ways of knowing plus ways of working constitute what Pickstone (2007) calls ‘working knowledges’. The ways of making in Pickstone (2000) are craft, rationalized production and systematic invention (Pickstone 2000, 18), plus the technoscientific making (Pickstone 2000, 19; 223). We will now see how the working knowledges (i.e. late ways of knowing plus ways of working rather than ways of making) are described by Pickstone:
a) *Reading* and *rhetorics*, which deal with *meanings*. Here I include the interpretive practices that read “cases” in terms of formal or informal “philosophies”, along with the corresponding persuasive or “spirit-transformative” practices that we can call rhetorics. If it seems odd to group formal natural philosophy with informal or vernacular understandings, that may be because we have forgotten how natural philosophy, including medical practice, worked in the world, and because positivists from the nineteenth century defined science to exclude such matters. But, of course, historical and sociological studies of STM characteristically put them back.

b) *Natural history* and *craft*, which deal with *kinds*. Here I include the descriptive and classificatory practices that we may refer to as natural history in an extended sense, along with the materially transformative practices of crafts. If this pairing seems strange, think of wine, and of the knowledges of grapes, plants, soils, seasons, recipes, fermentation, spoilage, and consumers that are involved in the crafting and selling of wines. And think how near are these working knowledges to the traditional practices of medicine, which dealt with disturbances of various kinds of people in their seasonal environments.

c) *Analysis* and *rationalization*, which deal with “*compounds*” of elements. Here I include acts of analysis that reduce complex movements or objects to configurations of elements—whether mathematical, as in planetary astronomy, or substantive, as in
modern chemistry. Such knowledge practices may be associated with the technical practices of rationalization. Both analysis and rationalization constitute their objects as, in some sense, “compounds”—whether of vectors, chemical elements, or the components of industrial production. Some substantive analysis (e.g., modern chemistry) involves intervention in the phenomena, some (e.g., stratigraphy) does not.

d) *Synthetic experimentation and systematic invention*, which create systems as understood through analysis. Synthetic systems include new compounds (as in chemistry from ca. 1870) that are intellectual creations as well as possible additions to technology, along with “prototypes” of mechanical or electrical *inventions* meant to change the world outside the laboratory. I also include experimental systems where we can exercise control, as in the “experimental medicine” advocated by Claude Bernard. And I now add here the explicit mathematical modeling that (also) featured in the late nineteenth century, of which the present-day progeny include interactive computer simulations. All these “systems,” whether substantive or mathematical, are created; but some would seem to be more interventional (or interactive) than others (Pickstone 2007, 494-495, original emphasis).

In the preceding descriptions (points a to d, which also constitute the definitive account of how the ways of knowing and ways of working stand) the first part of the description of the working knowledge is the way of knowing and the second
is the way of working. In (Pickstone 2011, table 1, 236) the associations between ways of knowing and ways of working are as follows: 1) ‘reading meanings’ is associated with ‘readings from meanings’, 2) ‘sorting kinds’ with ‘diagnosis/prescription’ and with ‘crafting from kinds’, 3) ‘mathematical analysis by elements’ with ‘rationalization’, an example of which is the application of mathematicized physics to ballistics, 4) ‘mathematical synthesis from elements’ with ‘modelling’, examples of which include the planetary orbits (an old achievement) and systems biology (a recent development), 5) ‘substantive analysis’ with the ‘rationalizing of crafts’, and 6) ‘substantive synthesis’ is not associated with any example.

As I said at the beginning of our discussion of the ways of knowing, Pickstone’s ways of knowing, along with their associated ways of working, are of interest to us because they have been compared to Hacking’s styles of reasoning. The comparison is sensible since both accounts are grand conceptual schemes which link knowledge to arts and crafts, i.e. they link knowledge to practice. Pickstone makes a comparison with the styles of reasoning himself: “I have tried to extend my analysis across much of the ground where Crombie and Hacking sought to recognize different styles, including the statistical and the historical. But I have stressed the nesting of working knowledges, the need for open-ended historical analysis, and the utility and centrality of actors’ categorizations” (Pickstone 2007, 515).

Let us begin our assessment: Since Pickstone models his ways of knowing and ways of working after Weber’s conception of ‘ideal types’ (Pickstone 2000, 8; 24; 34, and Pickstone 2000, 18-19 for knowing and working respectively), like ‘bureaucracy’, which “could refer to a massive system of offices or to the
workings of a few people, and offices could also contain other social types, e.g. friendship or charismatic leadership” (Pickstone 2000, 8), the ways of knowing might be more suited for historically sensitive sociological analyses than the styles of reasoning; Pickstone has found that the styles of reasoning are usually read as taxonomic (Pickstone 2011, 235).

Furthermore, Pickstone has concluded from Hacking’s historical essays on statistics in *The Taming of Chance* (Hacking 1990) that “statistical methods may not best be seen as a primary style of science” (Pickstone 2007, 506), i.e. that there is no neat abstraction corresponding to the statistical style of reasoning. This assessment is a result of Pickstone’s observation that his ways of knowing capture fine seventeenth century statistics as Hacking has reconstructed them, and they do just as well for nineteenth century statistics (Pickstone 2007, 506). On the contrary, by using Hacking’s styles we end up with the statistical style having to accommodate two opposing fashions of social statistical inquiry (Pickstone 2007, 506). If we use the ways of knowing approach we find natural history and craft at play in the early period and a continuation of natural history plus analysis for the statistics of the nineteenth century (Pickstone 2007, 506). Pickstone thinks that his ways of knowing capture better Hacking’s history of statistics.

What Pickstone has got wrong is that a statistical style of reasoning according to Hacking is a presupposition for any possible competing statistical thinking and doing: the statistical style can logically accommodate any number of competing frameworks which are recognizably statistical, or, for the other styles, experimental, or mathematical, etc. This is because, as we have seen, Hacking casts explicitly Crombie’s styles as (a part of human) reason. Reason is more
fundamental than either knowing or working; reason is the ability to balance information, feelings, intentions, beliefs, dispositions of character and any other type of mental content. Reasoning has to do with thinking and doing in general, not only with justified thinking and sensible doing; these latter two are what working knowledges are about.

Pickstone’s argument is directed against his own conception of Hacking’s styles and not Hacking’s own conception of them, but the ways of knowing plus the ways of working have the advantage of explicitly including philosophy and history in the ‘knowings’ they encompass30.

I conclude that Pickstone’s working knowledges (ways of working plus ways of knowing) do not problematize why what counts as epistemically justified in science is so or is not so. I also conclude that the styles of reasoning and the ways of working are not competing abstractions of scientific thinking and practice, since they are logically compatible in virtue of being abstractions which belong to different levels (the styles abstract at the level of reason, the ways of knowing at the level of belief). My conclusion is bolstered by Hacking’s recent admission that his conception of the styles is philosophical rather than primarily historical (Hacking 2012, 601).

5.3 Truth and truthfulness

Hacking has devoted a lot of ink to the matter of truth, one of the constituents of knowledge. This is to be expected since Hacking has cast the issue of truth according to a style of reasoning (truth-or-falsity of a sentence) explicitly. The

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30 Philosophy of science is an example of post-enlightenment reading of meanings and experimental history is listed as a variety of the way of sorting kinds in (Pickstone 2011, table 1, 236).
issue with justification is a bit more complicated as we shall see when we finish
discussing truth.

In (2009a, 7-9; 2012, 605) Hacking introduces us to a facet of the concept of
truthfulness according to Bernard Williams: while truth does not have a history,
truthfulness (what counts as establishing the truth in different fields during
different times) has a history. Bernard Williams's distinction is useful, Hacking
thinks, because it allows him to explicate his viewpoint without saying anything
substantive about truth (Hacking 2009a, 9). So Hacking is clear that he is not
after a theory of truth. In a useful footnote (Hacking 2009a, 9) Hacking points us
to older papers to see why he says nothing about truth after having implicated it
in his account of styles of reasoning. In Hacking (2002a, 192) we read: "The
truth of a proposition in no way explains our discovery of it, or its acceptance by
a scientific community, or its staying in place as a standard item of knowledge.
Nor does being a fact, nor reality, nor the way the world is". Truth is not
explanatory, but the various styles of reasoning are providing explanations, in
virtue of their being the standards of truth-or-falsehood (Hacking 2002a, 193).
The explanation sought is distinctively philosophical in the traditional sense
(Hacking 2002a, 192); this means that Hacking will not rest content with
historical or other narratives about a particular style of reasoning: knowledge is
normative.

But what are the central details of such a distinctively traditional philosophy?

In (2002a), Hacking offers a description how truth is not explanatory:

I may believe that there was a solar eclipse this summer

because there was one in the place I was then staying; the
eclipse is part of the explanation of my belief..., along with my
experience, my memory, my general knowledge, the folderol in
the newspapers, etc. But the fact that there was an eclipse, or
the truth of the proposition that there was an eclipse, is not part
of the explanation, or at any rate not over and above the
eclipse itself (Hacking 2002a, 192-193).

The passage reveals more than a dismissal of philosophy with formalistic
tendencies, like logical empiricism. It is demonstrative of Hacking's general
philosophical outlook. The attitude indicated is one of genuine unpremeditated
awe with plain occurrences in the world. Such awe was the hallmark of the
beginnings of western philosophy in ancient Greece from the pre-socratics until
at least Aristotle. Hacking's standpoint is "...reminiscent of very traditional
philosophy" (Hacking 2002a, 192) indeed.

Hacking speaks a little more about the technical aspects of his conception of
truth in (2009a):

Truth... has no history, beyond the fact that it is coeval with the
emergence of linguistic structures to convey information. This
conception is Aristotelian and Tarskian. The adjective 'true' has
many uses, but truth is a formal concept, essential to semantics
but with no semantics of its own. Thus it spans all informative
discourse, and has no genealogy.

Aristotle: 'To say that that which is the case, is the case, and that
which is not the case, is not the case, is to say the truth' [Aristotle,
Metaphysics, 1011b25]. That is a blank, formal, assertion,
conveying in passing the fundamental fact that the adjective ‘true’
primarily applies to what is said, was said, or can be said. There
is undoubtedly a history of when human beings began to talk, to say things informatively, to make what we can recognize as assertions. But there is no further history of truth than that.

I read Aristotle’s maxim as an early version of Tarski’s equally formal semantic theory of truth. Its scheme, ‘s is true if and only if p’, makes as plain as Aristotle did that the adjective applies to sentences (Hacking 2009a, 8).

This conception of truth appears to be not just independent from ontological commitments about facts, but, in an important sense, also from the history of a particular fact; recapitulating what we have seen to be Hacking’s attitude about the world, we can now see that the affairs referred to by the reporting sentence ‘Mycobacterium tuberculosis can be lethal’ have always been true, before people found out about pathogenic microorganisms in general and about Mycobacterium tuberculosis in particular. The condition which Mycobacterium tuberculosis causes to people unfortunate enough to catch it is illustrated vividly by its telling surname. In Hacking’s understanding of things, knowledge, the establishment of the fact that Mycobacterium tuberculosis is the causal agent bringing about lung disease is irrelevant to the application of truth as a predicate, viz. the fact does not explain why ‘Mycobacterium tuberculosis can be lethal’ is a true statement. It is the styles of reasoning that explain the truth predication, despite that we can say a lot about how the styles have been applied in particular occasions, i.e. the circumstances in which the proposition (meaningful utterance) ‘Mycobacterium tuberculosis can be lethal’ became a matter of fact.
So now we can definitely see that the state of affairs depicted by Hacking is one where the world is, but the understandings of it are; please notice the plural and the lack of emphasis in the final manifestation of the verb to be. By understanding I mean nothing more than a psychological situation in which one is able to think about and to deal with a physical or abstract object.

5.4 Reference

Reference is the final of the peripheral issues left over from chapter 1. Rheinberger’s (1995a, 51) view on reference can be summarized as a constant exploration of objects, a never-ending movement from epistemic trace to epistemic trace during the process of establishing representations. Hacking’s account is different, but, as we will see in detail, not at odds with the core of Rheinberger’s position (articulated in the previous sentence): Hacking’s main thesis is that meanings can change. We follow Hacking’s steps in the rest of this section. Hacking has dedicated a chapter on reference (1983, ch. 6).

Hacking explains that the sort of reference theory the entity realist needs is one that “does not invite talk of [meaning-]incommensurability” (Hacking 1983, 91). Meaning-incommensurability is the position that people subscribing to different theories accounting for the same phenomena cannot refer to the same entities partaking in these phenomena. For instance, the people involved in the discovery of the electron had different theories about this entity (Hacking 1983, 82-84). Yet, it would be counter-intuitive to think that they were not referring to the same object; every actor in the drama was concerned with the object the mass of which had been experimentally measured by J. J. Thompson (Hacking 1983, 84).
Meaning-incommensurability, Hacking asserts, is the partial outcome of Gottlob Frege’s way of analyzing meaning: expressions should have “definite fixed” senses, which we can apprehend (Hacking 1983, 76). It is the apprehension of the sense which permits us to “pick out” the reference of a term (Hacking 1983, 76). Meaning for Frege has these two components only, sense and reference (Hacking 1983, 76). The idea is that the understanding of the “abstract, objective” sense does “all the work” (Hacking 1983, 76):

Frege ascribes to senses and thoughts objective existence. In his mind, they are objects every bit as real as tables and chairs. Their existence is not dependent on language or the mind. Instead, they are said to exist in a timeless ‘third realm’ of sense, existing apart from both the mental and the physical. Frege concludes this because, although senses are obviously not physical entities, their existence likewise does not depend on any one person’s psychology. A thought, for example, has a truth-value regardless of whether or not anyone believes it and even whether or not anyone has grasped it at all. Moreover, senses are interpersonal. Different people are able to grasp the same senses and same thoughts and communicate them, and it is even possible for expressions in different languages to express the same sense or thought. Frege concludes that they are abstract objects, incapable of full causal interaction with the physical world. They are actual only in the very limited sense that they can have an effect on those who grasp them, but are themselves incapable of being changed or acted upon. They are
neither created by our uses of language or acts of thinking, nor
destroyed by their cessation (Klement 2005).

A person possessing the sense of ‘tiger’ can point one when she sees a
specimen of that species in a zoo. Things can get more complicated when a
person with an understanding of the sense of the gene is asked to pick out a
gene. The complexity arises from the “unFregeian idea” that we can only get the
sense of theoretical terms like the gene from their position in a web of
theoretical propositions (Hacking 1983, 76).

As far as genes are concerned, Lenny Moss (2003) has analyzed the historical
origins of the modern notion of the gene: the historical analysis of the notion of
the gene allows Moss to identify two separate gene notions, the Gene-P and
the Gene-D. The use of capital letters for these gene notions is Moss's. The
Gene-P is the original gene notion. Genes-P are genes which allow for the
prediction of a trait's appearance in an organism (and the explanation of traits
based on heredity and the ancestral genetic substratum of an organism) (Moss
2003, 45). What this means is that we can predict that two blue-eyed parents
will have blue-eyed children (the probability of a baby of this union to be born
with blue-eyes is 1). We can also predict the frequency with which blue-eyed
children are expected to be born from a blue-eyed parent and a brown-eyed
parent who has a copy of the gene for brown eyes and a copy resulting in blue
eyes. In this case every fetus is ½ likely to have brown eyes and ½ blue eyes.
Brown prevails over blue; brown eyes are a dominant trait. Now let us suppose
there is a gene-P responsible for larger than average height. A person who has
inherited it from her parents but was growing up during a famine will in all
probability not be a tall adult, but her descendants are likely to be. Genes-D are
defined by their molecular sequence. They are the core potential from which an organism's development takes place, but the outcome of their presence in the genome, more often than not, cannot be determined in advance. They can produce a huge variety of phenotypes (Moss 2003, 46). Examples of Genes-P are the genes for blue eyes or cystic fibrosis; both are inherited traits which are not caused by a single or a limited array of sequences in the relevant DNA loci. A person with blue eyes only needs to have the area responsible for the production of brown pigment in their DNA somehow altered so that no functional product can be created; the result is blue eyes. The same happens in the case of cystic fibrosis and breast cancer as well. Genes-P are used instrumentally to encompass a broad variety of phenotypes which can be said to be slightly different manifestations of the same trait or condition (Moss 2003, 44-46).

Examples of Genes-D abound in the scientific literature (Moss 2003, 46). They are associated with a particular product, or they are regarded as the common template for many different products. The defining feature is the sequence, allowing researchers to compare these sequences for similarities and differences. I.e., the human and chimpanzee DNA sequences responsible for the molecule that will become insulin can be compared. So, there are two current senses of ‘gene’.

To make things really complicated, Moss finds out (2003, 52) that the two gene notions, each perfectly fine as a referent on its own, have been conflated in a less-than-clear gene notion. The conflated gene elevates -or at least permits aspirations for elevating- a segment of DNA to the status of an exhaustively causally efficacious agent, which brings about phenotypic outcomes without residue. The conflated gene idea has been instrumental in the sedimentation of a biological orthodoxy which calls for our regarding the gene as text -viz.
programme, blueprint, code-script, books of life and information (Moss 2003, 52; 94), bound in misunderstandings of the empirical reality and rhetorical glue (Moss 2003, 184): "The growth of the gene-as-text discussion appears to veer off from empirical reality (or perhaps becomes central to determining what would count as empirical reality)" (Moss 2003, xvii). Moss argues against the view that genes determine organisms: genes are developmental resources than blueprints. In the gene case the network of theoretical propositions which underlie our grasping of the term’s sense is in desperate need of rectification.

In a contemporary genetics textbook the concept of the gene is introduced in the following way:

A gene is classically defined as a unit of heredity, but such a vague definition does not do justice to the exciting characteristics of genes as intricate molecular units that manifest themselves as critical contributors to cell structure and function. At the molecular level, a gene is a segment of DNA that produces a functional product. The functional product of most genes is a polypeptide, which is a linear sequence of amino acids that folds into units that constitute proteins. In addition, genes are commonly described according to the way they affect traits, which are the characteristics of an organism. In humans, for example, we speak of traits such as eye color, hair texture, and height. The ongoing theme of this textbook is the relationship between genes and traits. As an organism grows and develops, its collection of genes provides a blueprint that determines its characteristics (Brooker 2012, 4).
As careful as Brooker is to speak of the impact of the “collection of genes” during growth and development, the blueprint language has emerged in the last sentence. The clarity of the referent is significant; we use referents as building blocks for expanding our understanding. Let us see how we do that.

Hacking suggests the entity realist adopt an account of meaning like Hilary Putnam’s (1979) account of meaning. Putnam’s ‘meaning’ is composed of four components: the syntactic marker, the semantic marker (Hacking 1983, 77), the stereotype (Hacking 1983, 77-78), and the reference/extension of the term (Hacking 1983, 80). The fourth component can be either the reference or the extension, or both of them (Hacking 1983, 80).

Before I elaborate on the components I must add that Putnam’s theory is about the meaning of natural kind terms. Putnam thinks that it is the experts who have the clearest idea of a natural kind in their field, even if they get it wrong (Hacking 1983, 79). Water is an example of a natural kind31, aluminum is another, and tiger is yet another one. Genes-D and Genes-P appear to be natural kinds, too, but the conflated ‘gene’ is not a natural kind.

The syntactic marker is grammatical. For instance, ‘tiger’ is a count noun, ‘water’ is a mass noun (Hacking 1983, 77). The semantic marker is knowledge that the term stands for an animal, a mineral or an element. The semantic

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31 Hacking’s view on natural kinds is that there can be no doing (intervention) without them: “Kinds are important to the agents and artisans who want to use things to do things. Were not our world amenable to classification into kinds that we cognize, we should not have been able to develop any crafts. The animals, perhaps, inhabit a world of properties. We dwell in a universe of kinds” (Hacking 1991, 114). He also stresses that he does not believe that our natural kinds amount to our possessing knowledge of aspects of any “unique best taxonomy” of the things that populate the universe (Hacking 1991, 111). There is no unique best taxonomy to be discovered (Hacking 1991, 111). Natural kinds do not have essences (Hacking 2006, 29); natural kinds are not to be found out there (Hacking 2006, 1, 35).
marker shows “the category of items to which the words apply” (Hacking 1983, 77). The semantic marker of water is ‘liquid’ (Hacking 1983, 77); Genes-D are molecules, Genes-P are characteristics of organisms. The stereotype is “a conventional idea associated with a word, which might well be inaccurate” (Hacking 1983, 77). The stereotype of a tiger in our linguistic community is that tigers have stripes. Hacking points out that despite our “standard” tigers, it is not a contradiction to speak of a tiger that has lost its stripes (Hacking 1983, 77). Stereotypes can include mistakes. Additions can be made to them, too (Hacking 1983, 78). Stereotypes can change (Hacking 1983, 79), what remains constant in the meaning of a term is the reference or the extension (Hacking 1983, 80). A natural kind term’s reference is the natural kind itself: for instance, the reference of water is $\text{H}_2\text{O}$ (Hacking 1983, 80). The reference of Gene-D is ‘DNA sequence’; the reference of Gene-P is ‘unit of heredity’. The extension of a term is “the set of things it is true of” (Hacking 1983, 80). So, the extension of the term tiger is the set of all tigers, past, present, and future.

The significance of this excursion in meaning and reference is a shift from the abstract (a term’s sense) to the concrete (a term’s meaning depends on the practices of a linguistic community and the variety of things in the world); Hacking writes that “the fundamental principle of identity for a term shifts from Fregeian sense to Putnamian reference” (Hacking 1983, 81, original emphasized). There is no ‘third realm’ of senses somehow immutably coupled with stuff, what we have is stuff and our various instances of representing it. ‘Stuff’ can stand for tigers, lemons, water, electrons, Genes-D or Genes-P.

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32 Frege does not explain how (Klement 2005).
Putnam’s theory is a nice account of “success stories” in science, like that of the electron, but it is “imperfect around the edges” (Hacking 1983, 90). It does not fare well for every episode in the history of science (Hacking 1983, 84-90), but it is an account based on the intuitive stance that the soluble RNAs of Zamecnik’s team are our tRNAs—if tRNAs are a natural kind, that is.

The theme of reference, paired with Hacking’s attitude on truth (Hacking 1983, 98-99, 105-106), shapes the metaphysical background of entity realism, which is, as we have said, that the world is. Hacking puts it thus: “I wanted to emphasize that… assuring reference is not primarily a matter of uttering truths, but of interacting with the world…” (Hacking 1983, 107-108).

Hacking warns us that Putnam’s account of reference is often discussed in tandem with Saul Kripke’s views (Hacking 1983, 82). Kripke’s views, Hacking states, open the door to essentialism:

Kripke holds that when one succeeds in naming a natural kind of thing, a thing of that kind must, as part of its very essence, of its very nature, be that kind. This harks back to a philosophy due to Aristotle, called essentialism. According to Kripke, if water is in fact H₂O then water is necessarily H₂O. As a matter of metaphysical necessity, it cannot be anything else. Of course for all we know, it might be something else, but that is an epistemic matter. This essentialism is only accidentally connected with Putnam’s meaning of ‘meaning’ (Hacking 1983, 82).

Hacking is emphatic about avoiding essentialism. We will encounter this stance of his again. In the beginning of this chapter I mentioned that Hacking’s major influences are Kant and Aristotle. We have seen Aristotle’s thought featuring in
Hacking’s conception of truth. We will move on to see how Hacking understands his philosophy in relation to Kant’s thought. The starting point is how the realist conceives the world. The point to take home from the following paragraphs is that we can understand the world even if our frameworks of categorization are subject to historical development, i.e. they are subject to change.

Now that the interaction with the world has appeared in the picture through reference, it is time to complete the circle by arriving back at the styles of reasoning. Hacking reminds us of a philosophical distinction: realism can be the opposite either of nominalism or of idealism (1983, 108). Nominalism is a thesis about classification of stuff; it is the idea that the categorization of the world is mind-dependent, no such thing as a natural kind exists (Hacking 1983, 108). The opposite position, anti-nominalism, an example of which is Aristotelian realism, suggests that "real stuff" (Hacking 1983, 108) belongs intrinsically to certain categories independent of how we think about it. Trees and shrubs are really different things, categories prescribed by nature. The nominalist does not deny that pine trees and rose shrubs are real, she simply thinks that the categories 'tree' and 'shrub' are not to be found out there, manifest in pine trees and rose shrubs respectively (Hacking 1983, 108). I have chosen the rose example deliberately, because rose shrubs belong to that group of shrubs which can grow into trees, just to show what sort of considerations may play a part in thinking that nominalism is correct.

The idealist, on the other hand, supports the thesis that the existence of empirical stuff is dependent on the mind of the beholder. She need not have any opinion about classification (Hacking 1983, 108). Idealism is a position
about existence (Hacking 1983, 108). The (extreme) idealist thinks that pine
trees and rose shrubs are mental entities only.

Now it is the moment to introduce some more terminology. The adjective
‘transcendental’ has to do with the form and possibility of the empirical. So, a
transcendental argument is an argument based on the constitution of our
grasping (i.e. understanding) the things and events around us. The
transcendental is the half of a pair; the other half is the empirical. The empirical
is the content filling the structure laid by the transcendental. John Locke who
thought that objects really do exist and that we infer their existence and
properties from our senses was called by Kant a transcendental realist (Hacking
1983, 96). The opposite position, namely that matter does not exist and all that
exists is mental events, George Berkeley’s position, Kant called empirical
idealism (Hacking 1983, 96). Kant had two labels for his own views: he called
his position an empirical realist and transcendental idealist one (Hacking 1983,
96). His philosophy was a synthesis of Berkeley’s and Locke’s positions. Kant
thought that objects exist, but our perception of them in space and time is
something added by the perceiver –added necessarily since the addition is one
of the constitutive components of perception (Hacking 1983, 97). Kant is a
crucial historical figure: before Kant the realist considered herself to be anti-
nominalist, after Kant the realist is usually an anti-idealist (Hacking 1983, 108).

Thomas Kuhn showed that our frameworks of scientific understanding change.
Hacking believes that Kuhn’s philosophy of science is best read as
transcendental nominalism (Hacking 1983, 109). Kuhn, however, differs
radically from his nominalist predecessors: ”The old-fashioned nominalist of
times gone by held that our systems of classification are products of the human
mind. But he did not suppose that they could be radically altered. Kuhn has changed all that. The categories have been altered and may be altered again" (Hacking 1983, 110). All this is fine, but we should remember that we are using realism as the point of departure here: According to Hacking, Kuhnian nominalism allows that "many of our prescientific categories are natural kinds: people and grass, flesh and horseflesh" (Hacking 1983, 110, original emphasis). Then, the author gradually departs from the position of the Kuhnian nominalist:

The world simply does have horses and grass in it, no matter what we think, and any conceptual scheme will acknowledge that. There is no reason that the history of science should deny that the world sorts itself in these ways. Nor is there much reason, in the comparative study of cultures, to suppose that any other people fail to sort in similar ways. Kuhn’s nominalism, in so far as it is founded upon his historical studies, could teach only that some of our scientific categories could be dislodged (Hacking 1983, 110, emphases added).

Hacking endorses the only lesson Kuhnian nominalism has to offer:

To sum up the idea: we do investigate nature as sorted into the natural kinds delivered by our present sciences, but at the same time hold that these very schemes constitute only an historical event. Moreover, there is no concept of the right, final representation of the world (Hacking 1983, 110, original emphasis).

As you might have already guessed, this field trip culminates in the styles of reasoning. The world is hardly self-explanatory. Hacking does us the favour to
mention them explicitly in the coda of the chapter on anti-realisms, chapter 7 (Hacking 1983, 111). Just before that mention he changes the focus from the world and the ways it sorts itself out to us, the perceivers of it:

   We can hardly avoid approaching nature with our present categories, problems, systems of analysis, methods of technology and of learning. We are in fact empirical realists: we think as if we are using natural kinds, real principles of sorting. Yet in the course of historical reflection we realize that the inquiries most dear to us may be replaced (Hacking, 1983, 110).

Here we have a re-affirmation that the styles of reasoning are the lenses which make knowledge of the world possible. This thesis is recognizably Kantian.

Hacking’s following in Kant’s steps stops there:

   [Kant’s] own realism/idealism was directed at familiar observable objects. He denied that we infer them from our sense-data. Theoretical entities are in contrast inferred from data. Would Kant have been an empirical realist about chairs, that need no inferring, while staying an empirical anti-realist about electrons? That seems to be a possible position (Hacking 1983, 101).

There is more to Hacking’s story: there is a portion of the world (well beyond chairs, in the direction of the elementary) which is knowable through these lenses. The stage is set for showing that belief in the existence of electrons is like belief in the existence of typewriters, pine trees and rose shrubs, through doing.
Now we are ready to return to Rheinberger’s position that—as far as unobservable entities are concerned—we cannot pick out the referent, except as a representation. Burian, who we have briefly seen in chapter 1 criticizing Rheinberger for assuming a normative posture with his historical epistemology, also thinks that Rheinberger does not

…[explore] how one might justify the claim that scientists working with different experimental systems… might nonetheless have good grounds to hold that they had gotten hold of different parts or aspects of the same elephant (Burian 1995, 130).

Burian (1995, 132) is not persuaded by Rheinberger’s way of bringing everything together. This bringing together of everything involves experimental cultures:

[Experimental cultures] are as bricked and tinkered as the experimental systems they are composed of. But they are held together by a specific kind of glue: material, not only formal, interaction… (Rheinberger 1995c, 119).

The emphasis is on the material interaction; as we have already seen Hacking (1983, 107-108) phrase it, it is the interaction with the world that assures reference. So, our two philosophers of experiment, Rheinberger and Hacking, reach the same conclusion. Meddling with electrons or tRNAs in the laboratory is no different than experiencing a cat without a tail: it still is a cat. The bottom line of Hacking’s views on reference is that, in so far as interaction with the world is one of the arbiters of our representations (the other is reasoning), we can be sure that different experimental systems investigate the same thing.
5.5 Experiment

This section is about intervening. It is about experiments and skill. It is also about theories.

Hacking borrows his view of science from Francis Bacon, the Elizabethan philosopher and prosecuting attorney (Hacking 1983, 246). There can be three types of scientist: the “reasoner”, who, like the spider makes cobwebs “out of her own substance”, the “experimenter”, who, like the ant “collects and uses”, and the bee, who follows a middle course, collecting pollen from the flowers and then transforming it to something new and useful “by a power of its own” (quoted in Hacking 1983, 247). The “great” thing about science is (the possibility of) collaboration between theoreticians and experimenters (Hacking 1983, 248), giving rise to some bees.

The interplay between experiment and theory is contingent: a number of historical cases show that we cannot expect a mostly accurate answer to the question what comes first, theory or experiment (Hacking 1983, 166). The history of science offers us with examples of experiments the outcomes of which nobody had a clue how to understand, develop or use (Hacking 1983, 158). We also encounter experiments the findings of which made sense after the experimenters encountered by chance a relevant theoretical suggestion developed independently (Hacking 1983, 159). Some experiments begin by reflection (Hacking 1983, 161-162) and measurements intended to calibrate machines become enshrined in theory (Hacking 1983, 162-164). Finally, there are sets of experimental laws which have waited some time before a more general theory came along to bring them together (Hacking 1983, 164-165).
Based on actual instances of scientific practice, Hacking infers that experimenting is to create phenomena. Phenomena are interesting, instructive regularities (Hacking 1983, 225), which do not exist in nature (Hacking 1983, 230). Hacking draws our attention to the fact that experiments do not work most of the time (1983, 230). The job of the experimentalist is not to collect specimens of events from the wild, but to corner a piece of nature in a stable way. There are countless ways to do that.

*Caenorhabditis elegans* is a small worm, a nematode, which is a model organism for biologists to investigate various workings of animals in the full complexity of a living organism. A long article by David Fay (2013), essentially a manual about keeping nematodes in the lab and about how to go about doing genetic research with them, offers some insight on how phenomena are created. In the passage that follows we are given the rationale on which of the interesting worms are kept for further research:

More than anything else, genetic mapping provides a *litmus test* for determining whether or not a given mutant [worm] is worth pursuing. In our own work, for example, we have encountered many situations where seemingly ‘good’ mutants fail to behave in a normal Mendelian fashion [i.e. they fail to pass traits on to their progeny in a predictable fashion] when put to the rigors of mapping [the locus of genes in the worm’s genetic material]. The reasons for these occurrences [sic] are often murky, but may in some cases be attributed to contributions from multiple loci or possibly even epigenetic phenomena. Regardless, the clear take home message is that such strains are probably not worth
pursuing either by classical or modern [DNA] sequencing
methods. In general, if a mutant can be partially mapped, it is
worth working on (Fay 2013).

Epigenesis is a DNA modification event which affects gene expression but not a
gene’s actual sequence. It can affect the phenotype of an individual but it does
not persist over many generations (Brooker 2012, 103). Fay’s instructions
signify that even if we can explain the complexity in the irregular inheritance of a
trait which seems promising, we should not proceed with it. This creation of
suitable experimental material is an aspect of informed exploration (informed
due to skills and past knowledge), about which I had spoken in relation to
Bonner’s discovery in chapter 4.

There are many ways to go about theorizing, too. Theorizing can be qualitative
or it can involve mathematics (Hacking 1983, 213). No doubt theories play a
large part in science, but Hacking is sceptical about them. The main reason,
apart from his own historical examples are the findings of Cartwright (1983)
about the relations between theorizing, constructing models (an intermediate
activity between theory and experiment), and the phenomena (Hacking 1983,
216-218). He remarks that theoretical entities do not necessarily come with
theoretical paraphernalia. So, when people say "that's a positron", they do not
"somehow assert the theory" (Hacking 1983, 179). Entities for Hacking have a
definite priority over the theories. Based on what we have seen so far this
priority is not evaluative: the experimenters enjoy no prerogative over the
theoreticians. The priority only refers to matters philosophical; the right stance
about theories, Hacking points out, is to be anti-realist about them, i.e. to be
sceptical about the scientific realist's commitment that our theories are true or approximately true (Hacking 1983, 217-218).

After introducing us to some instances of more or less theoretically orphaned phenomena in the history of science which attracted the attention of scientists, Hacking clarifies that:

I make no claim that experimental work could exist independently of theory. That would be the blind work of those whom Bacon mocked as ‘mere empirics’ (Hacking 1983, 158).

Bacon's archetypes of the ant and the spider are given flesh and blood by Hacking by introducing us to the events of the Michelson-Morley series of experiments on light in the 1880s. The series included a "benchmark" experiment, unsurprisingly referred to as the Michelson-Morley experiment, which created phenomena binding for any future theory (Hacking 1983, 264). The Michelson-Morley experiment has been cited as "a decisive reason to reject the Newtonian idea, that space is filled with all-pervading aether" (Hacking 1983, 264). Today physicists do not entertain the possibility of space being filled with aether. Einstein's relativity is an aether-free theory, but Einstein "barely knew about the Michelson-Morley experiment" (Hacking 1983, 264). In addition, Michelson and Morley did not set out to test any theory (Hacking 1983, 264, 257, 260). Moreover, Michelson was more interested in his invented experimental apparatus, the interferometer, than in aether-or-not theoretical issues (Hacking 1983, 260). There is also a theoretician in the story, H. Lorentz. His contribution was to show that Michelson's early calculations were wrong (Hacking 1983, 259). Experimentation is not about testing theories. Conclusions
arrived at from experimental work do not depend on theories for their validity. Experimentation is autonomous.

Now we will see how Hacking's philosophy of experiment culminates in entity realism.

5.6 Material interaction

In this section we will get introduced to some minutiae of how spraying electrons is done.

The 'spraying' terminology used by Hacking originated during a discussion on how experimenters measuring the step of electrical charge changes in a niobium ball changed the electric charge of the ball (Hacking 1983, 23). They sprayed the niobium with electrons and positrons (Hacking 1983, 23). The niobium experiment tried to detect quarks, the particles protons and neutrons are made of. Hacking was not persuaded that quarks exist by the experimenters' account, but concluded that the sprayed particles exist (Hacking 1983, 24):

We are completely convinced of the reality of electrons when we set out to build -and often enough succeed in building- new kinds of device that use various well-understood causal properties of electrons to interfere in other more hypothetical parts of nature (Hacking 1983, 265).

Hacking describes another example of using electrons, an experiment that took place in 1978 (Hacking 1983, 266). Its purpose was to investigate the prediction that from all the electrons parading in a beam, slightly more electrons 'facing' to the point of their origin would be scattered than electrons ‘facing’ in the direction
of the beam (Hacking 1983, 267). The experiment confirmed the expectation (Hacking 1983, 270).

For the experiment to be conducted a new electron-spraying apparatus, PEGGY II, had to be made. The new device was able to generate the amount of parading (linearly polarized) electrons needed, far more than previous devices, thanks to reading about the “curious” electron-emitting properties of gallium arsenide crystals by chance (Hacking 1983, 268). PEGGY II’s making was “fairly non-theoretical” (Hacking 1983, 270). Its ability in getting electrons to behave was fine-tuned by using “crude mechanical means” to get some backtracking electrons in non-interfering paths (Hacking 1983, 269). An experimenter’s hunch that dust in the beam path might behave in any unexpected non-random way, thus producing interference, got the team using a lot of anti-dust spray for a month (Hacking 1983, 270). The statistical evaluation of the scattering events took into account ingrained uncertainties about the electron polarization, jitter from the laser beam responsible for getting electrons on their way, and other laser and electron beam-related problems (Hacking 1983, 270).

Manipulating an entity necessarily commits us to believing it exists: “only manipulating an entity, in order to experiment on something else, need do that” (Hacking 1983, 263, second emphasis added).

Applying Hacking’s realism to the gene, we can unreservedly believe that gene sequences (Genes-D) exist. Scientists have been copying, cutting and splicing and moving from organism to organism pieces of DNA sequence for some time now.

5.7 A transcendental argument for entity realism
Here we will see that Hacking’s (in)famous dictum that if theoretical entities can be manipulated in the course of experiments, then they are real, is the conclusion of a transcendental argument. Using a transcendental argument permits Hacking to provide an unconventional account of what it is to be rational—namely acting according to the standards prescribed by the styles of reasoning. In the following paragraphs I reconstruct how the introduction of experimentation helps Hacking to deploy the transcendental argument in favour of scientific realism.

The first clue is that Hacking understands anti-realism to mean a sceptical stance, to mean reason to doubt (Hacking 1983, 23, 263, 275). As we have discussed in chapter 2, transcendental arguments are usually deployed against scepticism.

The second clue has to do with verificationism; we remember that Stroud (1968) argued that some verification criterion needs to supplement a transcendental argument. As we will see after we bring the styles of reasoning in the game, Hacking has thought about the verification requirement.

The third clue is that Hacking assures us that his argument does not rely on the success of science to be valid (Hacking 1983, 202, 265, 271):

Once upon a time the best reason for thinking that there are electrons might have been success in explanation… Luckily, we no longer have to pretend to infer from explanatory success (Hacking 1983, 271).

We have enough clues for the time being. David Resnik has reconstructed Hacking’s argument for entity realism as follows:
1. We are entitled to believe that a theoretical entity is real if and only if we can use that entity to do things to the world.

2. We can use some theoretical entities, e.g. electrons, to do things to the world, e.g. change the charges of niobium balls.

3. Hence, we are entitled to believe that some theoretical entities, e.g. electrons, are real. (Resnik 1994, 401).

That is an interesting reconstruction of Hacking’s argument, but it is not the best one. Let us see why. Hacking’s argument revolves around causality (Hacking 1983, 263, 265):

…it is not even that you use electrons to experiment on something else that makes it impossible to doubt electrons. Understanding some causal properties of electrons, you guess how to build a very ingenious complex device that enables you to line up the electrons the way you want… Electrons are no longer ways of organizing our thoughts or saving the phenomena that have been observed. They are ways of creating phenomena in some other domain of nature. Electrons are tools (Hacking 1983, 263).

Causality is Cartwright’s (1983) causality (Hacking 1983, 37-38); the effects of interactions in the world are brought about by worldly stuff, stuff which does not acquire its meaning from any theory (Hacking 1983, 38). As we have seen, it is the reference and the extension which do not change when meanings change. So, we can label Hacking’s having brought causality in the argument the “Enter the World” step.
But we are not over yet; “There are an enormous number of ways in which to make instruments that rely on causal properties of electrons in order to produce desired effects of unsurpassed precision” (Hacking 1983, 265). The major problem from this diagnosis is not that there are many ways to interact with electrons, it has to do with which of them are deemed intersubjectively appropriate, fruitful, etc:

Even if experimenters are realists about entities, it does not follow that they are right. Perhaps it is a matter of psychology: maybe the very skills that make for a great experimenter go with a certain cast of mind that objectifies whatever it thinks about.
Yet this won’t do (Hacking 1983, 265).

The great objectifiers in Hacking’s philosophy are the styles of reasoning. The styles of reasoning include the experimental style and the laboratory style. The laboratory style, Hacking’s addition to Crombie’s six styles is a combination of the styles b and c, the experimental style and the hypothetical creation of analogical models style respectively (Hacking 2002a, 184-185). Now Hacking does not consider it a style on its own right but has judged it to belong to style b (Hacking 2012, 603). The full description of style b is the following: The deployment of experiment both to control postulation and to explore by observation and measurement (Hacking 2002a, 182). We have seen a manifestation of the control of postulation, as the investigation of the complex relations between theory and experiment. What makes certain the case that Hacking writes having the experimental style in his mind in the role of the objectifier is his treatment of observation and measurement (1983, chapters 10 and 14), where he argues that observation is a skill and measurement is not just
about testing theories, but there are “pure determinations of the constants of nature” (Hacking 1983, xiii), as well. It is, once more, evident that Hacking makes a case for the autonomy of the experimental style before he uses it in his argument for entity realism. Now we have the second step in the argument, let us call it the “Enter the Style” step.

When Hacking assures us that we do not infer the reality of electrons after we make the instruments (Hacking 1983, 265) and that we do not believe in the existence of electrons because we predict how our experimental apparatus will behave (Hacking 1983, 265), he casts the existence of electrons in the field of implicit assumption about the world. In effect he recasts it as a presupposition.

At this point we can use Resnik’s summary of the story so far:

Hacking’s theory-free, entity realism is a metaphysically consistent position – one can believe in theoretical entities without believing in the theories in which they are embedded - but it is not a reasonable position. It is not a reasonable position because it gives the experimenter belief (and perhaps even true belief) in theoretical entities without justified belief. Given that justification is a necessary condition for knowledge, theory-free realism cannot yield knowledge about theoretical entities. And if Hacking’s realism is a position which does not yield knowledge, then it would be, as he says, ‘idle’ (Resnik 1994, 407).

Resnik does not entertain the involvement of the experimental style in his portrayal. There are critics of Hacking who fare better: Margaret Morrison (1990,
2) considers briefly the possibility that Hacking is using a transcendental argument to support his entity realism.

Morrison objects to the “manipulability criterion” she found to exist in *Representing and Intervening*, claiming that Hacking addresses the metaphysical questions implied in a realist program, ignoring the epistemological ones (Morrison 1990, 1). Her line of argument is similar to Resnik’s: it hinges on the success of science (Resnik 1994, 404), despite Hacking’s disavowal of it. She understands Hacking to ask the question “Given that the practice of science (physics in particular) consists, in part, of successfully building very complex machinery, what must we presuppose in order to make this process an intelligible one?” (Morrison 1990, 18). The success of science is a central concept in Morrison’s analysis of Hacking:

> On pain of inconsistency the argument for realism could perhaps be seen as one which claims that entities and their properties must be presupposed in successful practice; it simply makes no sense to doubt the ontological and epistemological claims that render that practice meaningful. If we understand this as a kind of transcendental argument from the cogency of scientific practice, does it provide an interpretation of Hacking’s position that dismisses… epistemological problems…? (Morrison 1990, 17).

After considering the concept of manipulation in the context of a transcendental argument, she raises a valid concern: “The obvious difficulty is that a commitment to realism about a specific entity need not accompany a piece of manipulation or successful engineering” (Morrison 1990, 18). Reconstructing
Hacking’s argument for entity realism as a transcendental argument does not help the case for entity realism, because:

…the act of manipulation [is] not what [carries] conviction, it [is] the interaction between theory and experiment that [occurs] at various stages throughout the investigation that finally produced commitment and belief. In other words, ‘doing’ does not imply the truth of theoretical presuppositions that accompany the ‘doing’ (i.e., that entity x exists and we have correctly understood its causal properties). Nor does it necessarily provide good evidence for the truth of these presuppositions (Morrison 1990, 18).

If we happily ignore that the experimental style is doing a lot of work in the background, Morrison is right that a transcendental argument based on manipulation alone fails. Apriority presupposes some ability to deal with objects and concepts (objects of the understanding), viz. apriority presupposes some (crude or refined) understanding. Morrison thinks that the only option Hacking has available that is able to provide the presupposed understanding is theory. He has the styles of reasoning. In more recent work, Hacking clarifies that if there is a manipulability criterion to be arrived at from his work on scientific realism, then it is not the only criterion (i.e. the sole necessary and sufficient condition) which can provide reasons to believe in the existence of an unobservable entity x, but rather a criterion of justifying why we know that x exists. Manipulability, according to Hacking, can make an argument compelling; we are in the space of justification and not in the space of demarcation:
I went on to make the consideration, to my mind, rather compelling. I have never thought of it as much more than that. I also thought that if an entity has not yet got to the stage, where we can manipulate it, use it to do something, use to find out about something else, then we do not yet have a compelling argument for its existence. I did not say that in those circumstances that we have no argument, or that we cannot reasonably think that the entity exists. I certainly did not say or imagine, 'failing manipulability, the entity does not exist' (Hacking, 2009a, 9, original emphasis).

Hacking's formulation of the "criterion" suggests that he simply intends to convey that cloning gene sequences or spraying electrons implies self-evidently that genes and electrons exist. An exact parallel would be the -trivial-proposition that pruning a rose shrub implies self-evidently that rose shrubs exist. So far we have been talking about the steps. It is time we brought the clues on stage, too. Taken together, they direct us to reconstruct Hacking's entity realism argument as a transcendental argument. It would read like this:

1. Following some rules and patterns, the scientists have the ability to create phenomena by manipulating theoretical entities. (Empirical premise, which the sceptic cannot doubt).

33 There are examples of rules in Hacking’s texts. One example is the statistical analysis of data “with no rationale whatsoever” in an electron-spraying experiment (Hacking 1983, 270). Another example is Hacking’s proposal to regard “formulas” like “5+7=12” not as truths but as instructions “about the manipulation of information” (Hacking 2011, 13). Yet another example, one which does not come from Hacking, is Fay’s (2013) instructions about which *Caenorhabditis elegans* mutants are worth working on.
2. The regular manipulation of theoretical entities according to rules presupposes the existence of the manipulated entities. (A priori premise).

3. Therefore, scientists are entitled to believe the entities they manipulate following rules and patterns are real. (Or, in other words, if you can manipulate them, then they are real).

The apriority of premise 2 is due to the style of reasoning in virtue of a style’s being the limit of possible intelligibility in its domain. So, Hacking's manipulability requirement for entity realism is the formal presupposition in a transcendental argument. In particular, the proposition "if you can spray electrons, then they are real" is shown by the transcendental argument to be self-evident irrespective to actually spraying electrons. It is a contingent a priori proposition

34 Knowledge of the existence of things like gene sequences is not just contingent a priori knowledge; it is synthetic contingent a priori knowledge (recall Kant’s analytic-synthetic distinction, found in chapter 2). Are there synthetic a priori propositions? Hacking’s answer is affirmative. His argument has its origins in some questions arising in the context of the mathematical styles of reasoning: in mathematics, in contrast to biology, physics and chemistry there is no world to resort to (no matter how people understand it). The mathematical styles seem to bring forth self-evident propositions in virtue of thinking, not thinking and doing. Hacking reads Imre Lakatos’s philosophy of mathematics in such a way that mathematical sentences turn into a priori propositions during the process of being proven (Hacking 2000, 21-22): “Logical positivism held that every mathematical truth is true in virtue of the meaning of the words used to express it. By a sudden and unexpected twist Lakatos’s philosophy suddenly makes sense of that implausible claim. After the dialectic of conjecture and refutation that culminates in a proven theorem, the meanings of the words in the theorem have been so refined that indeed the theorem is true in virtue of what the words mean (when properly understood)” (Hacking 2000, 22). Mathematical knowledge is analytic a priori – let us dub Hacking’s position on apriority ‘analytic-for-all-intents-and-purposes’ or “analytified” a priori knowledge’ (Hacking 2000, 22). Necessity is not a property that propositions have or do not have; necessity is something that a proposition can acquire (Hacking 2000, 27). (Now we can grasp the precise content of the ‘weaker necessity’ I mentioned back in chapter 2). Hacking extends his “analytification” to every style of reasoning (Hacking 2002a, 194), connecting it
have not noticed that the styles of reasoning are assumed in the background in *Representing and Intervening*.

For Hacking, the existence of electrons is self-evident as a result of having made them part of the fabric of our understanding. It follows, by the properties of apriority, that we *know* that gene sequences and electrons are real.

We recall that, in their field of influence, styles determine which statement is up for grabs for being true or false, as well as the methods for establishing the truth or falsity of a statement (Hacking 2002b, 166). We also remember that according to the consensus on transcendental arguments, the validity of Hacking’s argument for entity realism depends on his assuming some sort of verificationism (Stroud 1968). Hacking accepts Stroud’s conclusion about transcendental arguments: “Among shop-soiled theories of truth and meaning, the one that best fits sentences of a kind introduced by a style of reasoning is a verification theory” (Hacking 2002a, 191). The relevant version of verificationism, Hacking explains, is the verificationism of Moritz Schlick, “the meaning of a statement is its method of verification”, with the added qualification that “...here we realize that the possibilities for truth, and hence of what can be found out, and of methods of verification, are themselves molded in time” (Hacking 2002c, 4). In “Language, Truth and Reason” (Hacking 2002b), Hacking is more explicit:

One of the more memorable statements of logical positivism is Moritz Schlick's, 'the meaning of a statement is its method of verification' [Schlick 1936]. Those words could not stand unmodified, because the Vienna Circle had succumbed to

to the self-stabilization (Hacking 2002a, 194) and the self-authentication (Hacking 2000, 22; Hacking 2002a 192-193) of the styles.
Gottlob Frege’s dictum that meanings are definite, objective, and fixed. Schlick’s maxim would imply that a change or advance in a method of verification would change the meanings of a sentence. Rather than give up the idea of meanings handed down from generation to generation, tranquil and unmodified, logical positivists revised Schlick’s maxim again and again, although with no satisfactory outcome... But for [Auguste] Comte, or any other of those fortunate writers of 1840 not yet infected by Fregean theories of meaning, Schlick’s statement would be just fine. It is precisely, for Comte, the methods of verification -[i.e.] the ways in which the positive truth values are to be established- that determine the content of a body of knowledge (Hacking 2002b, 165).

Hacking bites the bullet. His Comtean positivity is able to withstand Stroud’s criticism in a fascinating way: the styles of reasoning (along with some basic human understanding, let us dub it base reasoning) are the arbiters of their own reasonableness.

Our discussion on transcendental arguments does not end just yet. Peter Strawson, one of the first to re-deploy transcendental arguments in recent times, and a target of Stroud’s (1968) paper, has come to regard transcendental arguments as useful for “investigating the connections among the major structural elements of our [as opposed to an immutable] conceptual scheme” (Strawson 2005, 25, emphasis added). The styles of reasoning withstand this sort of problem, too: the styles of reasoning do not rise because of some necessity which can permit us to blame the ancient Chinese for not having
developed them, or can make us expect that if the natives of Andromeda have developed scientific reasoning, then it will be identical to our own. Hacking is emphasizing that reason has a history.

In the same vein with Morrison (1990) and Resnik (1994), Axel Gelfert has some misgivings about manipulation: he thinks it is too promiscuous (Gelfert 2003, 261). He uses some phenomena involving the manipulation of electron quasi-particles. As the name suggests, they are not real entities.

When an experimenter ‘sprays’ a quasi-particle, she exploits perfectly real causal properties –but not the causal properties of a new entity. Rather, the causal properties she exploits are those of a large (and possibly varying) indeterminate number of electrons behaving in a collective fashion (Gelfert 2003, 260).

This is a problem for the entity realist, who has, Gelfert thinks, to admit to adding a caveat: “if you don’t know what you are spraying, you cannot tell whether it is real or not” (Gelfert 2003, 261). Electrons are real; an electron quasi-particle is not. It is a number of electrons behaving like a single electron with a different mass than the single electron’s mass. Gelfert’s critique is in the same vein with Morrison’s (1990), Mohamed Elsamahi’s (1994), and Resnik’s (1994). The major common shortcoming between these three papers that we can readily pick out is their not taking the styles of reasoning into account. The entity realist is in fact saying: if you don’t understand (rather than know) what you are spraying, you cannot tell if it is real or not. We understand first, we know later. This is rather Aristotelian; before attempting to find the definition or explanation of an object or fact we need to cognize it first of all (Posterior Analytics, 89b22-35).
Scientific understanding proceeds according to the styles of reasoning. So, rather than offering a valid objection, Gelfert has offered the entity realist an opportunity to clarify that she has an account why the quasi-particles are called quasi-particles in the first place: science is the interplay of some common prescientific features of human understanding (Hacking 1983, 149-167), in conjunction with Bacon’s ants, spiders and bees of scientific inquiry.

The implication is that we have some understanding of what is a candidate to be a material object, real or not, what objects might be like the objects of geometry, and what ‘objects of the understanding’ are just that, i.e. concepts. The strength of Hacking’s view of science is that we can have justified true belief.

Hacking’s description of the PEGGY II experiment illustrates how some statistical-style reasoning has been assimilated into the experimental style:

[The systematic uncertainties about the direction the electrons were facing, the laser jitter and other uncertainties about the beam] were analysed and linearly added to the statistical error. To a student of statistical inference this is real seat-of-the-pants analysis with no rationale whatsoever (Hacking 1983, 270).

A style of reasoning can be applied in the domain of another style.

In my review of the literature during the research and composition of this project, I have found only two instances that Hacking might be using a transcendental argument to support his entity realism, in Morrison (1990) and in

35 Viz. there is a truth of the matter about their properties when drawn. Cf. Socrates teaching Meno’s slave how to double the surface of a square (Plato, *Meno*, 84c-85d).
Bradner (2009). We have seen that Morrison’s argument revolves around Hacking's manipulation thesis isolated from the styles of reasoning, which she understands to be a condition intended to support entity realism on its own. I find this silence on the transcendental arguments for scientific realism slightly perplexing. Not only Hacking’s verificationism makes no sense if he does not intend to make some use of it, but Nancy Cartwright, who sided with Hacking on the issue of the reality of entities (Cartwright 1983, 20, 98), says that her version of experimental realism is based on a transcendental argument (Cartwright 1999, 23; cf. Clarke 2010).

5.8 Reasoning with style

In the discussion of apriority in contemporary philosophy (chapter 2), we noted that the concept of truth is usually associated with necessity. Hacking's considerations about truth have the effect of restricting the notion of necessity that can have any significance: it is much weaker than Kant's necessity, who thought that necessity is a clear sign of a priori thinking. For Hacking, I conclude, thinking in aprioristic terms does not provide foundational warrant. A scientist can be thinking a priori, i.e. normatively and self-evidently, when she thinks in terms of the phlogiston theory, or in the terms of Ptolemaic astronomy (along with the ethical connotations Ptolemy wove into it).

Visualizing the search for apriority as the point where a diver (the philosopher) can reach safely and must stop descending, Hacking's story for apriority locates the said apriority in less depth than Kant thought was possible, and deeper than Reichenbach. We must note the convergence of Hacking's philosophy of science with the contemporary epistemology of the a priori.
Hacking’s realism is made possible by the styles of reasoning. Their self-authentication is an idea which has provoked some scepticism. In the next chapter I rely on the concept of skill, to show that if we are to have a notion of compartmentalized reason in the shape of the styles of reasoning, then we must conceive it as self-authenticating. In taking this step I remain firmly in the space allocated by Hacking to the styles of reasoning: skill is also used but never elaborated upon by Hacking. Observation is a skill (Hacking 1983, ch. 10). Along with measurement, observation is one of the defining characteristics of the experimental style starring in ‘Intervening’ (Hacking 1983). In the following chapter I show that all the styles of reasoning are skills.
6. Can Hacking’s A Priori Justification Survive Scepticism?

6.1 “On the very idea of a style of reasoning”

The soundness of entity realism depends on the styles of reasoning. Indeed it seems that the soundness of many of Hacking’s arguments depends on the styles of reasoning. In this chapter we will address the scepticism of Bradner (2009) about the styles of reasoning. Her objections are about the self-authentication of the styles. The title of this section (6.1) is the title of Bradner’s (2009) paper.

Let us begin by a recent formulation of that curious trait of the styles, self-authentication:

Scientific styles are in a certain sense self-authenticating. For each style there is a class of sentences that are candidates for truth or for falsehood only in the context of the style. The only way to find out whether they are true or false is by using the relevant style. The criteria of truthfulness are determined by the style. All individual propositions are fallible. In reasoning according to a style, one can always make mistakes. But it is in the framework of the given style that one establishes that an error has been made (Hacking 2009a, 14).

We saw in chapter 5 that Hacking's styles withstand any critique based on the conceived strength of transcendental arguments, which can be said to have been one of the implicit concerns in Morrison’s (1990) argument. Another line of criticism, which is potentially devastating for the styles of reasoning, is Bradner's scepticism. She frames her objections thus (Bradner 2009, 14): "It is the style-
to-topic determinism of Hacking’s idea that ‘I will question, along with the lack of any effective constraint on our theorizing about styles” (2009, 14).

In the next sections I will develop my argument, which aims to show that style-to-topic determinism follows by necessity from the ‘nature’ of a style of reasoning, and that the lack of any effective theoretical constraint is not a real problem.

6.2 Scepticism about the styles of reasoning

In this chapter I develop a transcendental argument in favour of an epistemology built around the concept of styles of reasoning. I will not attempt to show that the styles of reasoning are members of a conceptual menagerie displaying recently discovered exotic specimens; I wish to indicate that we can believe they are what gives the law-likeness to science every time a question arises about epistemic normativity arises. It might be pointed that such an endeavour is not necessary, since the styles of reasoning have fulfilled their goal: the introduction of experiment in the philosophy of the sciences (Hacking 2009a, 8-9). But the styles also lead to more radical results than only the introduction of experiment in the shelf with the important concepts; Hacking locates these radical results in the fields of truth and objectivity (Hacking 2009b, 30-32).

It is not surprising that Hacking’s description of the styles of reasoning provokes reactions like Bradner’s. He suggests that the styles do not have any formal property for the philosophers to identify; we must understand them in their own context:
Should there not be rough and ready necessary and sufficient conditions for being on Crombie's list? No. His styles of scientific thinking and doing have no essence. That is not to say that the list is arbitrary, or that the idea behind it is vague. It is not even to imply that its members are bound together by 'family resemblances'. [Crombie]... said Look! These are several distinct genres of inquiry used in modern science, and they pretty well cover the waterfront. If we ask why they persist the answer is more likely to be ecological than logical or pragmatic. We do not use them because we have good reason to use them. They are what we use. They become our standards for good reason. (Anarcho-rationalism!) (Hacking 2012, 601, original emphasis).

According to Hacking, then, styles of reasoning are not something that can be pinned down without information about the historical situation in which they deploy.

In the following, I will not emphasize the interactions between strands of understanding: I will not dwell in reason's historical aspect, neither its public aspect, but I will rather focus on the epistemic aspect. The usual treatment of epistemic matters in the philosophical tradition is one of the relations between the knower and the known. Historicity and the effects of communality will be assumed throughout my following argument, but they are not explicit features of the argument.

My justification for doing so is the impracticality of attempting to amend the principles of the epistemological debates. We should always keep in mind that
apriority, self-evidence, self-justification and aprioristic normativity are terms, which do not by definition include connotations of atemporality and necessary universality.

Bradner suggests that Hacking should provide a transcendental argument to support his idea of the styles of reasoning (2009, abstract). She goes on to add that "Hacking has a... problem, in that he cannot remain a Kantian without justifying his style idea with a transcendental argument. But this kind of argument is only available to those who support a univocal notion of reason, which the very idea of a style seems to outlaw" (Bradner 2009, abstract). Bradner's challenge is serious.

The main concern of Bradner in this passage is that there can be no constraint in what is taken to be a style of reasoning. The necessity which, e.g., accompanies our deductions would rest on contingency:

Hacking emphasizes that he is after scientific, not universal, styles of reasoning. But it is only because Kant was concerned with the latter that he was able to employ his special kind of argument. It seems unlikely that Hacking will be able to retain his commitment to diversity in styles of reason, while also continuing Kant's project. Nor can Hacking leave Kant behind: If he wants to argue that a style of reasoning has form, there must be some indication as to how this form is shaped; there must be some constraint that sets the bounds of the style or at least ensures that the different styles have distinctive boundaries. And where Kant's arguments regarding this matter are transcendental, Hacking's are contingent (Bradner 2009, 6).
Bradner has detected that Hacking is deploying a transcendental argument for entity realism. Her evaluation is that argument is not really transcendental, after all. She challenges Hacking to provide a transcendental argument for identifying a style of reasoning. It is the purpose of this chapter to show that the “form” Hacking presents the styles of reasoning to have is less rigid than the one Bradner calls for. Bradner’s form is a notion about distinct shapes, making the styles of reasoning object-like entities. I read her to call for a perfectly delineated form, lending itself to explicit understanding. Hacking (2012, 601) suggests otherwise: there is nothing to make us regard a style of reasoning as an entity. By the end of this chapter we will have clarified the issue why styles of reasoning are identifiable although they do not have clear borders; the styles of reasoning are skills.

A minor additional point is that it is not correct to say that the styles of reasoning have or do not have form; the styles of reasoning provide form to objects (to physical objects and to abstract objects of the understanding alike). What I say is that each style of reasoning has no essential nature. It is hard to engage in the metaphysics of reason because reason is the ability which allows us to speak about what there is “in many ways” (Metaphysics, 1003a33); it is difficult for me to conceive it independent of people exercising it. I should repeat my conception of reason as logos, viz. as the capacity for carrying out human discursive thinking, in discourse with others and in one’s mind. A style of reasoning is logos, prescientific understanding is logos, and finally, a person’s thinking is logos. Of course, a person’s thinking is bound not to be sound on every occasion.
Concerning Bradner's remark that Kant's arguments are transcendental, when Hacking's are contingent, my reply is that this particular problem of delinating a style of reasoning disappears if there is an account of skills -under which we can subsume the styles of reasoning, provisionally for the time being- which rests upon a philosophy explicitly admitting no gap between the external world and the mental realm. A philosophy like that is Merleau-Ponty's:

Suppose that my friend Paul and I are looking at a landscape. What precisely happens? Must it be said that we have both private sensations, that we know things but cannot communicate them to each other - that, as far as pure, lived-through experience goes, we are each incarcerated in our separate perspectives - that the landscape is not numerically the same for both of us and that it is a question only of a specific identity? When I consider my perception itself, before any objectifying reflection, at no moment am I aware of being shut up within my own sensations. My friend Paul and I point out to each other certain details of the landscape; and Paul's finger, which is pointing out the church tower, is not a finger-for-me that I think of as orientated towards a church-tower-for-me, it is Paul's finger which itself shows me the tower that Paul sees, just as, conversely, when I make a movement towards some point in the landscape that I can see, I do not imagine that I am producing in Paul, in virtue of some pre-established harmony, inner visions merely analogous to mine: I believe, on the contrary, that my gestures invade Paul's world and guide his gaze. When I think of Paul, I do not think of a flow of private sensations indirectly
related to mine through the medium of interposed signs, but of someone who has a living experience of the same world as mine, as well as the same history, and with whom I am in communication through that world and that history (Merleau-Ponty 2002, 471-472, original emphasis).

Merleau-Ponty’s account of understanding through experiencing will help me complement the image of my conception of reason as *logos* without the metaphysical paraphernalia, like essences, one finds in ancient thought.

Echoing Morrison (1990), the deployment of manipulation by Hacking is Bradner's other major concern:

[Hacking] errs by suggesting yet another theory of understanding - manipulation. Two people understand one another when they manipulate or work through things in the same way... By specifying exactly what we have to do in order to understand another person, era, or culture, he opens the door to [the modern sceptic]. These modern day [sceptics] will argue that the criterion for individuating styles of reasoning depends for its efficacy on the existence of novel kinds that are generated by the very styles in question... Hacking might spend less time in a darkened theater working his spotlight and more time in more natural light of the real world... (Bradner 2009, 13-14).

The version of scepticism Bradner refers to is pyrrhonism (Bradner 2009, 14). Sextus Empiricus, whom Bradner cites, describes pyrrhonism in his *Outlines of Pyrrhonism* in the following way:
Scepticism is an ability to set out oppositions among things which appear and are thought of in any way at all, an ability by which, because of the equipollence in the opposed objects and accounts, we come first to suspension of judgment and afterwards to tranquility (Outlines of Pyrrhonism, I 8).

The judgement Bradner urges us to suspend is that unobservable entities can be known to be really real after we have used them as tools. From her sceptical vantage point, she offers counter-arguments to show that the idea of styles of reasoning is unclear: Bradner criticizes Hacking’s position for its circularity. This is a serious objection, related to the self-authentication of the styles. As we have seen in chapter 5, Hacking believes that the “apparent circularity… is to be welcomed” (Hacking 2002a, 192). My task in this chapter is to prove him right, by showing that the styles of reasoning are not unclear at all.

The most pronounced of Bradner’s insights is her identifying that entity realism depends on the styles of reasoning. To the best of my knowledge, she is the only person in the literature on entity realism to have explicitly recognized that.

6.3 Enter the subject, or the personal point of view

Remaining faithful to my ‘enter the world’ and ‘enter the styles of reasoning’ terminology, I wish to ‘enter the subject’ at this point. The subject is the third component in the triad of public representation, the other two being the material world with its objects and processes and the sociocultural milieu.

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36 She follows Sextus Empiricus once more. He writes that: “Pyrrhonists do not assent to anything unclear” (Outlines of Pyrrhonism, I 13).
According to Bradner, Hacking succumbs to over-intellectualizing scientific practice and the scientists' conduct in relation to their work. Bradner follows Hacking in using a Shakespearean character, Hamlet, to illustrate:

[Hamlet's] dwelling on his wretched life in Denmark is the very thing that legitimizes the question of Denmark's status. The newfound concern does not determine Denmark's status; Hamlet can't make Denmark bad simply by thinking Denmark is bad. But his intense preoccupation with the issue makes it possible for Denmark to be bad. His concern creates an opportunity for debate on the topic, rather trivially, because without that focused attention, the issue of Denmark's worth would not appear in relief against the backdrop of the deeply mysterious. (Or, alternatively, without that focused attention, nothing would distinguish the issue of Denmark's worth from the infinitely many other debatable issues)... Just as Hamlet's focused obsession automatically makes Denmark a candidate for best or worst place to live, a scientist's style of reasoning cannot help but highlight a set of reasonable topics, or at least topics worthy of further discussion (Bradner 2009, 1-2).

Does Bradner mean that Hacking is excessively subjectivist? We have seen that this is not true; representations are public and discourse takes place in settings permeated by styles of reasoning. Bradner appears to favour detached approaches to ontological matters, like the existence of unobservables. Hacking's triangle of the knower, public discourse, and the known is defended in the analytic fashion of philosophy but it entails our being in the world.
Bradner understands the styles of reasoning as follows:

At the risk of overtaxing the theater metaphor, a style of reasoning is a spotlight. It shines its light on a portion of the world, and in doing so, separates whatever lies within its focus from whatever lies without. This is all it can do... But the spotlight, neutral as it is, remains crucial, for without it, nothing would stand out in relief for the audience to judge — all would be dark. The light marks a temporary and artificial boundary within which or about which a discussion can occur. And in this way, it makes the discussion possible (Bradner 2009, 2).

The first error in this metaphor is that it is incomplete: there can be all sorts of spotlights, revealing spots in a tinged manner. In addition it is misleading: Bradner fails to appreciate the ecological understanding (Hacking 2012, 601) of the co-existence of the styles of reasoning with one another and with prescientific understanding. In the theatre metaphorical setting, the styles of reasoning are like spotlights cast by members of the audience. These lights have varying colours like yellow-white, blue-white, etc. A person can cast one or more spotlights on the stage, but not more than one light of a particular shade of colour. The spotlights may cast illuminating discs of varying sizes. People using the same style of reasoning will have torches that cast the same quality of light, e.g. yellow-white, but each person’s torch casts a beam creating a unique pattern of bright and less-bright distorted circles on the stage. People can combine lights and see what happens. Not all of the spectators hold a torch, some of them have turned theirs off, and most people hold one of the varying-colour torches at any given time. The stage is not completely dark. There is a
twilight creating shapes and shades, depending on the place the spectators are sitting. Some beam colours get out of fashion after some time, while others persist. In this new version of the theatre metaphor the stage is the world, and the torches are the styles of reasoning.

An alternative philosophy of science takes into account that involvement in the conducting of science requires some sort of personal stake (viz. to light the torch); the philosopher's gaze in such an approach is not directed to the practice as an entity complete in itself, but she examines the practitioners in order to understand the practice. Science above all, is about people being scientists. The practice approach in the philosophy of science and historical epistemology are ways to make the practice explicit through the practitioner's comportment when going about practicing it.

To show that there is a way to support Hacking's idea of the styles of reasoning, I will not treat them as theoretical abstractions of instances of actual thinking and doing, but I will attempt to subsume them under a broader category of thinking and doing, that of skilful coping. If the assignment of the styles of reasoning under skilful coping is successful, I will be able to infer that there are many possible styles of reasoning and there is no formal constraint on our theorizing about them from the properties of the hierarchically higher category.

In order to identify the broader category which will be of use in the argument presented here, we must revisit the styles of reasoning from a first person perspective, in the Merleau-Pontean fashion (chapter 4). In the following paragraphs we abandon the vantage of a historian, assuming the point of view of the scientist who thinks and acts according to them. This is not a change of
point of view performed just to debunk Bradner’s scepticism; it is implicit in Hacking’s work: public discourse takes place between individuals.

The emphasis on scientific practice, i.e. on experiment, and not on what the scientists are just thinking, but also on what they are doing, goes part and parcel with a historicized understanding of reason, apriority and objectivity. If, in addition to these ingredients, we add the personal point of view of a living, bodily-sentient and culturally localized human being, Hacking’s framework can be generalized. By ‘generalization’ I do not mean that it makes sense to arbitrarily postulate styles of reasoning providing understanding on this or that odd matter. What I intend is that the scientific styles of reasoning can be conceived as junctions in a network of reasoning-at-large, which has a history. Marjorie Grene puts it better:

...the synthetic a prioris that make objective experience possible are historicized. Each society, each group of language-users, in a limited way each human being, has its categories and principles. There is no one fixed and eternal system of human reason, no guarantee that any principle in its exact formulation has always legislated and will always legislate for all human experience of nature (Grene 1978, 20).

Unlike Hacking, who speaks about science, the “historicized a prioris” Grene refers to are encountered in scientific and mundane settings. In this chapter I use the broader sense of the historicized a priori to argue for the self-authentication of the styles of reasoning from the familiar coziness of the mundane. I use the notion of skill to do so.
Not just yet. This section lends itself to some further considerations about transcendental arguments. A transcendental argument aims to begin from an uncontentious starting point (the premise that the sceptic is willing to grant). As a result, transcendental arguments tend to have a first premise in the first person, viz. about how I or we experience, think, judge etc. (Stern 2011).

Hacking's experimental argument for entity realism may give the impression to be a philosopher's reconstruction of what a group of other people, the scientists, have a priori reasons to believe. The solution to this problem is that anyone wishing to discover in detail the workings of an aspect of the world will be exposed to how other people have been investigating similar topics. Even if one is among the pioneers in the emergence of a totally new field she will have to contrast her approach with what others have been doing. It is rather hard not to get exposed to the styles of reasoning.

So, ‘Enter the subject’ I say, but I raise a flag of warning in doing so: the subject that appears on stage at this point should not make us shift our focus from knower-known interactions back to a philosophy of knowers discovering properties of objects in an endless exhibition a.k.a. ‘the world’. We should always remember that our epistemology is much about the objects to be known as it is about the knowers (cf. Rheinberger 2010, 2-3, 82).

‘Entering the subject’ in our case signifies Dreyfus’s notion of skills and the Merleau-Pontean frame in which Dreyfus situates them.

We have seen in chapter 4 that Dreyfusian skills are an extensive and heterogeneous class. Among the skills Dreyfus includes what he calls "the cultural style" (Dreyfus 2009, 44-45); cultural styles -there are many of them- are ways of being, which are pervasive; they also are invisible (or transparent)
from the inside (Dreyfus 2009, 45-46). People become apprentices to their parents from the moment of birth, displaying their cultural style throughout their lives (Dreyfus 2009, 45-46).

The use of the word “style” by Dreyfus about culture seems able to accommodate Hacking’s usage; Dreyfus, however, refers to ways of being, not to conditions of possibility of knowledge. The intended reference by Dreyfus is not a problem: We can make the move to epistemology because Dreyfus accounts for the model of skill acquisition on the basis of the philosophy of Merleau-Ponty, (Dreyfus 2002, 372-373; Dreyfus 2009, 54-56), who, as we have already witnessed in chapter 4, has a lot to say on things epistemic.

6.4 Skills have the traits of the styles of reasoning

The Dreyfus model of skill acquisition admittedly can be better seen in action in cases of motor skills (Dreyfus 2009, 34), but, as we have already described, it is not limited to motor skills like driving an automobile (Dreyfus & Dreyfus 1986, Dreyfus 2009) or piloting an aircraft (Dreyfus & Dreyfus 1980) only. Intellectual pursuits, such as the chess playing example (Dreyfus & Dreyfus 1980, Dreyfus 2009) or the example of learning a foreign language (Dreyfus & Dreyfus 1980) also fit well to the model. We have also witnessed that Dreyfus (2009) thinks his model to be relevant for highly abstract, general classes of practices whose form is harder to capture as a result of the variety of their being conducted. Examples include teaching and lecturing which differ according to the audience, the subject taught, etc. Dreyfus’s model is clearly intended to be a universal account of purposeful action, as well as a fundamental representation of understanding, and also a fundamental description and explanation of comportment.
The model's scope is sufficiently general to perform these functions. Another testimony to the broadness of the model is its application to ethics (Dreyfus & Dreyfus 1991; Dreyfus & Dreyfus 1992; Dreyfus & Dreyfus 2004). Dreyfus and Dreyfus contend that their model of skill acquisition can reform our thinking about ethics and that it shows morals are best captured by theories like Aristotle's or John Dewey's instead of more detached accounts -intellectualist accounts in Merleau-Pontean parlance- like Kant's (Dreyfus & Dreyfus 2004).

I will move on to a comparison between some of the properties of the structure of skills according to Dreyfus and the characteristics of the styles of reasoning as Bradner has enumerated those (2009, 3-4). Let us remember Bradner's list of style traits:

1. styles are general, not personal

2. not in the head

3. ahistorical, in that they outlive their original historical instances

4. not predictable or (in any sense) derivable, styles emerge contingently

5. dynamic, styles can change or evolve

6. immune to refutation, but may become invisible or "extinct"

7. they are not accidental, haphazard or one-time approaches, styles have form, recurring structure.

8. must introduce novelties, like objects, evidence, laws, possibilities, or new ways of being a candidate for truth and falsehood

37 So, a better characterization for the styles of reasoning would be that they are persistent, rather than ahistorical.
9. they are self-authenticating and self-stabilizing

I will now proceed to discuss how skills have the traits of the styles of reasoning. The trait under discussion is introduced as a number, corresponding to the relevant trait in Bradner’s list. The numbers are to be found at the beginning of the paragraphs where I change the trait focus. We will now compare skills and styles.

1. A style of reasoning is general, not personal. They also are not discipline specific, although Bradner can sensibly call them “topic-specific”, provided the topic in question is broad enough. We can exclude that Hacking has in mind a style-for-experiment relation, although historically the need to set up an experiment or interpret the results of another might have something to do with a particular style’s emergence. Skilful performance might be a disposition of the individual practitioner, but what counts as successful practice is a matter decided intersubjectively among peers.

The word personal in this context simply means that a style of reasoning is not a single individual’s standard of thinking and doing, but an intersubjective way of thinking and doing; in other words, styles of reasoning are not private. There is a caveat: the actual implementation of a style of reasoning is affected by a scientist’s personal dispositions, but the styles’ being applied is also a matter of the practical dispositions of the person applying them; the seeds of the styles’ development are to be found in their continued use. Skills do not differ in these respects. An expert can enjoy a large degree of freedom about how to perform; she might also be free to try out new things, but what she does can be recognized as ‘a new way of playing basketball’ by many. Given exposure to instances or products of skilful performances we can usually pick out a
competent performer, even if we are not trained in the skill. So, skills share another similarity with the styles of reasoning: they are general as opposed to private.

2. Styles of reasoning are not in the head, but ways of working through worldly stuff. The same is true for Dreyfus's skills. Expertise requires situated involvement in the world; the material aspects of the world are predominant in these interactions. Sometimes, like in a theatrical performance, the involvement is with objects, concepts and people together. According to Dreyfus, expertise as presence of know-how in the mind is not kept there as mental representations, but as dispositions to respond to solicitations of situations in the world (Dreyfus 2002, 367).

In a similar vein, when asserting that the styles of reasoning "are not in the head", Hacking wants to stress that "reasoning is done in public as well as in private: by thinking, yes, but also by talking and arguing and showing" (Hacking 2002a, 180). Pursuing a Wittgensteinian track, Hacking also believes that the styles of reasoning are not in the head, because they acquire their signification from their context (Hacking 2002d, 214-226, 226). The word context here can be substituted with the word situatedness. The styles do have a normative character; otherwise the said signification cannot exist at all.

Dreyfus draws on a different philosophical background for expertise. Recall that it is a Merleau-Pontean approach, which allows him to address the whole spectrum of skills, from learning, to knowledge, to sublime theatrical performance. According to Merleau-Ponty, "Whether a system of motor or perceptual powers, our body is not an object for an 'I think', it is a grouping of lived-through meanings which moves towards its equilibrium" (Merleau-Ponty
2002, 177). For Merleau-Ponty, human beings as individuals are not so much minds as they are bodies: "by... remaking contact with the body and with the world, we shall also rediscover ourself, since, perceiving as we do with our body, the body is a natural self and, as it were, the subject of perception" (Merleu-Ponty 2002, 239). By virtue of points like the previous ones Merleau-Ponty can go on to argue for an apriority embedded in human embodied being-in-the-world. Human, embodied, being-in-the-world includes the ability to reflect and attempt to understand the world we find ourselves in.

Now we can turn to a close examination of the second characteristic of the styles of reasoning according to Hacking. Always, the goal is to show their similarity with Dreyfusian skilful coping.

Expanding on Merleau-Ponty's theme, Dreyfus concludes that:

...in absorbed, skilful coping, I don't need a mental representation of my goal. Rather, acting is experienced as a steady flow of skilful activity in response to one's sense of the situation. Part of that experience is a sense that when one's situation deviates from some optimal body-environment relationship, one's activity takes one closer to that optimum and thereby relieves the "tension" of the deviation. One does not need to know, nor can one normally express, what that optimum is. One's body is simply solicited by the situation to get into equilibrium with it (Dreyfus 2002, 378).

For Dreyfus, then, skilful coping is not so much in the head, too. Thinking enjoys no primacy over perception. In the simple case of interactions with objects, the
framework is dictated by the nature of the objects themselves and the means of perceiving, the body. Of course, this does not preclude that we cannot think about objects and their properties in the detached manner of propositional terms. The detached skilful coping is better grasped if we regard it from the angle of its being different from deliberate action; when we exercise a skill, we experience the movements to be drawn out of us by the situation and not to originate in our will (Dreyfus 2002, 380-381). This applies to conclusions, judgements and decisions, as well: having the situation under control, i.e. knowing what she is doing, the expert arrives at them intuitively (Dreyfus 2009, 35-40). We can say that for Hacking, carrying out an experiment is not different from driving a car, although the experiment's results merit publication and further discussion for knowledge to be considered established.

I have deliberately quoted the part where Dreyfus says there is no need for mental representation in skilful coping in the last passage (Dreyfus 2002, 378). Dreyfus's Merleau-Pontean theory of the mind happens to be an interesting account of the self-evidence of a priori propositions.

3. Another characteristic of a style of reasoning is that it outlives its original historical instances. The styles do not continue their existence as they began, however. The styles are not monolithic. Despite their persistence, they can change or evolve. Additionally, the styles' beginnings and actual development are not predictable or anyhow derivable. Skills are also like that. To illustrate, we will consider the example of the study of the motion of the heavenly bodies in the works of Claudius Ptolemaeus (known as Ptolemy), a prominent expert on the subject during the late antiquity (Beck 2007, 4). The relevant skill here is the mathematical representation of the motions of the heavenly bodies around
the centre of the universe (yes, by ‘centre of the universe’ Ptolemy understood the Earth). During the analysis that follows (points 3 to 6) we should remember that Ptolemaic astronomy is a Dreyfusian skill; the styles of reasoning as identified by Crombie are not applicable to Ptolemy, Crombie’s styles are for late medieval and early modern Europe.

Ptolemy’s astronomy differs from contemporary astronomy in that the latter makes extensive use of telescopes. In other respects, his output does not differ radically from the modern astronomer’s: He had a cosmological model, he offered mathematical models of the motions of heavenly bodies which worked sufficiently well, he used instruments to make observations and he included in his work the catalogue of the visible fixed stars compiled by Hipparchus, an earlier astronomer (Almagest). I do not suggest that Ptolemy is to blame for not having invented the telescope: fast forward to the Renaissance and Tycho Brahe. Brahe did not have a telescope at his disposal; Galileo had yet to point one in the direction of the heavenly bodies (Galileo did so in 1609), when in November 1572 Brahe used instruments to measure the difference of the apparent position of a bright new star in the constellation Cassiopeia viewed from two different lines of sight (in astronomical jargon, he measured the star’s parallax). Brahe’s major contribution to astronomy was an attitude of systematic observation:

Though Tycho Brahe was not the first Renaissance astronomer to observe the heavens, he was the first to realise that long-term, systematic observation was required, and that the quality

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38 E.g., Ptolemy writes that he invented an armillary sphere, a spherical model of objects in the sky, (Almagest V.1) and that he used a dioptra, a sighting rod attached to an angle-measuring semi-circle, like Hipparchus (Almagest V.14).

39 He measured the parallax of a supernova (Krause et al. 2008).
of these observations—and the cosmological conclusions which
could be drawn from them—depended on the improving accuracy
of instruments (Chapman 1989, 70).

The caveat in the last passage is Chapman’s restricting the time-frame for
assessing the significance of Brahe’s observational attitude in the Renaissance
period. He is correct to do so, because:

Much criticism has been leveled at ancient Greek astronomers
for placing too little reliance on observation, and too much on
preconceived notions, such as the perfection of the sphere and
of spherical motion and the heavens as illustrating that
perfection. Much of this is justified; yet, there were important
exceptions, such as the careful observational work of
Timocharis and his school in Alexandria, of Eratosthenes who
determined observationally the size of the Earth, and of
Hipparchos\textsuperscript{40}, whose star catalog and theories of the Sun and
Moon were founded on observation. In fact, in Hellenistic times,
early eclipse and occultation observations were highly valued
and aided the discovery of precession. These data are still of
interest today, as are ancient observations of the Sun’s activity
and even its size (Kelley & Milone 2011, 109).

The conclusion is that scientific styles can be traced further back in time than
the late medieval period. This is not surprising: the scientific taxonomy of
organisms can be traced back to Aristotle. Hacking suggests pursuing a

\textsuperscript{40} That is Hipparchus in transliterated Greek. Hipparchus is the Latinized form of
his name.
cognitive history, which will have an ecological and an anthropological aspect (Hacking 2012, 606-607). The brief foray into the history of astronomy above is a part of the ecological aspect, while my reconstruction of Hacking's argument in chapter 5 and my argument in the present one are part of the anthropological aspect. The ecological and the anthropological styles converge on the issue of the self-authentication of the styles of reasoning (Hacking 2012, 607).

Astronomers in the ancient world were preoccupied with the motion of the bodies of the celestial sphere. The study of the behaviour of these objects, which are located far up in the sky between the sublunary world of corruptible bodies and the heavens, believed to be an immutable divine realm, was different from the behaviour of objects on the earth, which do not move in circles, but up and down. The appropriate tool for the study of the motion of these objects (viz. objects which did not happen to have any tendency to fall on Earth as everything else seemed to do) was mathematics. Ptolemy's definition of mathematics is the following:

...that division [of theoretical philosophy] which determines the nature involved in forms and motion from place to place, and which serves to investigate shape, number, size, and place, time and suchlike, one may define as ‘mathematics’ (Almagest, 1.1).

Mathematics are about the unchanging, the necessary and the substantial. Mathematical reasoning is the correct way to acquire knowledge about the apparently eternal, including the objects revolving in the celestial sphere. Knowledge about the world of appearances, on the other hand, is acquired through another way of inquiry:
The division [of theoretical philosophy] which investigates
material and ever-moving nature, and which concerns itself with
'white', 'hot', 'sweet', 'soft' and suchlike qualities one may call
'physics'; such an order of being is situated (for the most part)
amongst corruptible bodies and below the lunar sphere
(_Almagest_, 1.1).

Notice that for Ptolemy, the event that I saw a boulder last Tuesday in the
University of Exeter's Streatham campus is a brute fact. So are the boulder's
dimensions, volume and weight, which force me to call it a boulder, rather than
a big stone. The presumed difficulty to move this rock without assistance is
because it is big, which is -simply- how that object _is_. On the other hand, its
being heated by the sun when I see it is happenstance. The boulder's
dimensions, its volume and its weight are its essential properties. Its
temperature is an accidental property. Ptolemy set out to write a treatise on the
motions of bodies different from the matter accreted at the centre of the
universe (the Earth). For him, Venus and Jupiter were not worlds, objects
sharing similarities with the Earth.

Ptolemy's _Almagest_ is a scientific work, using either ancient or modern criteria
(Beck 2007, 6-7). Its formulas allow the prediction of the position of stars and
planets, and such predictions are verifiable. Astronomy had interesting
applications even back then; they were ethical:

    With regard to virtuous conduct in practical actions and
    character, this science, above all things, could make men see
    clearly; from the constancy, order, symmetry and calm which are
    associated with the divine, it makes its followers lovers of this
divine beauty, accustoming them and reforming their natures, as it were, to a similar spiritual state (*Almagest*, 1.1).

As far as Ptolemy is concerned, the ultimate goal of predicting the motion of the heavenly bodies is the assumption of a philosophical attitude, of an inquisitive way of life accompanied with rigorous thinking.

During Ptolemy's time, the planets were thought to possess some natural qualities. Many people, on the basis of either commonsensical grounds or because of the qualities' being unfounded, did not think of these qualities as influential (Beck 2007, 3). Ptolemy, on the contrary, was one of those who believed that as the sun and the moon obviously affect the earth (the day-night cycle, tides, etc. (*Tetrabiblos*, 1.2)), so it is reasonable that the planets, too, exercise influence on earth through their qualities (Beck 2007, 8). Ptolemy considered astrological predictions possible.

As a result of the impermanence and changeability of everything earthly, astrological predictions are not written in stone, and they are not definitive. Ptolemy warns against assuming that predictions referring to states of affairs on earth enjoy anything more than a certain degree of probability and reliability (Beck 2007, 8), despite the fact that the motions of the planets can be represented by mathematical equations with great accuracy. This does not stop him from considering astrology a part of astronomy. Ptolemy expanded on the astrological aspects of astronomy in a different book, known as the *Tetrabiblos*. The subject of the influence of the heavens on things mundane was different to a sufficient degree so that to not be included in the purely astronomical treatise, the *Almagest*, but also important enough to merit extensive analysis. In the definition of the subject to be treated, Ptolemy does not use a different technical
term for astrology. It is part of astronomy, equally scientific, worth of attention and above vulgar fortune-telling, with the added qualification that predictive astronomy in the sublunar sphere is like medicine, conjectural (Beck 2007, 5-7).

Of the means of prediction through astronomy, ...two are the most important and valid. One, which is first both in order and effectiveness, is that whereby we apprehend the aspects of the movements of sun, moon, and stars in relation to each other and to the earth, as they occur from time to time; the second is that in which by means of the natural character of these aspects themselves we investigate the changes which they bring about in that which they surround [i.e. everything sublunar].

(Tetrabiblos, 1.1).

Ptolemaic astronomy (the inclusion of the ethical purposes in the term astronomy is optional) is still recognizable as astronomy; it has outlasted its historical instances during the hellenistic/early roman era. It has also changed profoundly: astronomers now do not double as astrologers.

4. Styles are not predictable or (in any sense) derivable. As far as we know, there is nothing in the history of astronomy before Ptolemy that could allow the prediction of the development of the Ptolemaic system. I am not saying that there was no scientific astronomy before Ptolemy; Ptolemy's methodologies were dictated to a significant degree by the work of others. (The practical use of astronomy as astrology was also probably not invented by Ptolemy). Ptolemy's beliefs and work are explainable, but claiming that Hipparchus could have predicted the development of the Ptolemaic "theoretical philosophy" exactly as it did develop, would be a not so sensible application of hindsight.
5. Styles are dynamic, they can change or evolve. The use of a contemporary-physics-informed geocentrism (Ptolemy’s system was geocentric) is still relevant. Expertise on the skills needed for the calculation of the apparent positions of the heavenly bodies from Earth found in Ptolemy’s *Almagest* is still required for teaching purposes, demonstration (planetaria) and navigation (Kaler 2002, 25). Space agencies also use the geocentric and other planetocentric systems where appropriate:

When a spacecraft is in the vicinity of Mars, it is convenient to utilize Mars-centered coordinate systems. These are systems that are centered at the center of the planet itself, as opposed to the system barycenter [the centre of mass in a system of two objects orbiting each other] or on the planet surface. The systems described here are utilized regularly by the flight operations and mission planning teams for JPL [NASA’s Jet Propulsion Laboratory] Mars missions (P. Burkhart 2006, 6).

Ptolemy's rationale may seem strange to us, because we know that the celestial bodies are not immutable. There is weather on Jupiter and stars have life cycles. Facts like these can defeat the astrological assumptions of Ptolemaic astronomy. The rationale is nevertheless in accordance with the cosmological beliefs of his time and Ptolemy executed it with exemplary rigour and sophistication. Ptolemy's world-view as a whole, with its scientific, ethical and astrological considerations can be dismissed, wholly -which has not happened- or partially, but cannot be refuted.

6. The styles are immune to refutation. The example of Ptolemaic science demonstrates in what terms we should think that styles of reasoning are
immune to refutation. Skilful coping is like the styles of reasoning in this aspect, too: learning to play the electric bass requires immersion on the player's part in the instrument's possibilities for sound production in order to make it emit something that is perceived as a melody rather than scratching noises. A master player's -who, since she is a master, can play music rather than make noise- choice of playing style(s), her repertoire and her compositions is not something that can have a truth value. On the other hand, propositions about her playing, her repertoire and her compositions are true-or-false, but they presuppose some exposure (understanding) to bass-playing.

7. Styles are not mere groping. Another characteristic the styles of reasoning share with skills is that they have a form; Hacking asserts us they are not haphazard or one-time approaches. Dreyfusian experts are compliant to a normative form pertaining to the skill they exercise expertly, as well. A master could attempt a radically innovative approach, but it will not be haphazard (visualize the master bass player once more, experimenting with new rhythms) and it will become an one-time approach only if it fails to catch on (maybe very different music styles are prevalent).

8. Styles introduce novelties. Hacking stresses that scientific styles must introduce novelties. Such novelties can be objects, evidence, laws or simply new possibilities; these are different things, which all share the trait of bringing forth new ways of being a candidate for truth and falsehood (Hacking 2002a, 189). Skills are useful because they enhance a person's repertoire of activity and thought: Skills can definitely lead to the introduction of new possibilities (like new bass rhythms, or being able to be in London by today afternoon because you know how to drive your car). But skills also can introduce new objects (like
a novel piece of furniture with new utilities, a revolutionary car engine, a
telescope, an electric bass, etc.), new evidence (having the skill to read the
symbols on paper provides evidence to believe that the last line of F. Scott
Fitzgerald’s *The Great Gatsby* is the content of the following sequence of
marks: “So we beat on, boats against the current, borne back ceaselessly into
the past”).

Let us examine if skills qualify for the broadest class of novelties, viz. new ways
of being a candidate for truth and falsehood. Consider the following sentence:
"A stall in a P-51 is comparatively mild" (Eaker/ United States Army Air Forces
1945, 76). The statement is a factual description for the benefit of student pilots
who were training to fly the Second World War-era P-51D propeller-driven
fighter aircraft. The section it comes from describes stalls and recovery
techniques. An airplane stalls when its speed drops beyond a certain value,
depending on aircraft design, load and other factors. When in a stall, the wings
do not generate lift and the aircraft falls towards the ground, pedal-to-the-metal
reactions notwithstanding. The truth of that statement depends on the existence
of fixed-wing flying machines and, naturally, of people who have flown before.
On the contrary, when a heavy loaded motorcar’s movement is arrested on an
uphill course, it just stalls and cannot climb further; no qualification, such as
‘mild’, is applicable. Of course, wheeled motor vehicles running on more-or-less
conventional surfaces are designed not to stall. Human flight has introduced
new phenomena, new ways of thinking and talking about them, together with
the means to validate statements expressing the new content. Skills can
introduce new ways for being true-or-false.
Concerning introduced objects, Hacking contends that "each new class of objects [introduced by a scientific style of reasoning] invites an ontological debate, often described as realism versus some kind of anti-realism. These debates are mere by-products of the styles of thinking... Each ontological debate takes place within its own scientific style. That is because every style of finding out creates its own objects" (Hacking 2009b, 47-48). It would be hard to find something that would spur an ontological debate in the realm of aircraft, stalling or not. Airplanes, after all, can be seen and touched. The flight dynamics of a new design can be tested in a wind-tunnel. But Hacking is clear; possibilities and sentences do count as novelties, although it is objects like the unobservable entities of the laboratory, numbers in mathematics or biological taxa (usually) higher than the species taxon that stir up debates about what is really real (Hacking 2002a, 189). After all, it is not the ontological debates' settlement that matters, but the fact that the styles of reasoning afford us a way to make sense of them:

In at least [a number of debates pertaining to the sciences] we may offer a diagnosis of the ontological disputes. It does not make them go away: there will always be platonists and anti-platonists [about numbers]. But for those who have difficulty taking the debates seriously, a diagnosis may be helpful. The ontological debates are by-products of the ways in which styles of reasoning introduce into discourse new classes of objects (Hacking 2012, 606).

Hacking includes himself among those that find it difficult to take such ontological debates seriously. He, however, takes seriously the existence of
postulated entities in the sciences: "[Talk about classes of objects being introduced] does not mean that objects of the class did not exist before there was a way to investigate them. That is nonsense" (Hacking 2012, 606). He complements this by saying:

Hacking [Representing and Intervening] (1983) took scientific realism seriously when it presented an experimental argument for realism about theoretical entities - as the best argument, not as a conclusive one. A remark on page 2 is seldom noticed:

‘Disputes about both reason and reality have long polarized philosophers of science. [ ... ] Is either kind of question important? I doubt it.’ I continue to doubt it (Hacking 2012, 606, fn.).

In other words, existence does matter, debates about existence do not.

9. Hacking's final characteristic of the styles of reasoning is their self-authentication and their self-stabilization. First, let us direct our gaze again at the styles' self-authentication.

In Hacking (2002a) the self-authentication of styles is introduced through its implications for the notion of truth:

The truth of a sentence (of a kind introduced by a style of reasoning) is what we find out by using that style. Styles become standards of objectivity because they get at the truth. But a sentence of that kind is a candidate for truth of falsehood only in the context of the style. Thus styles are in a certain sense 'self-authenticating'... The apparent circularity in the self-
authenticating styles is to be welcomed. It helps explain why, although styles may evolve or be abandoned, they are curiously immune to refutation (Hacking 2002a, 191-192).

In (Hacking 2012) it is presented from a different angle. Success does not play a role in a style's prevalence:

...yes, the genres of inquiry central to the sciences do work. But work for what? In part, for purposes of their own devising. 'Success'... helps direct what in the future will count as success. In our case the effect is heightened, because success changes the world so that success of that kind is easier to achieve. This returns us to 'self-authentication'. The styles in our list do not answer to any criteria of truthfulness other than their own. They are not 'chosen' because they 'work'. They help determine what counts as working (Hacking 2012, 607-608).

Another description of self-authentication is found in Hacking (2009a). We return to the (Hacking 2002a) formulation:

Scientific styles are in a certain sense self-authenticating. For each style there is a class of sentences that are candidates for truth or for falsehood only in the context of the style. The only way to find out whether they are true or false is by using the relevant style. The criteria of truthfulness are determined by the style. All individual propositions are fallible. In reasoning according to a style, one can always make mistakes. But it is in
the framework of the given style that one establishes that an error has been made (Hacking 2009a, 14).

The stress in the third formulation is on a class of sentences that are dependent on a style of reasoning for their truth or falsehood. In the following and the next paragraphs, I will explicate this further.

Hacking stresses that there are propositions belonging to a class representing (part of) the thinking and doing mandated by a mature style of reasoning (Hacking 2012, 604). My using of the adjective mature about the styles of reasoning in the beginning of this paragraph does not signify that the style of reasoning has stopped developing and evolving after its emergence, but is used to refer to the apparent organization that sets clearly apart a style of reasoning from one-time troubleshooting; there even are specific traceable moments of historical emergence for some styles (Hacking 2009a, 9-13). There are classes of skill-specific propositions, too. We have already considered the 'mild stall' example.

Sentences are shells lacking meaning other than the one found in dictionaries; they only are properly considered propositions when regarded from the point of view of a person uttering them in a particular context. Consider the sentence “That's a penalty”. We take it to probably mean a penalty in a game of football. We associate it with football rather than, say, with courts of law. A lot in meaning is determined by the historical setting. Let us suppose we hear it in a stadium. Whether the utterance is justified or not is a matter of football basics and some fitting events occurring during playing football. Finally, the proposition is a candidate for being true or false. Skills appear to be self-authenticating.
When Hacking uses the word 'justification' he refers to the styles of reasoning and not to the propositions generated by them, as I do most of the time: "...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. A justification would be an independent way of showing that the style gets at the truth, but there is no characterization of the truth over and above what is reached by the styles of reason itself" (Hacking 2002b, 175-176).

Hacking's mention of "external justification" is an assertion that there are no absolute grounds for justification. This is a position I agree with: knowledge and justification may not appear so compelling without some minimal grasp of the setting they were formulated in. The past and foreign countries are loci where we can often encounter instances of thinking and doing which seem inexplicable at first glance.

The formulation "the styles of reason itself" is an emphatic one; in effect it conveys that 'the styles of reasoning are reason'.

Now we will spend some time on Hacking’s conception of self-stabilization rather than on self-authentication. Hacking introduces it thus:

Each style of reasoning has its own characteristic self-stabilizing techniques. An account of each technique requires detailed analysis, specific to the style, and it is aided by vivid historical illustration. Each is a long story (Hacking 2002a, 193).
The self-stabilizing techniques are the rules I mentioned in my reconstruction of Hacking’s transcendental argument for entity realism. In the case of the experimental style:\(^{41}\):

\[\ldots\text{we are concerned with a mutual adjustment of ideas (which include theories of different types), materiel (which we revise as much as theories) and marks (including data and data analysis)}\]

(Hacking 2002a, 193).

The emphasis on the construction of the experimental apparatus and on the statistical analysis of error in the PEGGY II experiment by Hacking is an illustration of what he intends to express with the passage just quoted.

At this point we will leave the space of sentences and propositions and the space of self-stabilizing techniques. The focus is on sports.

In a lecture given in 1934, Marcel Mauss recounts how learning to swim and the practice of swimming are different from his younger days:

Previously we were taught to dive after having learnt to swim.

And when we were learning to dive, we were taught to close our eyes and then to open them under water. Today the technique is the other way round. The whole training begins by getting the children used to keeping their eyes open under water. Thus, even before they can swim, particular care is taken to get the children to control their dangerous but instinctive ocular reflexes, before all else they are familiarised with the water, their fears

\(^{41}\) In (2002a) Hacking speaks about the “laboratory style”, which he now thinks is an instance of the experimental style (Hacking 2012, 603).
are suppressed, a certain confidence is created, suspensions and movements are selected. Hence there is a technique of diving and a technique of education in diving which have been discovered in my day. And you can see that it really is a technical education and, as in every technique, there is an apprenticeship in swimming. On the other hand, here our generation has witnessed a complete change in technique: we have seen the breast-stroke with the head out of the water replaced by the different sorts of crawl. Moreover, the habit of swallowing water and spitting it out again has gone. In my day swimmers thought of themselves as a kind of steam-boat. It was stupid, but in fact I still do this: I cannot get rid of my technique (Mauss 1973, 71).

Mauss’s description of swimming consists of his reflections on a skill from the standpoint of the practitioner. This is the inside standpoint. Skills are usually viewed analytically from the outside. Introducing a discussion on the possible directions of the development of professional sports in the next ten years Brooke Borel asks:

If you’ve ever seen grainy old sports footage… you probably noticed something: how different the game looks, compared to its modern counterpart. The equipment looks too clunky, the uniforms impossibly baggy. Even the bodies of the players look weirdly out of shape. Why is that?

Like any human endeavor, sports evolve over time. Science and technology fuel these changes, providing ever-better gear made
with superior materials, better information about nutrition and training, and improvements in data generation and analysis that help push the limits of athletic capability (Borel 2014).

I have used sports as an example to show how skills transform with the passage of time\(^\text{42}\), often under the influence of knowledge and skills in other fields. Skills like sports seem to share the self-stabilization and the self-authentication traits of the styles of reasoning: the development of the practice revolves around a common lore, as we have witnessed Hacking putting it. The common lore persists as it fuels its own gradual transformation; it persists, that is, until it might happen to die out. But not all practices are like sports, driving, the Ptolemaic prediction of the position of the planets on the celestial sphere, and like hunter-gatherer hunting and gathering, where there are tried ways to do things, some collective knowledge. Some appear to be pure doing. In these cases the self-stabilization and the self-authentication are still present. I will borrow some examples from Mauss:

A kind of revelation came to me in hospital. I was ill in New York. I wondered where previously I had seen girls walking as my nurses walked. I had the time to think about it. At last I realised that it was at the cinema. Returning to France, I noticed how common this gait was, especially in Paris; the girls were French and they too were walking in this way. In fact, American walking fashions had begun to arrive over here, thanks to the cinema. This was an idea I could generalise. The positions of the arms and hands while walking form a social idiosyncracy, they are not

\(^{42}\) So, apart from geocentric astronomy, sports too show that skills outlast the circumstances of their genesis and that they evolve.
simply a product of some purely individual, almost completely psychical arrangements and mechanisms. For example: I think I can also recognise a girl who has been raised in a convent. In general she will walk with her fists closed. And I can still remember my thirdform teacher shouting at me: 'Idiot! why do you walk around the whole time with your hands flapping wide open?' Thus there exists an education in walking, too.

Another example: there are polite and impolite *positions for the hands* at rest. Thus you can be certain that if a child at table keeps his elbows in when he is not eating he is English. A young Frenchman has no idea how to sit up straight; his elbows stick out sideways; he puts them on the table, and so on (Mauss 1973, 72-73, original emphasis).

So there is common lore in the doing-without-necessarily-thinking, too. Mauss is in accord with Merleau-Ponty’s argument that what fuels the lore is embodiment:

…all that need be said is quite simply that we are dealing with *techniques of the body*. The body is man's first and most natural instrument. Or more accurately, not to speak of instruments, man's first and most natural technical object, and at the same time technical means, is his body… Before instrumental techniques there is the ensemble of techniques of the body (Mauss 1973, 75-76, original emphasis).
Judging from the examples, we suspect that the self-stabilization of the styles of reasoning is not so different from the self-stabilization of the skills Dreyfus and Mauss describe. Indeed, that is the case; we are provided with a preamble to embodiment:

A proposed account of self-stabilizing techniques begins by observing that a style becomes autonomous of the local microsocial incidents that brought it into being. Then there is the detailed account of how each style does stabilize itself. That is not the end of the matter. It is a contingent fact about us and our world that the techniques work at all—that we can... create phenomena in the laboratory to which our models are true. The persistence of a style demands some brute conditions about people and their place in nature (Hacking 2002a, 196).

In the last sentence Hacking evokes what is that self-stabilization affects, namely: “…that [stabilizing techniques] enable a self-authenticating style to persist, to endure” (Hacking 2002a, 193).

The catalogue of similarities between Dreyfusian skills and Hacking's styles of reasoning is long. Since every characteristic of the styles of reasoning is a characteristic of skills as Dreyfus construes them, we can conclude that every style of reasoning is a skill. The opposite is obviously false; skills and styles of reasoning are not identical. Not every skill is a style of reasoning. The skill concept is broader than the styles of reasoning concept.

Dreyfus's account of skill acquisition and expertise is a self-avowedly Merleau-Pontean approach. Hacking's styles of reasoning, it will be objected, have many
similarities with Dreufus's skills, but these similarities are coincidental (or even superficial). My response to this objection is embodiment, found in Hacking's reasons for reconsidering the label 'styles of reasoning' to describe the historically identified ways of finding out in the sciences:

LT&R [i.e. "Language, Truth and Reason" (Hacking 2002d), first published in 1982] insisted that Crombie's styles are not just styles of thinking. It seemed at the time that changing the gerund to reasoning might do the trick, for reasoning is also practical as well as theoretical; it involves as much doing as thinking. It would have been better to have been explicit, speaking of styles of scientific thinking & doing in the European tradition. By the time he wrote the preface to his big book [Crombie, 1994, i-vii], Crombie was well aware that the phenomena he was describing are 'a product of nature as conscious embodied beings'. This embodied creature uses not just its mind but its body to think and to act in the world in which it finds itself. There is also a lot more to be said for Crombie's 'thinking', for, as he wrote in the first paragraph, 'scientific thinking combines imagination and reasoning'. Probably bits of his 1994 preface are a gentle reprimand to LT&R of 1982, and to its successor text of 1992 [(Hacking 2002a), first published in 1992] (with which Crombie was well acquainted before its publication) (Hacking 2012, 600, original emphasis).
Hacking has accepted Crombie's reprimand: he is no longer committed to the name 'styles of reasoning' (Hacking 2012, 599). His acceptance provides us with the final direction of how to make sense of homo depictor. We have finally reached embodiment, as I had promised in chapter 1.

A question that could possibly arise is this one: The styles of reasoning are skills. The styles of reasoning are also constitutive of the practices they pertain to. Do these considerations amount to saying that a skill is also constitutive of its being practiced? The short answer is affirmative, again. Having competent or more experienced practitioners in mind, I can assert that the skills and the styles of reasoning literally are part of a relevant situation's “latent logic” (Merleau-Ponty 2002, 257), along with the world and with prescientific and other general reasoning.

6.5 A transcendental argument for self-authentication

6.5.1 Aristotelian Ethics

Bradner's scepticism about the styles of reasoning concerns style-to-topic determinism and "the lack of any effective constraint on our theorizing about styles" (2009, 14). The ‘style-to-topic determinism’ refers to our being able to use the style “to explain why we consider certain… topics debatable” (Bradner 2009, 12). The unconstrained character of the styles is illustrated further in the following way:

If we want to puzzle over the issue of John F. Kennedy's death, for example, we might invent an astrological style of reasoning that problematizes this event. We can put any topic into conversation with any style. We might employ the astrological
style to highlight the breakup of a Hollywood marriage as a
topic in need of discussion. But we might also employ the
astrological style to rationalize our investigation into volcanic
activity in Hawaii. Hacking argues that styles identify topics, but
he offers no theory of why a style shines its light on one
particular part of the historical stage rather than any other
( Bradner 2009, 17).

Hacking is very conscious about objections of the second point's kind. Various
misunderstandings (other conceptions of 'styles of reasoning') have their
beginning in his choice to use the label 'styles of reasoning' for the items in
Crombie's list ( Hacking 2012, 600-601). In the following passage, Hacking
decries the frame of mind the possibility of which provoked Bradner's objection:

Naming the class of items on Crombie's list [i.e. the styles]
tended to reify it. It suggested that the styles he listed had
some distinctive logical property that the philosopher might
elucidate. Should there not be rough and ready necessary and
sufficient conditions for being on Crombie's list? No. His styles
of scientific thinking & doing have no essence. That is not to
say that the list is arbitrary, or that the idea behind it is vague.
It is not even to imply that its members are bound together by
'family resemblances' ( Hacking 2012, 601).

He then adds that Crombie's styles are just descriptions, he had worked "like an
early taxonomist" (Hacking 2012, 601).
I do not think that Bradner will be totally satisfied with this account. Her series of examples show that absurdity is her main concern. My response to her worry is that self-authentication does not culminate in absurdity. The first step to do that is to acquaint ourselves with some Aristotelian ethics.

Having concluded that the styles of reasoning are Dreyfusian skills, I will explore Dreyfus's instigation to use the phronimos of the *Nicomachean Ethics* in order to shed light on how craftsmanship develops creatively rather than being the repetition of established formulas only. (Dreyfus 2004; Dreyfus 2009, 44).

We should take a closer look at Aristotle's notions of *technē*, translated as ‘art’, ‘craft’ or ‘skill’ and *phronēsis*, translated as ‘practical wisdom’, ‘general intellectual accomplishment’ -or just left in its greek form, transliterated as ‘phronesis’. In (*Nicomacean Ethics*, 1140a1) Aristotle distinguishes between two different accounts of the things that are potentially subject to change. Such things or events might be understood either as practical dispositions according to reason, or as dispositions about technically making something according to reason, which are two different things and the one is not included in the other. The practical disposition is about action (praxis) (*Nicomachean Ethics*, 1140a2-7). The technical disposition is about the genesis, the bringing about or the birth, of things, about how to bring them about and how to understand the process of making them (*Nicomachean Ethics*, 1140a12-14). The "beings" that are brought about by techne are not products of nature, or necessity (*Nicomachean Ethics*, 1140a15-17); they have their starting point, or principle (archē), in the maker and not in the product (*Nicomachean Ethics*, 1140a14-15). The definition of techne, Aristotle contends, is “a making disposition according to true reasoning” (*Nicomachean Ethics*, 1140a11, 23-24). Interestingly, chance
has a part to play in techne (Nicomachean Ethics, 1140a19-22): that is the reason why Aristotle adds the qualification “true” to logos in the definition of techne. We recall that Hacking used Aristotle as an instance of his own, semantic, conception of truth. In Aristotle, truth is not a substantive property of propositions (Broadie & Rowe in Aristotle 2002, 362).

Aristotle's distinction of practical and creative dispositions allows us to distinguish between two sorts of questions when we see a skilled practitioner in action. Visualize the guitar bass player. Rather tactlessly on both occasions, we can ask her 'why did you choose to play this melody?', or we can ask 'why didn't you learn an instrument that can produce fuller melodies?'. (A bass is better at producing rhythmic sounds than fully nuanced songs).

Techne has to do with replies to the second question. The player could provide a number of reasons for her choice of instrument, but none of them would be proof, or strictly speaking, conclusive. Technai (plural of techne) have final purposes (ends) different from themselves (Nicomachean Ethics, 1140b7-8); our bass player will play the bass to express herself, to entertain herself and others, etc.

The actual world is more complicated: Aristotle does not always separate between techne and systematic knowledge, which he calls epistēmē. An example is medicine; the physician studies health, and not health in general but specifically human health, or even the health of an individual because it is individual patients who are treated (Nicomachean Ethics, 1097a10-15).

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43 Following the philological standard, here e is used to transliterate epsilon (e=ε), ē is used for long e, which is represented by eta (ē=η).
Replies to the first question have to address something specific. In Aristotle’s thinking, this specificity is best accounted for by the notion of phronesis. Aristotle gets at great pains to analyze phronesis. Its definition is what concerns us most here: practical disposition according to true reasoning (Nicomachean Ethics, 1140b 5-7, 24-25). The adjective ‘practical’ is derived from the noun praxis (action). Praxis is the coordination between free choice (proairesis) and the desire to find out about and act according to rational ends (Nicomachean Ethics, 1139a36-38). Praxeis (the plural of praxis) are their own ends (Nicomachean Ethics, 1140b8). Phronesis is general: it was said with respect to a person’s understanding how to pursue their own good, but also was said about home management (economics), legislation and politics (Nicomachean Ethics, 1141b34-38). The generality of phronesis is revealed if we remember that the personal good often depends on the good condition of the household and the state affairs (Nicomachean Ethics, 1142a10-11). So, Aristotle continues, phronesis requires much experience (Nicomachean Ethics, 1142a16-17). The difference between techne and phronesis is that techne is a sort of dexterity and an ability to successfully pursue goals, while phronesis is a sort of wisdom, an ability to discern ideal courses of action in the setting of the situation at hand.

Phronesis concerns things which are not readily expressible and require thinking (Nicomachean Ethics, 1142a10-11). So the guitar bass player might reply to the first question that the melody she played was called for by the prevailing mood before she attempts to elaborate.

Moving back to less ancient philosophical concerns, what is involved in Dreyfusian skills is described well by a combination of techne (creative
disposition) and phronesis (practical disposition) (Benner et al. 2009, xv, xvi): both the technical expertise and the exercise of good judgement and wisdom is necessary for the nurse to become expert. The case of nursing is of particular interest; it has been one of the minutely detailed cases where the Dreyfus model of skill acquisition has been shown to be more accurate than the alternatives.

Using the explication of Benner et al. (2009) and Aristotle's analyses on techne and phronesis, we can infer that skills like nursing, playing basketball, playing chess and teaching are about being inclined to know about and act according to rational ends. Nevertheless, Aristotle would grant that a person without phronesis would still be able to perform her skill/art/craft. Dreyfus appears to know that all too well when he laments that people often do not proceed over the stage of competence. So, a more pragmatic definition of skill would be like an updated definition of technē. Such a definition would be “skill is a making/productive/creative disposition according to rational ends”. This definition can accommodate body techniques like Mauss's example of nurses’ walking and Polanyi's bike riding. The ‘according to rational ends’ part entails that there is consciousness of the comportment; we are above Dreyfus’s “ground floor”. The adjective ‘rational’ accompanying the ends is a socio-historical variant. It also depends on the person doing the reasoning and on interacting with the physical world.

I will explicate a little more: Aristotle’s analysis in the Ethics revolves around ends; we have seen that in his discussion on techne and phronesis. The whole issue of ethics is also introduced with the search for the general good (which is an end) in human conduct. Aristotle locates this good in happiness
(eudaimonia) (Nicomachean Ethics, 1097b23). The concept of justification enters the picture if we recall that for Aristotle ends are aitia (Physics, 194b33), i.e. causes, or better, explications. Aristotle’s introduction to ethics from happiness and the dispositional requisite for phronesis seem to suggest that reason alone is not enough for action. His text in the end of the first book of the Nicomachean Ethics corroborates this reading:

Take those with and without self-control⁴⁴: we praise their reason and the aspect of their soul that possesses reason, but there appears to be something else besides reason that is naturally in them, which fights against reason and resists it” (Nicomachean Ethics, 1102b14-19, Broadie & Rowe trans.).

The assumption here is that reasoning can lead us to order our conduct under the guidance of the world, but the balance of the ordering is ours. Aristotle distinguishes between accepting the accounts of others and having an account (Nicomachean Ethics, 1102b33-35). The difference is that when you accept an account you do not (partially or entirely) understand why the account is valid, but in the case of having an account enough understanding is there. One can accept a prescription either because it is a prescription (viz. valued by others), because, e.g., she does not wish to be marginalized, or because she thinks she can recognize the correctness of the prescription, but she cannot sufficiently understand why it is correct. The first case is a case of accepting an account, rather than having it. The second case can be both called accepting an account and having it (Nicomachean Ethics, 1103a1-2), depending on the vantage point of the spectator doing the naming. The spectator might be the person

⁴⁴ Aristotle refers to a single type of person.
accepting/having the account herself. The situation is not different from the example of medicine, which Aristotle treats as both *episteme* and *techne*.

This reading of Aristotle is in accord with Bernard Williams's observation that reasons for action must be relative to one’s subjective motivational set (Williams 1981a, 102). This subjective motivational set includes desires as well as “dispositions of evaluation, patterns of emotional reaction, personal loyalties, and various projects, as they may be abstractly called, embodying commitments of the agent” (Williams 1981a, 105). It is clear to my mind that Williams’s list of commitments of the doer can accommodate critical (or uncritical) admittance of what is generally said about how things are as being accurate: Williams’s model is not meant to only explain action, but to problematize rationality, too (Williams 1981a, 102-103). Apart from more-or-less straightforward causal cases, where desire leads directly to action, Williams takes into account cases of deliberation, in which the doer comes to “see” that she has reason to do something about which she did not “see” she had reason to do before deliberating (Williams 1981a, 104). Deliberation might also lead in a doer’s not doing something she had reason to do (Williams 1981a, 104-105).

We will leave this section having in mind that the justification of actions in skills admitting deliberation is relative to the doer’s motivational set. We also must make another mental note: even if a person is not motivated to become an expert, she can still perform in the field of the relevant skill from the level of competence.

**6.5.2 Objections considered**
At this point, armed with Aristotle’s inexactitude -but not vagueness- we can return to Bradner’s objection that the styles of reasoning are described by Hacking as unconstrained. As we will see in the following, for Bradner unconstrained means i) that the styles of reasoning do not develop according to some plan, and ii) that it is impossible to theoretically explore the (platonic) form (εἶδος, literally the ‘outlook’ of a thing, physical or an object of the understanding) of a style of reasoning. The answer to such concerns, as we will see, is simply that they have to be unconstrained.

As we have witnessed, for Bradner (2009, 17) the styles’ being unconstrained harbours three dangers: First, that we are free to apply any style to any inquiry. Second, that the styles determine which topics are worth investigating. Third, that there is danger of applying styles in an absurd way. In effect, it does not work out quite like that –one of the basic reasons is that expertise and mastery of any skill require personal responsibility, manifesting as emotional involvement. The hellenistic thought on astronomy, represented by Ptolemy, is still recognizable to be science on the one hand, and it is still considered useful for some applications on the other. We can trace the seeds of the present back to the distant past. Thinking’s historicity does not allow for an unconstrained array of possibilities to develop. Moreover, Ptolemy’s astrological work, what he considered to be practical astronomy, was considered by its author a subject distinct enough from astronomy to be addressed in another treatise. Under the light of the previous section, the situation is similar with all the skills admitting reasoning.

The phronetic element in skills, and by extension in the styles of reasoning shows Bradner’s contention that we can put any topic into conversation with any
style per our wishes to be false: There is order amidst the chaos of a large number of skills, which seems, apart from our inhabiting a world of material things, to be due to our being lodged in communities. The opinions of others function as filters for what we think and do. The effect of the communities is not so pronounced in Merleau-Ponty's philosophy, except for the explicit mention to it in “Cézanne’s Doubt” (chapter 4). Aristotle's philosophy helps us reinstate the communal in the thick of things. In Hacking we have encountered it in the myth about the public exchanges establishing the 'real' as a postulate. This anthropological myth in the 'Break' is an explication of how things come to be agreed upon to be said to be so-and-so, so that an Aristotle may later analyze what is being said to be the case.

The inevitable implication of Aristotle's philosophy will raise questions about his metaphysics, which might result in certain complications from regarding logos as a res (thing). Dreyfusian skills and their manifestation in the sciences, the styles of reasoning, do not have essences. It might be in principle possible to arrive at a definition for each one skill, including the styles of reasoning, as if they had essences, but these definitions will be neither adequate, nor exhaustive.

So, it seems to be the case that i) it is impossible for the styles of reasoning to have theoretical constraints and ii) this feature is welcome because it fits well with how skills are in the real world. Moreover, iii) the style-to-topic determinism, if the topic is conceived narrowly, like the explosion of the volcano in Bradner's example, is nonsensical judging by the present practice of science. If the topic is conceived broadly, like experimentation, or taxonomy, then style-to-topic specificity is to be expected, since it is a relevant skill that enables the
practitioner to regard a puzzle as best thematized according to a topic in the first place. There is nothing that precludes a puzzle thematized according to a certain style to become so under another one, too. For instance, a bass player's original composition can be regarded as sound waves only and it can be studied by a physicist, using some of Hacking's styles of reasoning. Bradner's concerns can be allayed: skills and styles emerge contingently, but they are not invented.

But what about using a (let us imagine) culturally well-accepted astrological style to elevate the importance of a Hollywood divorce as something requiring scientific attention? Well, if Bradner asks for a demarcation of science then she is asking for too much. If on the other hand she is just expressing concern that a 'style' which might be in vogue at some point in the history of a particular culture can become scientific, it seems to me that the astrological style is not a fortunate example. I will invoke Ptolemy's choice to write two treatises for a final time.

Bringing the discussion in the previous section to bear, we will expect people to be either critically endorsing/rejecting/coming to be motivationally indifferent to what is being generally said or uncritically endorsing/rejecting/being indifferent to what is being said; otherwise, it seems to me, we will have to come up with an account of being human without engaging in public and personal\textsuperscript{45} discursive thinking (i.e. reasoning) at all. The phronetic part of skills signifies that there often is some deliberation on the part of the person doing the practical reasoning, and it does not signify that people with phronesis will not make adventurous choices now and then. Additionally, the observation of Williams

\textsuperscript{45} Not private, the personal is in communion with the public sphere.
about the relevance of a person’s motivational set to her actions chimes well
with Dreyfus’s finding that people may not wish to advance beyond
competence. The bottom line concerning Bradner’s worries is that her
counterexamples, if they happen, will be open to scrutiny by reasoning.

Another objection to my line of thought might arise from the mathematical style
of reasoning (style a). It is intellectual like chess, but there is no chessboard
with pieces on it to visualize in mathematics, we might think. We would think
wrong Hacking asserts: he cites (2014, 257) André Lichnerowicz, a differential
geometer and mathematical physicist describing the work of the mathematician
as working with “mathematical beings” and begins to “play” with them until they
become “familiar” (Connes, Lichnerowicz & Schützenberger 2001, 24-25).
Hacking’s own position is that some mathematical objects which seem to have
always existed patiently awaiting to be discovered are “by-products” of the
human “genetic envelope” (Hacking 2011, 7). So, some mathematics is the
outcome of the way the hardware is wired. Still, this is no argument that
something known by thinking alone (known a priori) is also true of the world:
this, Hacking argues, was Kant’s “conundrum” (Hacking 2011, 8-9). The
solution to the conundrum is the various applications of mathematics (Hacking
2011, 9). Hacking identifies six, all of which have created philosophical debates
-plus a seventh “App 0”, the application of mathematics to mathematics, which
has not attracted the attention of philosophers much (Hacking 2011, 11). One of
them is of interest to us here. It is “App 4”, which gave rise to “Kant’s
conundrum”:

…there are endless ‘common or garden’ uses of mathematics
by accountants, shop-keepers, carpenters, contractors, farmers
and lawyers. And by almost everybody in the contemporary world. Minimal numeracy has long been required of almost everyone who wants to have the minimum standard of living of an industrial state. When Kant (and [Bertrand] Russell) asked how pure mathematics is possible, they were mostly thinking of App 4. But notice that one may be less inclined to focus on truths here than on rules for making informative transformations. Kant took for granted that ‘5+7=12’ is a truth which we know to be true. His conundrum would seem less pressing if we took this formula to be an instruction about the manipulation of information (Hacking 2011, 13, original emphases).

My discussion about the exclamation ‘That’s a penalty!’ applies to mathematics and not only to football, even though in mathematics there are no events to see—or at least they are not there to be seen by all. The triangle of subject, public representation and the world (this third component both as application and through our “genetic envelope”) is also present in the discussion about the mathematical style. The same, as we would anticipate, applies to the statistical style (style e) (Hacking 1992, 150-151).

6.5.3 Self-authentication is a necessary trait of the styles of reasoning

It will be objected that this forage into the *Nicomachean Ethics*, shows only that the styles’ self-authentication is reasonable, not that it is necessary. In order to show this we will need a transcendental argument, as Bradner has suggested (Bradner 2009, abstract). We should always have in the back of our minds that the necessity we are dealing with in this thesis is acquired by engagement in the world, physical and social.
The first premise in an argument demonstrating the unconstrained character of the styles is that Hacking's and Crombie's styles of reasoning are Dreyfusian skills. The Dreyfus and Dreyfus concept of skills is not based on specialized concepts such as techne and phronesis, despite the fact that these concepts happen to help put it in more explicit terms, along with Merleau-Pontean ones – these last at a most basic level. Dreyfusian skills are what we learn and do, and we observe people to learn and to do, in our daily lives.

Hiding from predators and climbing trees is a skill for Dreyfus (natural aptitude that can be perfected with practice), as well as non-propositional normative social skills like the physical proximity to peers and distance to superiors when standing (Dreyfus 2000, 320-321). The differences between various sorts of skills are a good opportunity to repeat that every style of reasoning is a skill, but not every skill is a species of reason. It is the natural-language meaning of Dreyfusian skills which I will use to construct the transcendental argument for the self-authentication of the styles of reasoning.

Natural-language terms are not necessarily pre-theoretical, in the ancient Greek sense of *theorein*, meaning 'having a good view'. There is understanding at play in natural language. But, one can ponder over the phrase 'no object is round and square at the same time in the same sense' without a theory about roundness or squareness and determine that it seems to be self-justified not because she has never witnessed objects like that, but just after thinking about it using conceptions akin to the dictionary definitions of round and square. An important observation is that the person making the claim has not acquired the meaning of 'round' and 'square' from a dictionary, but from experience. The
thinking about the truth and the self-evidence of the claim, however, does not involve experience, but only concepts acquired from experience.

I will move on to the transcendental argument:

1. Hacking's styles of reasoning are skills as Dreyfus conceptualizes them. (premise)

2. Dreyfus's concept of skill does not differ from the average competent speaker's concept of skill. (premise)

3. Dreyfus's analysis of skills and their acquisition does not prove premise (2) to be false. (premise)

4. The average competent speaker can acquire her concept of skill from experience and use it in the appropriate way\(^{46}\). (premise that the sceptic must grant)

5. Our analysis\(^{47}\) of the concepts used to think about skill implies that skills do not require regulative constraints\(^{48}\). (a priori premise)

6. Therefore, the styles of reasoning do not require regulative constraints.

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\(^{46}\) Law-likeness due to the normativity of natural language.

\(^{47}\) That is, Dreyfus's analyses, the Aristotelian analysis conducted by me after the points of Dreyfus (2004) and Benner et al. (2009), and, crucially, pre-philosophical thinking about skill.

\(^{48}\) I.e. there is no need for an overarching conception of reason vindicating the styles of reasoning. (Vindication is a kind of justification of logical empiricist pedigree, which is less strong than how I use the concept 'justification' in the thesis. I have chosen the word 'vindication' as an indication of the methodology I would employ if I had to use reason to justify reason). Aristotle is useful again to fully explain what I intend: there were phronimoi (people with phronesis) and virtuous people (allowing that today we might not agree with the assessments of Aristotle and his contemporaries about the virtue of certain people) before he set out to analyze what virtue is. Cf. Dreyfus: "although science requires that the skilled performance be described according to rules, these rules need in no way be involved in producing the performance" (Dreyfus 1992, 253, original emphasis).
My conclusion can be put in the following terms: ‘if $x$ is a skill, then it is unconstrained’. The proposition can also be expressed thus: ‘if $x$ is not unconstrained, then it is not a skill’. Finally, there is asymmetry in logical implication, so the proposition ‘if $x$ is unconstrained, then it is a skill’ is false.

My conclusion does not entail that the practice and evolution of skills cannot be restrained externally, e.g. by law, due to moral concerns, by insufficient technology and/or knowledge in other domains, etc.

I have chosen to deploy a transcendental argument not only because Bradner has called for one such argument, but, more significantly, because I wish to fend off possible objections stemming from my assumption that reason is logos. I have had good reasons to make this assumption, namely logical necessity from some of Dreyfus’s and Hacking’s premises and conclusions, but conceptions of what reason is can be difficult territory to navigate, so I have just practised reason to avoid provoking debates about the correct definition or concept of reason. I think that as a result of reason’s historicality there is no such correct concept or definition.

I should also explain that I have used the law-likeness of natural language in order to avoid circularity. Notice that I do not speak about the ‘meaning’ of skill, but about the ‘concept’ of skill. Concepts connote some understanding of what is being said or thought. Concepts, which are mental drafts, are connected with meanings, which are word-to-world relations, by Merleau-Ponty. On physical objects, he talks about meaning and concept by describing an examination of a cube:
From the point of view of my body I never see as equal the six sides of the cube, even if it is made of glass, and yet the word ‘cube’ has a meaning; the cube itself, the cube in reality, beyond its sensible appearances, has its six equal sides. As I move round it, I see the front face, hitherto a square, change its shape, then disappear, while the other sides come into view and one by one become squares. But the successive stages of this experience are for me merely the opportunity of conceiving the whole cube with its six equal and simultaneous faces, the intelligible structure which provides the explanation of it. And it is even necessary, for my tour of inspection of the cube to warrant the judgement: ‘here is a cube’, that my movements themselves be located in objective space and, far from its being the case that the experience of my own movement conditions the position of an object, it is, on the contrary, by conceiving my body itself as a mobile object that I am able to interpret perceptual appearance and construct the cube as it truly is (Merleau-Ponty 2002, 236).

Merleau-Ponty arrives at the conceptualization of the cube on the next page:

If there is, for me, a cube with six equal sides, and if I can link up with the object, this... is because I delve into the thickness of the world by perceptual experience. The cube with six equal sides is the limiting idea whereby I express the material presence of the cube which is there before my eyes, under my hands, in its perceptual self-evidence. The sides of the cube are
not projections of it, but precisely sides. When I perceive them successively, with the appearance they present in different perspectives, I do not construct the idea of the geometrized projection which accounts for these perspectives: the cube is already there in front of me and reveals itself through them. I do not need to take an objective view of my own movement, or take it into account, in order to reconstitute the true form of the object behind its appearing: the account is already taken, and already the new appearance has compounded itself with the lived-through movement and presented itself as an appearance of a cube (Merleau-Ponty 2002, 237).

The cube example offers the opportunity to speak about words which are not nouns:

Now, if the words ‘enclose’ and ‘between’ have a meaning for us, it is because they derive it from our experience as embodied subjects. In space itself independently of the presence of a psycho-physical subject, there is no direction, no inside and no outside (Merleau-Ponty 2002, 236, original emphasis).

Merleau-Ponty expands his idea about meaning and concept in the field of language, prescientific and otherwise.

There is… a taking up of others’ thought through speech, a reflection in others, an ability to think according to others which enriches our own thoughts. Here the meaning of words must be finally induced by the words themselves, or more exactly, their
conceptual meaning must be formed by a kind of deduction from a *gestural meaning*, which is immanent in speech. And as, in a foreign country, I begin to understand the meaning of words through their place in a context of action, and by taking part in communal life – in the same way an as yet imperfectly understood piece of philosophical writing discloses to me at least a certain ‘style’… which is the first draft of its meaning (Merleau-Ponty 2002, 208, original emphases).

Merleau-Ponty’s connection of meaning and concept in lived experience is what permits me to speak of concepts, and in so doing, deploy the transcendental argument. Merleau-Ponty does not provide an account of meaning. He is interested in meaning as purposeful direction, as speaking expression of the body. There is no need to amend anything about the semantic Putnamian meaning of meaning Hacking has suggested since they address separate issues.

Premise (5) may not appear to be a priori, but it is. The sort of apriority involved is called Aristotelian apriority (Mares 2011, 123-137). Interestingly, this apriority is not rigid, metaphysically necessary and timeless; our understanding of things can increase or it can be modified. But it seems that when we are required to exhaust our explicit understanding of a matter, apriority is inevitable. This explanation of the apriority of skills extends, as expected, to the apriority of the styles of reasoning.

The form of Aristotelian self-justification is this:

The analysis of the concepts used to think about $p$ implies $p$
Therefore, \( p \)

(Mares 2011, 126).

Aristotelian apriority is possible due to the way Aristotle thinks we acquire concepts; we acquire the concepts involved in the analysis after abstracting from the objects of experience. In the *Posterior Analytics*, Aristotle explains that first we cognize things or facts; we proceed to find their definitions or explanations at a later stage (89b22-35).

Aristotelian apriority resembles arguments appealing to memory, but they are different: memories are retrieved through introspection, after an initial experience (Mares 2011, 128). As a species of apriority, Aristotelian apriority has been reconstructed from Aristotle's work, and it is an element of neo-Aristotelianism. As is the case with every sort of apriority in contemporary philosophy, Aristotelian apriority has traits, like self-evidence and normativity, whose explicit origin dates to Kant. Aristotelian concepts become refined after multiple experiences.

Aristotelian apriority resembles analytic apriority according to the logical empiricists. Analytic apriority can be represented with the general form:

\[
\text{The analysis of the meaning of the words in a sentence } S \implies S
\]

Therefore, \( S \)

(Mares 2011, 126)

In Mares’s forms of Aristotelian and analytic apriority \( p \) stands for proposition and \( S \) for sentence. The difference is that in Aristotelian apriority the sentence comes paired with a particular content; with Aristotelian apriority the interplay
between the subject, the public representation and the world is in the thick of things. (“To say that that which is the case, is the case, and that which is not the case, is not the case, is to say the truth” (Metaphysics, 1011b25)). In short, Aristotelianism logically allows for meanings to change and for reason to have a history.

Another reason that one more Aristotelian notion came to the fore in my line of thought, namely the brand of apriority in Aristotle's work, is Hacking's understanding of Schlick's verificationist maxim, that “the meaning of a sentence is its method of verification”. Aristotelian abstraction is compatible with Hacking's verificationism, which stipulates that meanings are not definite, objective and fixed. Recall that, according to the contemporary consensus about transcendental arguments, verificationism is the only option for a transcendental argument to work if we are to avoid idealism. Hacking's verificationism can be embraced.

Aristotelian apriority has some advantages over its look-alike, the analytic apriority. Its reliance on experience instead of meaning makes a priori reasoning easier to grasp (Mares 2011, 129). Aristotelian apriority can be defeated under the pressure of new evidence. Wrong justifications due to faulty reasoning or false justifications due to the abstraction of an incorrect concept are possible (Mares 2011, 130). Analytic justifications are by definition not empirically defeasible. The appeal of Aristotelian apriority in the milieu of contemporary philosophy can be visualized if we consider examples like 'no object is round and square at the same time in the same sense', an example I have borrowed from Mares (2011, 129) (the addition of the 'in the same sense' excludes other uses of 'round' and 'straight', like 'round numbers' and 'a straight
person') and, especially, 'no object can be red and green all over at the same time', another of Mares's examples (Mares 2011, 134). Finally, Aristotelianism does not rely on reason as a special faculty which is responsible for all of our a priori judgements, like rationalism does (Mares 2011, 135).

We can conclude that Hacking's addition of self-authentication to the styles of reasoning is self-evident. There is nothing wrong with the idea of contingent "reason itself" leading to necessary reasoning.

The apriority stemming from the styles of reasoning makes historical epistemology normative rather than purely descriptive; its norms are also genuinely epistemic in the sense that they cannot be reduced to the group norms or to the social norms of the time and place in which they operate.
Concluding thoughts: A definition of practice

Change occurring with the passing of time is a recurrent feature in this thesis. We have talked a lot about the situatedness of embodied thinking and doing, apriority collapsing under the weight of new evidence, and about reason having a history.

We have seen apriority emerging in the flux of change. We have seen that evidence, empirical and evidence independent from experience alike, are the outcome of being-in-the-world. We have concluded that epistemic justification is to be found in doing, apart from thinking. All this is from the angle of the knower. Assuming the angle of the known, I understand Rheinberger's speaking about the material transcendence of objects to be about evidence. Recall that Hacking's venturing into mathematics is, among other things, about using mathematics as tools for the manipulation of information and about mental playing with mathematical objects. So, it seems that "transcendence" is not just a feature of objects which are extended in space: when grasping a mathematical object, like any other object, what you get is a something with certain characteristics. To see what I am talking about, visualize a geometrical shape.

We are in the field of Rheinberger's epistemic things. An epistemic thing is the outcome of the interactions between the knower and the known. The study of knowledge is now a study of change, the study of change conceived as the study of interactions between knowers and knowns. Scientific practices are interactions of this sort.
We are now in a position to offer a definition for practices, replying to the question which had arisen in the first chapter. Practices are sedimented approaches for the pursuit of a variety of ends, according to true thinking and fitting doing. The sedimentation of practices is brought about by the coordination of the individual knower's dispositions about finding out and about how to act along the lines of the dynamic true thinking and the also dynamic fitting doing. Notice that practices are not skills; they just come about by the implementation of a number of skills, sound reasoning being one of them. So, there is room for shortcomings, failures and malpractice. True thinking is dialectic in the sense of being discursive and fitting doing is dialectic in the sense that things do play a part in how we understand them. As far as science is concerned, the dialectic character of thinking and doing seems to be a common trait of pre-scientific thinking and doing and of the styles of reasoning alike. According to the proposed definition the exercise of a practice feeds back to its own sedimentation.

The distinction between skills and practices is that skills underlie practices. Skill is know-how. Practice is execution. To explain this point, imagine a person cooking something she has not prepared before. Following the recipe she stumbles upon an instruction to add ‘some salt’. If she is a competent (or more skilled) cook, she will have an idea about how much salt is some salt. She can opt to not add any salt at all. The not so savvy cook will find the instruction lacking in information. Having a clue what to do is skill. Cooking the new recipe, irrespective of finding instructions adequate or vague, is practice.
Appendix: Edgar Zilsel and the Cult of Genius

Reichenbach was not the only one in the empiricist movement to pay attention to the concept of genius. The concept had been analyzed by a fellow logical empiricist, Edgar Zilsel, who, in tandem with other sympathizers of the logical empiricist programme, wished to reform the conceptual foundations and the methodologies of the humanities.

Zilsel was a regular participant in the Vienna Circle’s Thursday evening meetings (Stadler 2007, 15). Zilsel, a physicist, mathematician and philosopher (Nemeth 2011, 521), is mainly known today for his contributions in the sociology of science (Nemeth 2007, 293).

Early in his career, Zilsel (The Application Problem, 1916) became convinced that there are some philosophical problems of a very fundamental nature, which affect all the sciences, and which cannot be overcome with each science’s internal resources. The positivism-inclined members of the Vienna Circle disagreed with Zilsel that the problems he had identified were real; they tended to dismiss questions of this nature as metaphysical pseudo-problems. Moreover, Zilsel held the conviction that philosophy, speculative as it predominantly is, cannot provide answers to the questions that interested him, unless it joins forces with empirical research (Krohn & Raven 2000, 926). In that respect, Zilsel did not share the convictions of the Vienna Circle and other, similarly minded philosophers, like Reichenbach. The main goal of the logical empiricists was to account for the objectivity and the meaning of the scientific method and the scientific concepts. The central problem they faced was to demonstrate how scientific knowledge is rational and objective, bearing in mind that in most cases it is both formally constructed and logically consistent and
grounded on tests in the natural world (Passmore 1967). Dissatisfied with the traditional philosophy, which, in their opinion, had always been self-occupied in circles of metaphysical argument on subjects for which there could be no definite conclusion, the logical empiricists had been very conscious of the augmented offshooting of autonomous empirical sciences from philosophy. Philosophy had to be renewed by becoming itself scientific, but, contrary to its science offspring, it could not be entirely empirical (Creath 2011). Zilsel subscribed to the reformation of the theoreticians' armamentarium, on the basis of solid empirical grounds, but remained sceptical about philosophy's ability to provide tools for his research questions. To that end, he developed and employed a combination of philosophical analysis with meticulous historical research (Krohn & Raven 2000, 928). Summarily, Zilsel's view of the Vienna Circle was that it was an "empirical school without empirical research" (Raven & Krohn 2003, xlv).

More than other logical empiricists, Zilsel permitted himself to ask research questions that were reminiscent of traditional philosophy, albeit with the intention of reducing them to questions of social science, and considered the mainstream methodologies of the movement to be unduly speculative. This programmatic attitude of Zilsel can be already attested in his second published (1926) book-length work (Nemeth 2007, 293), *Die Entstehung des Geniebegriffs* (*The Origin of the Concept of the Genius*). Zilsel had been interested in dissecting the cult of the genius, which, in his experience, permeated the German-speaking educational and academic social strata, before dedicating an extended analysis to it. In 1918 he had published a study, using psychological and philosophical resources, in which he characterized the admiration for the genius as a pseudo-religion typical of the period it had
flourished, the late nineteenth and early twentieth centuries (Nemeth 2007, 293). In the *Origin*, he reconstructed the reverence for the genius in social terms, attempting to establish the social conditions under which various notions of exemplary individual excellence become prevalent (Nemeth 2007, 293). In fact, his point of departure is the premise that the term genius does not apply to particular qualities of specific human beings, but the concept derives its content from public opinion. The causal factors for the emergence of the notion of genius must, therefore, be identified through historical and statistical tools, which, Zilsel thought, could explain the cross-feeding of certain social processes and the manifestations, always in a social milieu, of the understanding of excellence in intellectual or creative terms (Zilsel 1926, 2; 323-326).

Zilsel's research on the cult of the genius begins with its manifestations in antiquity and ends with genius during early modernity, the Renaissance, focussing on the latter, although his research programme's emphasis is not historical, but on the discovery and explanation of laws (Krohn & Raven 2000, 927) pertaining to the social sciences, although in direct analogy and conceptual kinship with those of the natural sciences (Nemeth 2011). Zilsel, in accordance with the other logical empiricists, aimed at studying science in order to re-orient the humanities towards a scientific route, with the important difference that he emphasized the analysis of "*living science*" (Zilsel 1926, xxx, original emphasis) as opposed to the formal, and thus predominantly philosophical in nature, analyses of science, termed rational reconstructions, usually undertaken by the logical empiricists (Carnap 1969; Reichenbach 1938, 5). His study on the emergence of the genius, however critical of its cult incarnation, is a step in Zilsel's wider project, the central aspect of which was
the search for historical laws with the aid of philosophical analysis, in conscious imitation of the principles permeating the natural sciences (Nemeth 2011, 532). Moreover, it exemplifies his persistence on the utilization of cultural historical material for the establishment of premises corresponding to actual social phenomena as input for speculative analyses.

The treatment of the concept of the genius as a social phenomenon amounting to being a pseudo-religion does not signify that Zilsel does not believe that individuals can produce creations and innovations of excellence. Specific persons can be judged to belong in the category of genius. The word appears in its natural language sense in his work (e.g. in the passage quoted below from Zilsel 1941, 572; Zilsel 1945, 331), but Zilsel never had the intention of arguing in favour of a particular conception of the genius, and, consequently, could not have produced such a conception that could have influenced Reichenbach’s - rather atemporal- use of the word. Zilsel's wider project, the study of the genius cult included, had solely been the discovery and historico-sociological explanation of laws in the social sciences. He makes this clear in a defence of his methodology and intentions:

...human individuals influence history to different degrees because they differ in their personal gifts and abilities: there are good and bad artists, good and bad scientists and philosophers. Whether these differences are great enough to make statistical investigation and macro-laws [i.e. Zilsel's own methodology and goals, respectively] impossible can not be decided by a priori arguments, but only by the results of empirical search after such laws. At any rate a 'statistical' history, aiming at laws of
intellectual, artistic, and religious developments, would greatly differ from traditional historiography. It can neither dwell on masterpieces nor disregard the mass of mediocrities. The question as to whether an artistic or theoretical work is the product of a genius or a bungler would not even enter its investigation (Zilsel 1941, 572).

Although Zilsel's work on genius did not have any direct impact on Reichenbach, the same cannot be said for his broader programme. The two men were acquainted and exchanged correspondence (Krohn & Raven 2000). Reichenbach, as a co-editor with Rudolf Carnap, had repeatedly asked Zilsel to contribute to the journal *Erkenntnis* (Krohn & Raven 2000, 929, 932 n. 12; Raven & Krohn 2003, xlv). Zilsel published work on probability and protocol statements in the journal (Raven & Krohn 2003). We have witnessed how Zilsel's quest for the identification of historical laws was motivated by concerns of a clear theoretical nature, which could be fruitful if explored with the help of empirical studies. His views on how the numerous logically possible propositional systems, which the logical empiricists found Kant's conception of reason had to be substituted with, corresponded to experience were strong. Zilsel's rendering of this particular problem, the root of the protocol sentence debate, was the following: "Kant's question really [is]: what conditions must be fulfilled for science to develop? Science is not inevitable; this question is very fruitful indeed" (Zilsel 1932, 154). It is more than probable that Reichenbach shared Zilsel's worries on that issue, and he believed that science is not inevitable. In that case, a justification for science would be needed, one that could absorb the difficulties of the search for basic statements that correspond directly to experience, and would abate the concern inherent in the last Zilsel
quotation that science, apart from inevitable, might well be inexplicable as anything else but a historical accident among many; it would then possibly be without privileged access to the world and nothing more than a more elaborate cousin of the cult of the genius, a pseudo-religion.

However strong or weak Zilsel’s influence to Reichenbach had been, one thing is certain: Reichenbach’s genius does not share much with Zilsel’s. Reichenbach’s is an abstract concept with lexical (or lexical-philosophical) content, while Zilsel’s interest about it was on the application of the lexical content of the word ‘genius’ in the society he lived. What is of interest for my purposes here is the fact that Zilsel’s work had purged genius from certain historical accidents concerning its meaning (viz. the pseudo-religious connotations of admiration), so Reichenbach was free to use it in a timeless sense, as Kant had done.
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