The Minimal Method of Descartes*

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Abstract

What is, after all, the famous method of Descartes? The brief and vague passages devoted to this subject in Descartes' corpus have always puzzled his readers. In this paper, I investigate not only the two essays in which it is directly addressed (*the Regulae ad Directionem Ingenii*, and the *Discours de la Méthode*), but also his scientific works and correspondence. I finally advocate an interpretation that makes the best sense of his overt comments as well as of his actual scientific practice. Contrary to widely accepted views, I argue that there are no substantial discontinuities in his understanding of his own method, or between his theory and practice. I claim, by contrast, that Descartes advocated a minimal method: a method that says little, but that, nonetheless, marks a revolutionary rupture with the existing forms of explanation.

Keywords: Descartes - method - scientific explanation

Resumen

¿Qué es, después de todo, el famoso método de Descartes? Los breves y vagos pasajes dedicados a este tema en la obra de Descartes han confundido siempre a sus lectores. En este artículo, investigo no solo los dos ensayos en los que se lo aborda directamente (las *Regulae ad Directionem Ingenii* y el *Discours de la Méthode*), sino también sus trabajos científicos y su correspondencia. Finalmente, abogo por una interpretación que le da el mayor sentido tanto a sus comentarios manifiestos como a su práctica científica. En contra de las concepciones ampliamente aceptadas, argumento que no hay discontinuidades sustanciales en su comprensión de su propio método o entre su teoría y su práctica. Afirmo, por el contrario, que Descartes defendió un método mínimo: un método que dice poco, pero que, no obstante lo cual, marca una ruptura revolucionaria con las formas existentes de explicación.

Palabras clave: Descartes - método - explicación científica

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1. The Minimal Method of Descartes

Descartes is widely regarded as the advocate of a new method. The very title of his famous *Discours de la Méthode* leaves no doubt that he gave great importance to the method behind his many discoveries. But his enthusiasm about it can hardly be squared with the brief and vague hints that he gives of what the method is all about. In the *Discours*, as well as in the three essays published with it, the method is not explicitly formulated, and the few hints available seem too unimpressive to justify the importance given to it. The very nature of his method is unclear and has puzzled the readers since his works were first published.[1] Due to the lack of an explicit formulation, and to some apparently contradictory remarks about it in Descartes' corpus, many attempts have been made to read off the method from his actual scientific practice. These attempts have tried either to harmonize his many and scattered remarks (through some ingenious reinterpretation of crucial terms that are allegedly used in idiosyncratic and/or imprecise ways), or to draw some chronological distinctions that may explain how Descartes shifted views along his lifetime.

In this paper, I claim that the unclear nature of Descartes' comments about his own method mirrors the generality of the method itself. As it stands, the method is too general to be a precise guide for any particular scientific endeavor. Though general, it reveals something deeply important, that may seem obvious now, but that was not at his time. As a matter of fact, Descartes' methodological procedures marked a rupture with the existing forms of explanation. To a considerable degree, his method looks unclear because too much is asked of it. In what follows, I single out and emphasize the core of Descartes' method, which kept constant throughout his work.

The characterization of Descartes as a rationalist who sees knowledge as deriving solely from the intellect gave rise to deeply distorted views of his method. This characterization is not only wrong, but it is a gross caricature of his original intention. It is now widely recognized that Descartes was a serious experimenter and that experience played an essential role in his scientific method. In an important sense, Clarke's (1982, p. 2) claim that Descartes was mainly a practicing scientist who "wrote a few short and relatively unimportant philosophical essays" is accurate. Given the unclear nature of Descartes' comments about his own method, it seems reasonable to take his abundant scientific work as the primary evidence of his methodology. I will follow this suggestion and make use of his whole corpus

[1] At the publication of the *Discours*, Descartes instructed readers to correspond with him through Martin Mersenne, but most objections and replies received were considered seriously misguided. Among well-known Cartesians, such as Geraud Cordemoy, Louis de la Forge and Nicolas Malebranche, the method and the interplay between science and metaphysics were interpreted in radically diverse ways. More recently, Koyré (1939) described Descartes' method as purely a-prioristic, while, on the other extreme, Clarke (1982) characterized it as fully empiricist. Between the extremes, Beck (1952), Buchdahl (1969), Garber (1978), Williams (1978), among many others, have struggled to find a *via media*.

(including scientific works, correspondence, and philosophical essays) to make the best sense of it.

Hatfield (1988) and Garber (1988, 1998) warned against the dangers of reading off too much from Descartes' scientific practice. This could lead to the opposite mistake of embracing the extremely revisionist view that Descartes was in fact a radical empiricist, as it is defended by Clarke (1982). The complex interplay between *a priori* and *a posteriori* elements in Descartes' method asks for an alternative interpretation that either combines these elements in a consistent way or reveals the inconsistencies and shifts in his methodology. Hatfield and Garber take the second route. They interpret Descartes' inconsistencies as signs of radical changes in his scientific method. Their position, I claim, is motivated by an excessively restrictive notion of method. A minimal (and more permissive) interpretation, that will be defended here, makes more sense of Descartes' own comments about his method and of his actual scientific practice. The conflicting nature of many of his comments is real, and that, it seems to me, reflects shifts of interest, of style, and even of some substantial ideas. But none of these changes touch the minimal core of his method, which is what Descartes meant by *méthode* all along.

In the first section, I investigate the *loci classici* where the method was directly addressed: the *Regulae ad Directionem Ingenii* and the *Discours de la Méthode*. Following that, in the second section, I scrutinize Descartes' scientific practice and argue, contrary to Garber and Hatfield, that his practice *is* compatible with the *Discours* and the *Regulae*. Finally, in the last section, I advocate an alternative: the method did not change substantially, and that is why Descartes summarized his old ideas of the *Regulae* in the *Discours*. This reading becomes more plausible if the method is understood in a more general way. A way that, it seems to me, makes the best sense of Descartes' overtly general claims.

2. The *Regulae* and the *Discours*

The obvious places to look for Descartes' method are the two works in which it was explicitly addressed: the *Regulae ad Directionem Ingenii* and the *Discours de la Méthode*. The *Regulae* was written between 1619 and 1628, when it was abandoned. It was not published during Descartes' lifetime, and it was left as an unfinished draft. It was originally intended to have three parts, of which only the first and part of the second were written. It is important to keep in mind that the third part, that was left undone, would deal with the methodological rules for "imperfectly understood problems", or the problems of the empirical sciences. The fact that Descartes left this project exactly at this point has raised many speculations. But I prefer not to speculate on that. One thing, however, must be clear: the application of the existing rules to the empirical sciences must be done with caution, because they were not intended to be applied specifically to them.

The *Discours* was first published in 1637, in French, and its first edition also included three essays: the *Dioptrique*, the *Météores*, and the *Géometrie*. Though it was published almost ten years after the project of the *Regulae* was set aside, there are some obvious similarities between the two texts in what concerns the characterization of the method, even because the essays and parts of the *Discours* were written shortly after the *Regulae*.

I begin by unraveling the method as it appears in the *Regulae*. In Rule Two, Descartes states that "there are two ways of arriving at a knowledge of things – through experience [*experientiam*] and through deduction" (AT X, p. 365).[2] He then warns that "our experiences of things are often deceptive", and that most errors come from "certain poorly understood observations [*experimenta*]" (AT X, p. 365). Arithmetic and geometry are the only sciences "free from any taint of falsity or uncertainty" (AT X, p. 364), because "they alone are concerned with an object so pure and simple that they make no assumptions that experience might render uncertain" (AT X, p. 365). Though experiences bring the possibility of error, Descartes explicitly states that arithmetic and geometry are not the only sciences worth studying. In order to form "true and sound judgments" about *any* object, and not just about "pure and simple" objects, we must find some way of avoiding error.

According to Descartes, errors are avoided if we "investigate what we can clearly and evidently intuit or deduce with certainty, and not what other people have thought or what we ourselves conjecture" (AT X, p. 366). Here Descartes warns against the dangers of accepting traditional views or conjecturing unclear theories: old ideas and conjectures are usually "wrapped up in various obscurities" (AT X, p. 366). This is a clear reference to the practice of the schools at his time. According to Descartes, in order to "arrive at a knowledge of things with no fear of being mistaken", only two "actions of the intellect" are accepted: "intuition and deduction" (AT X, p. 368). Intuition, then, replaces the problematic experience, understood as "the fluctuating testimony of the senses or the deceptive judgment of the imagination" (AT X, p. 368).

However, intuitions are not intended to purify the method from any experiential element whatsoever. Intuitions must replace obscure and uncertain objects: experience *per se* is not obscure and uncertain. In Rule Six, Descartes affirms that we can intuit "pure and simple natures" either "in our sensory experience or by means of a light innate within us" (AT X, p. 383). The examples of intuitions given in the *Regulae* (such as, for instance, "a triangle is bounded by just three lines" (AT X, p. 368), or "2 plus 2 make 4" (AT X, p. 369)) should not mislead us into thinking

[2] References to the works of Descartes are given in parentheses in the text, following Adam & Tannery (1965/1975), abbreviated AT, with the volume number followed by the page number. The English translations were taken from Cottingham *et al.* (1985); except for the translations of *Les Météores*, taken from Olscamp (1965).

that intuitions concern only objects grasped by the pure intellect. It is important to remind here that the first part of the *Regulae* is not specifically concerned with "imperfectly understood problems". The examples in the third part, were it ever written, would probably be of a different sort. In Rule Four, Descartes remarks that "figures and numbers" are used as examples because "no other disciplines can yield illustrations as evident and certain as these", and also because they are "easier to present to the human mind" (AT X, p. 374). Descartes then adds that his main concern is not ordinary mathematics, and that "these illustrations are more its outer garments than its inner parts" (AT X, p. 374). His main concern, he states, is the "primary rudiments of human reason and extends to the discovery of truths in any field whatsoever" (AT X, p. 374). Therefore, the one-sided diet of examples in the first part of the *Regulae* seems only to serve a heuristic function, but it does not imply that all intuitions must be about the "pure and simple" objects of arithmetic and geometry.

In order to articulate intuitions and deductions in the right way, a method is needed. Rule Five states that we shall first "reduce complicated and obscure propositions step by step to simpler ones, and then, starting with the intuition of the simplest ones of all, try to ascend through the same steps to a knowledge of all the rest" (AT X, p. 379). This two-stage process has a reductive step (from more complex to simpler things) and a constructive step (from the simplest things back to the more complex ones). The reduction must be done carefully, so that no part of the more complex thing is omitted. That is why Rule Seven requires a "sufficient and well-ordered enumeration" (AT X, p. 387). Ideally, the reductive step will reach the simplest things, or things that we can intuit. The constructive step then starts and deductively moves from intuitions back to the complex things to be explained. As the reductive step advances, systematic enumerations will guarantee that the complex *explananda* is fully analyzed in the simpler *explanans*. Since each reductive step is made in a well-ordered way, with "sufficient enumerations", each particular inference will be evident and a matter of intuition. Even "when our knowledge of something is not reducible to simple intuition", we can still be confident in the reductions already made (AT X, p. 389).

In Rule Twelve, Descartes sums up the method and extracts some general lessons. He states that all human faculties (intellect, imagination, sense-perception, and memory) can be put to work both to provide intuitions and to combine and compare them in various ways. In order to reduce complex things to simpler ones:

> certain assumptions must be made [...] which perhaps not everyone will accept. But even if they are thought to be no more real than the imaginary circles which astronomers use to describe the phenomena they study, this matters little, provided they help us to pick out the kind of apprehension of any given thing that may be true and to distinguish it from the kind that may be false. (AT X, p. 417)

The method is very open: different sources of intuitions are accepted, and all human powers can be used to manipulate the various pieces of the puzzle. Even

assumptions and ingenious models (such as the astronomers' imaginary circles) can be used, provided that they illuminate some complex and obscure matter. When characterizing what is ruled out by the method, Descartes mentions the following attitude:

> whenever some difficulty is proposed for investigation, almost everyone gets stuck right at the outset, uncertain as to which thoughts he ought to concentrate his mind on, yet quite convinced that he ought to seek some new kind of entity previously unknown to him. (AT X, p. 427)

He illustrates this attitude with the investigation of the "nature of the magnet": the difficulty of the topic leads people "away from everything that is evident" (AT X, p. 427), and in search of some novel and mysterious entity. Instead of doing that, Descartes recommends the following procedure: first, "gather together all the available observations [*experimenta*] concerning the stone in question"; then, from the observations, try to articulate some "sort of mixture of simple natures" that is "necessary for producing all the effects which the magnet is found to have" (AT X, p. 427). Once this "mixture" is discovered, the inquirer "is in a position to make the bold claim that he has grasped the nature of the magnet, so far as it is humanly possible to discover it on the basis of given observations" (AT X, p. 427). No constraints are imposed on how the "mixture" can be achieved. The only requirement is that the elements in the mixture must all be simpler than the ones being explained (ideally, they should be objects of intuition). As far as the *Regulae* goes, the explanatory model (or the "mixture") can be a bold hypothesis combining simple natures in some ingenious way. The method only says that the elements of the *explanans* must be simpler than the *explananda*, and that all observed phenomena must be clearly deduced from the proposed model.

The correspondence between the two-stage method of the *Regulae*, that was roughly presented above, and the brief exposition of the four rules in Part Two of the *Discours* is quite straightforward. The first rule in the *Discours* requires that judgments only include what presents itself to the mind "so clearly and so distinctly that I had no occasion to doubt it" (AT VI, p. 18). The "clear and distinct" ideas correspond to the objects of intuitions in the *Regulae*. The second rule requires that we "divide each of the difficulties [...] into as many parts as possible and as may be required in order to resolve them better" (AT VI, p. 18). This is, of course, the reductive step. The third rule concerns the constructive step: "beginning with the simplest and most easily known objects", we "ascend little by little, step by step, to knowledge of the most complex" (AT VI, p. 18). Finally, the fourth rule stresses the importance of complete enumerations, so that one "could be sure of leaving nothing out" (AT VI, p. 19). We can safely conclude that, when Descartes explicitly addresses his method in the *Discours*, he simply summarizes the main ideas in the *Regulae*.

Although it is widely accepted that the way in which the method is presented in the *Discours* is not substantially different from the rules in the *Regulae*, Hatfield

(1988) and Garber (1988) have argued that the superficial similarity is not enough to show the continuity of his method throughout this period. They argue that this part of the *Discours* (Part Two) may be an autobiographical account of the author's thoughts when he was working on the *Regulae*; or, maybe, Descartes was unaware of the relevant changes that his scientific method had undergone, and so he referred to some old ideas that could hardly express his views at that time. This initially implausible claim, they believe, is justified by various incompatibilities between the *Regulae* and most of the scientific practice found in the essays published with the *Discours*. The *Regulae*, they claim, is also incompatible with Descartes' later works on the foundations of physics and on scientific matters.

Indeed, the method seems not to be fully developed in the few hints available in the *Discours*. In a letter to Mersenne from 1637 (when the *Discours* was first published), Descartes remarks that he only discussed some general points of the method, but the method itself "is concerned more with practice than with theory" (AT I, p. 349). He called the other essays published with the *Discours* the "*Essais de cette Méthode*", and claimed that the essays "show how much it [the method] is worth" (AT I, p. 349). Following the author's own recommendation, Garber (1988) and Hatfield (1988) investigate Descartes' scientific practice and conclude that the essays do not use the method sketched in the *Discours* and presented in the *Regulae*.

In the next section, I take a closer look at Descartes' scientific practice and argue, contrary to Garber and Hatfield, that his practice *is* compatible with the *Discours* and the *Regulae*.

3. Descartes' scientific practice

I examine now how Descartes' method is translated into practice. Some of his most celebrated scientific studies will be analyzed, so that his explicit remarks about the method can be compared with his actual practice.

In Rule Eight of the *Regulae*, Descartes gives as an example of his method the optical investigation of the "anaclastic line", which is "the line from which parallel rays are so refracted that they intersect at a single point" (AT X, p. 394). The problem here consists in determining this line. First of all, he refers to Rule Three and warns that the answer here should neither be searched in the philosophers nor should it be derived from unguided experiences or obscure conjectures. Descartes claims that "it is possible to have experiential knowledge which is certain only of things which are entirely simple and absolute" (AT X, p. 394), and that is the kind of objects that he will accept in his explanation. Observations of the relevant phenomena show that "the ratio between the angles of incidence and the angles of refraction depends upon the changes in these angles brought about by differences in the media" (AT X, p. 394). The initial problem is then reduced to a simpler one concerning the laws of reflection and refraction. This simpler problem, in turn:

> depends on the manner in which a ray passes through the entire transparent body, and the knowledge of this process presupposes also the knowledge of the nature of the action of light. (AT X, p. 394)

Finally, in order to understand the latter process, one "must know what a natural power in general is" (AT X, p. 395). This last step ends the reductive process.

According to his method, the simplest question we have reached must be answered by intuitions (or by some mixture of intuitions). In order to intuit what natural power in general is, or what the nature of light is, we should be guided, in accordance with Rule Seven, by exhaustive enumerations of other natural powers and by analogies between them. When an appropriate mixture of intuitions is reached, we can then turn to the constructive step: "he [the inquirer] will, in accordance with Rule Five, retrace his course through the same steps" (AT X, p. 395). The answer of the most complex problem (or the determination of the anaclastic line) will then be deduced from the mixture of intuitions.

Descartes' practice in the *Dioptrique* and in the *Monde, ou Traité de la Lumière* follow, or so I argue, the method outlined above.[3] The first topic of the *Dioptrique* concerns the nature of light and the laws of optics.[4] This investigation partially overlaps with the project in *Le Monde*. In the beginning of the *Dioptrique,* Descartes says that he will use some:

> comparisons in order to facilitate that conception of light which seems most suitable for explaining all those of its properties that we know through experience [*expérience*] and then for deducing all the others that we cannot observe so easily. (AT VI, p. 83)

The comparisons with ordinary observed phenomena suggest hypothetical models that are constructed out of clearly grasped objects. It is important to notice that the hypotheses here are not the obscure conjectures that he rejected in Rule Three of the *Regulae*: the hypotheses are guided by observations (*expérience*), and they are based on clearly understood objects. As in Rule Twelve of the *Regulae*, where Descartes refers to the "imaginary circles" posited by astronomers, in the *Dioptrique* he invokes the same comparison and says that he is:

> imitating the astronomers, whose suppositions are almost all false or uncertain, but who nevertheless draw many very true and certain consequences from them because they are related to various observations they have made. (AT VI, p. 83)

The hypothetical models are explanatory, in accordance with Rule Twelve, because they are based on intuitions, and also because all relevant phenomena can be deduced from them.

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[3] The project of *Le Monde, ou Traité de la Lumière* was abandoned in 1633, when Descartes decided not to publish it due to the condemnation of Galileo.

[4] The other topics, that will not be discussed here, concern the human vision and its improvement.

Consider the following question: what explains the behavior of light? In the *Dioptrique*, Descartes hypothesizes that light is "nothing other than a certain movement, or very rapid and lively action, which passes to our eyes through the medium of the air and other transparent bodies" (AT VI, p. 84). The strategy here is to extend the intuitions we have about the movement of macroscopic bodies to the behavior of light. If this assumption is true, the same laws of nature that explain the behavior of the various bodies that we can see can also be used to explain the behavior of light.

In *Le Monde,* he draws an analogy with something that we have a clear intuition of:

> when you swing a stone in a sling, not only does it fly straight out as soon as it leaves the sling, but also while it is in the sling it presses against the middle of it and causes the cord to stretch. This makes it obvious that it always has a tendency to go in straight line and that it goes in a circle only under constraint. (AT XI, p. 44)

The tendency of the stone in a sling to recede from the center point is compared with light, which is understood as a certain tendency to motion caused by luminous bodies. This analogy, combined with some others, is also used to explain the rectilinear propagation of light.

When investigating the nature of light, Descartes uses another analogy to explain the fact that it is propagated instantaneously.[5] In the *Dioptrique,* he says that light may "pass from the heavens to the earth in the same way" as "the movement or resistance of the bodies encountered by a blind man passes to his hand by means of his stick" (AT VI, p. 84). This analogy also suggests that "there is no need to suppose that something material passes from objects to our eyes to make us see colors and light" (AT VI, p. 85). Nothing passes through the blind man's stick: analogously, there is no subtle matter that passes from the heavens to the earth. This analogy suggests a model of light as instantaneous propagation of movement.

As showed in the examples above, Descartes' investigations in optics make massive use of mechanistic analogies. These analogies are based on everyday experiences that we can intuit. Based on these intuitions, some explanatory models are constructed. The models combine the intuitive elements in such a way that the observed phenomena can finally be deduced from them.

The best illustration of Descartes' method in the *Dioptrique* is the demonstration of the laws of reflection and refraction by means of a series of analogies with the behavior of a tennis ball. In Figure 1 below, the ball rebounds at an angle off a hard surface. The surface of the ground "stops its further passage and causes it to be deflected" (AT VI, p. 93). Given the two forces driving the ball to the ground and

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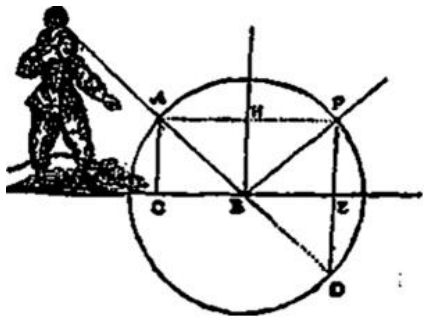
[5] Descartes says first that light is a "very rapid" movement, but later he explicitly claims that the propagation of light is "instantaneous". Given his analogies, this claim strikes me as quite surprising. However, I don't investigate this point any further, since I am concerned here solely with the way in which analogies are used to formulate explanatory hypotheses.

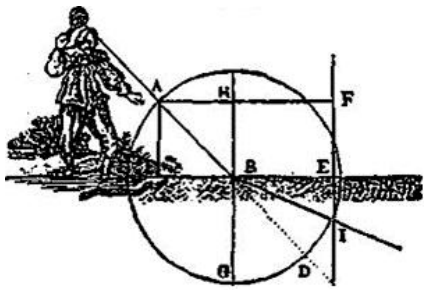
to the right, and assumed that the total speed of the ball is unaffected by reflection, Descartes concludes that the angle of incidence equals the angle of reflection. This is the law of reflection, already known by the ancient Greeks.[6]

Figure 1



Descartes then replaces the hard surface with a "linen sheet [...] which is so thin and finely woven that the ball has enough force to puncture it and pass right through, losing only some of its speed" (AT VI, p. 97) as depicted in Figure 2 below. The speed of the ball, after passing through the linen, will be partly determined by the resistance of the medium. By analogy, Descartes formulates the law of refraction, that explains how "the ratio between the angles of incidence and the angles of refraction depends upon the changes in these angles brought about by differences in the media" (AT X, p. 394). In the *Regulae,* the problem of determining the anaclastic line was reduced to the problem concerning the laws of reflection and refraction. Therefore, the anaclastic line can now be deduced from these laws and the constants determined by the resistance of the media involved. In this case, intuitions about bouncing balls motivate an explanatory model that, in the end, deductively explains the relevant phenomena. Descartes' investigations in optics, I conclude, seem fully compatible with the method described in the *Regulae.*

Figure 2



[6] See McDonough (forth.) for a more detailed exposition of this investigation and other studies of Descartes in optics.

The investigations in the *Météores* follow the same pattern. A mechanistic model is proposed, in which all bodies are composed of minute, differently shaped particles which, however joined, still have tiny spaces between them that are filled with a "subtle matter" moving at great speeds that vary under different circumstances. The hypothesis here seems quite contrived, but each element used in its formulation can be clearly grasped: material bodies, with different sizes and shapes, moving from one place to another in various speeds. In a letter from 1638 to Morin, he remarks that:

> in the analogies which I employ, I compare movements only with other movements, or shapes with other shapes; that is, I compare things that are too small to be perceived by the senses with other things that can be so perceived, the latter differing from the former simply as a large circle differs from a small one. (AT II, pp. 367-368)

The model constructed in the *Météores* mixes small versions of clearly observed things. When the appropriate "mixture" is formulated, it is used to explain the sensations of heat and cold, as well as most meteorological phenomena.

Consider now the famous account of the rainbow, in the eighth discourse of the *Météores*.[7] First, it is observed that rainbows are formed "whenever there are many drops of water in the air illuminated by the sun" (AT VI, p. 325). This leads Descartes to the hypothesis that rainbows result "merely from the way that the rays of light act against those drops, and from there tend toward our eyes" (AT VI, p. 325). Since drops are very small to be properly observed, he used "a perfectly round and transparent large flask with water" and prisms as substitutes of actual raindrops. By means of these analogies, Descartes explains the main features of the rainbow: its colors, the fact that it is composed of two regions separated by a dark space, and the fact that its lower and upper extremes are most brightly and sharply defined. The initial question (what causes the rainbow?) is reduced to questions concerning the reflection and refraction of light, which were already answered in the *Dioptrique*. Based on the analogies and on the already known laws of optics, an explanatory model is proposed and the phenomenon of rainbow, with all its features, is deduced from the model. From the nature of light, the way it passes through media, and the laws of reflection and refraction, it follows that the rays of sunlight hitting a multitude of raindrops will result in a rainbow. Once again, I conclude, Descartes' scientific practice nicely displays the method presented in the *Regulae*.

As summarized by Clarke (1998, p. 275), "it would hardly be an exaggeration to say that Descartes' whole scientific project is one of imaginatively constructing descriptions of the motions of particles which might explain natural phenomena and our experience of them". The *Regulae* and the *Discours*, as far as I can see, are

[7] In a letter to Vatier, from 1638, Descartes says that his account of the rainbow gives "a brief sample" of his method (AT I, p. 559).

not only compatible with this procedure, but they even suggest that this is the method envisioned by Descartes all along.

4. The continuity of the method

Garber (1988, 1998) claims that Descartes' method was abandoned in his later works (or, if you prefer, it was radically modified). According to Garber (1988), the *Discours* and the essays published with it are hybrid texts, mixing old and new ideas. Descartes hardly mentions his method after the *Discours,* and Garber (1988, p. 233) credits this fact to his change from a "mere problem solver" to a "system-builder". Descartes' mature work, which is sketched in Parts IV and V of the *Discours* (1637), and developed later in the *Meditationes de prima philosophia* (1641) and in the *Principia philosophiae* (1644), start from indubitable general principles that progress step by step to more particular matters. According to Garber, the two-stage process was abandoned because the system-building project had no place for the reductive step. Garber (1998, p. 239) also claims that while in the *Regulae* knowledge about the external world is grounded in immediately grasped intuitions, in the later works the grounding is ultimately in metaphysics, or in the existence of a non-deceiver God that guarantees our perceptual intuitions.

Hatfield (1988) also defends that the method of the *Regulae* was abandoned around the time Descartes published the *Discours.* According to Hatfield, the main reason of this change is the fact that when investigating the metaphysical foundations of physics, Descartes realized that his hope of an explanation of physical matters deduced *a priori* from solid bases was hopeless. Descartes:

> came to recognize the legitimacy and importance of conjectural hypotheses in particular areas of physics, and to acknowledge that, in deciding among competing hypotheses, absolute certainty could not be expected. (Hatfield 1988, p. 250)

The necessity of lowering the certainty in physics, he claims, led Descartes to abandon the idea of a single method encompassing metaphysics and the whole of physics. In metaphysics he kept absolute certainty; but in physics uncertain hypotheses became accepted. The "myth" of a unique method only arises, he argues, when:

> the epistemological project of the *Discours* and the *Meditationes* is read back into the *Regulae*, thereby creating an illusion of programmatic continuity which implicitly supports the thesis of methodological continuity. (Hatfield 1988, p. 251)

In the early 1630's, the conjectural positing of microstructures came to fore in Descartes' scientific explanations. Though he realized that the details of physics could not be strictly deduced *a priori* from general principles, he continued to use the term "deduce", which acquired, according to Hatfield, a broader sense: it refers

later to the relation between first principles and mechanistic explanatory models. According to Hatfield (1988), Descartes' earlier methodological conceptions are no longer applicable to his mechanistic explanations.

The arguments presented by Garber and Hatfield are unconvincing for many reasons. In a letter to Vatier from 1638, Descartes remarked that "I could not demonstrate the use of this method in the three treatises which I gave [*Dioptrique*, *Météores*, and *Géometrie*], because it prescribes an order of research which is quite different from the one I thought proper for exposition" (AT I, p. 559). This comment suggests that his "system-building" style was a mere form of exposition. In the scientific works analyzed above, the fact that he started by presenting hypothetical constructions does not imply that he had not, in the order of discovery, first reduced complex problems to simpler ones, with the help of observations. The reductive step, we can presume, eventually reached a position in which intuitions (or analogies) could step in and be organized in explanatory models. When presenting the achievements of a certain research, Descartes prefers to show the constructive step, starting from hypotheses and analogies; but that stylistic preference does not show that the two-stage process of the *Regulae* was abandoned in his scientific practice.

The more we reduce complex problems, the closer we get to intuitions. But the link between intuitions and problems to be answered may not be self-evident. In order to grasp how they are linked, intuitions must be organized in some way. In order to do that, all human powers can be used. At this stage, hypotheses are welcomed. Clarke remarks that the "imperceptibility of the kinds of causes which are involved and the mechanisms by which they operate implies that a Cartesian scientific explanation must be hypothetical" (Clarke 1998, p. 260).

In this sense, hypotheses are needed to organize intuitions. It is no surprise that the scientific studies analyzed above make overt use of hypotheses.

Hypotheses, however, should not be confused with guesswork. In Part Six of the *Discours,* Descartes considers the difficulty of selecting the right model, and states that he knows "no other means to discover this than by seeking further observations whose outcomes vary according to which of these ways provides the correct explanation" (AT VI, p. 65). This passage suggests that crucial experiments can help deciding among competing hypothetical models. He also says that "regarding observations [*expériences*], [...] the further we advance in our knowledge, the more necessary they become" (AT VI, p. 63). Since hypotheses are particularly needed when more complex problems are investigated, the increasingly need of observations seems to come from the crucial experiments that are increasingly needed to guide the selection of hypotheses. In a letter to Morin from 1638, Descartes argues that:

> although there are truly many effects to which it is easy to match different causes, with one cause for each effect, it is nevertheless not so easy to fit one single cause to many different effects, if it is not in fact the true cause which produces them. (AT II, p. 199)

All these passages suggest that Descartes believed that the troublesome uncertainty of hypotheses could be eliminated by a variety of different factors.

I fail to see any textual evidence in Descartes' corpus suggesting that hypothetical models cannot be used in scientific explanations. The *Regulae* suggests an important role for the "mixtures" of intuitions. The *Discours* discusses how models can be selected. In the *Principia Philosophiae,* Descartes says that "if a cause allows all the phenomena to be clearly deduced from it, then it is virtually impossible that it should not be true", and he adds that it would be unjust with God to "imply that God had endowed us with such an imperfect nature that even the proper use of our powers of reasoning allowed us to go wrong" (AT IXB, p. 99). In a letter to Mersenne from 1638, Descartes remarks that:

> if people say that they do not accept what I have written because I have deduced it from assumptions which are not proved, then they do not understand what they are asking, nor what they ought to ask for. (AT II, pp. 141-142)

The practical examples that Descartes himself gives to illustrate his method also make explicit use of hypotheses (the anaclastic line, the behavior of light, the rainbow). Therefore, the claim that the use of hypotheses contradicts Descartes' method strikes me as ungrounded.

The *Regulae* is also much more flexible concerning certainty than Hatfield (1988) seems to believe. How much certainty is required from the sciences in the *Regulae*? The very organization of the *Regulae* distinguishes "perfectly understood problems" from "imperfectly understood problems". The method must be general enough to cover both kinds of problems. Metaphysics, like geometry and arithmetic, may deal with "perfectly understood problems". These disciplines, according to Descartes, are "free from any taint of falsity or uncertainty" (AT X, p. 364). But the method in the *Regulae* is not restricted to these disciplines. In Rule Twelve, when Descartes mentions the "nature of the magnet" (which is one of the few examples of "imperfectly understood problems" given in the existing parts of the *Regulae*), he says that, by following his method (which consists in finding out a certain "mixture" of well-known objects from which the relevant phenomena can be deduced):

> he [the inquirer] is in a position to make the bold claim that he has grasped the nature of the magnet, *so far as it is humanly possible to discover it on the basis of given observations*. (AT X, p. 427; emphasis mine)

This passage suggests that not every knowledge must meet the standard of absolute certainty. If the *Regulae* does not require absolute certainty, and if hypotheses are not ruled out *per se* (being actually suggested in many passages, as well as explicitly used in practice), I fail to see how Hatfield's arguments can get off the ground.

A fully developed argumentation against Garber and Hatfield would also require a closer investigation of Descartes' later works (mainly Parts IV and V of the *Discours*, the *Meditationes,* and the *Principia*). However, I won't do it here. Their

misinterpretation of the *Regulae* and of Descartes' scientific practice, I believe, is enough to make my point that their views start off in the wrong track.

I finish this section raising some other concerns about their claim that the metaphysical argumentation in Descartes' later works marks a rupture with the method of the *Regulae.* Hatfield (1988, p. 255) remarks that there are no hints of the hyperbolic doubt of the *Meditationes* in the *Regulae.* The *Regulae,* in opposition to the *Meditationes*, is happy to accept any intuitively evident thing. However, contrary to Hatfield's argument, I believe that this does not reveal any deep methodological discontinuity. The metaphysical investigation aims at proving that ordinary sensory intuitions are reliable (or that physics is grounded). If the metaphysical project wants to show why certain intuitions are reliable, any appeal to these very intuitions at stake would be clearly circular. Metaphysics is, therefore, a peculiar domain. The standards of certainty in this domain cannot be simply extended to any other area as a general methodological principle. Moreover, in his metaphysical investigations, Descartes does not reject the senses altogether. In the *Meditationes*, the meditator concludes that "I do not think that everything that I seem to get from my senses should simply be accepted, but then I don't think that everything should be rendered doubtful either" (AT VII, p. 78). The "teachings of nature", which include the beliefs that appear to arise spontaneously with sensations, can be trusted as being for the most part true, even in the *Meditationes.* Only when investigating some specific matters these "teachings of nature" cannot be accepted. But that should not be surprising in any "perfectly understood problem", appeals to ordinary sensory intuitions are misplaced. To try to answer a geometrical problem by appealing to intuitions derived from the senses would be equally mistaken.

The *Regulae* is neutral on what counts as an appropriate intuition for a given discipline. It only claims, in general, that intuitions are used to explain more complex matters. As far as this general claim goes, Descartes' metaphysical investigations are perfectly compatible with the *Regulae*. Moreover, since the *cogito* and the proof of the existence of a God who does not deceive are intended to provide the foundations of physics, and such foundations are provided by showing that our ordinary intuitions about the world are reliable, then it follows that the metaphysical argumentation actually presupposes that ordinary sensory intuitions are essential to physical investigations. Metaphysics does not compete with physics: instead, metaphysics tries to show why physics is possible.

Metaphysics differs from physics in the same way in which geometry differs from physics. These differences reflect the nature of their objects and the problems being studied. However, the method in the *Regulae* is general enough to include all disciplines, with their various objects, problems, and peculiarities. The minimal character of Descartes' method allows different sciences to have different standards of certainty and to accept different kinds of intuitions.

5. Conclusive remarks

What is, after all, ruled out by Descartes' method? The minimal interpretation adopted here risks trivializing the method altogether. I sum up now the main lessons of the method, according to my minimal interpretation: (1) complex problems must be reduced to simpler ones (reductive step); (2) the answer to the simpler problems must not include obscure objects or conjectures; (3) the answer to the simplest problems will be based on evident intuitions (that may be organized in hypothetical explanatory models); (4) finally, the more complex problems are deductively explained by the intuitions (constructive step). As far as it goes, the method is neutral about what counts as a legitimate intuition for a given particular discipline. It is also permissive about what kinds of hypothetical models are permitted: the only requirement is that the materials used in these models must not include obscure notions.

These rules, though apparently vague and excessively general, are illuminating. What Descartes wants to avoid with his method is the practice of the schools. In the *Discours*, for instance, he says that his method allowed him to discover "a practical philosophy which might replace the speculative philosophy taught in the schools" (AT VI, pp. 61-62). The main target of his method is the practice of explaining the obscure by the more obscure (*obscurum per obscurius*). The scholastic explanation, according to Descartes, is a mere redescription, in an esoteric language, of *explanada*. In a letter to Huygens from 1638, he gives an example of a pseudo-explanation from the schools: "light is a proportional medium between substance and accident" (AT II, p. 51). Explanations like that, as noticed by Clarke (2003, p. 26), are not just obscure and complicated: they are absolutely uninformative (they "tell us nothing"). The whole method envisioned by Descartes aims at rejecting explanations like that. The reductive step aims at avoiding the obscurity of complex problems. But that is not enough. The answer to the simpler questions must also be free of obscure notions. The deepest lesson of the method is that we should explain what is confused by what is clearly grasped. The last step of the reduction will involve evident ideas, or intuitions, so that the whole explanation will be as clear and as certain as any human explanation can be. Descartes may be unclear about what counts as intuition, and how intuitions can be put together and linked to the problems to be solved, but he is fairly clear about what he wants to avoid.

Are the rules of his method obvious? Maybe now they are. But in Descartes' time, they were revolutionary. Not so much because of their explicit content, which may sound commonsensical and uninteresting. As Descartes says, his method "is concerned more with practice than with theory" (AT I, p. 349). In theory, it may look like a bunch of platitudes. But when it is put to work, the method leads to unprecedented discoveries.

The method is, I claim, nothing more than general guidelines for the sciences. These guidelines are apparently obvious, but if we take them seriously and do not

deviate from them, we will be able to discover, according to Descartes, everything that can be humanly discovered. What Descartes means by method is, therefore, very minimal: a set of seemingly obvious recommendations. In this sense, the few hints presented in Part Two of the *Discours* are, in fact, a good summary of what the method is all about. This minimal method can be detected in the whole scientific practice of Descartes, as well as in his remarks about his investigations. Contrary to Garber and Hatfield, I argued that Descartes' practice is perfectly compatible with his own characterization of the method in the *Discours* and the *Regulae*. That is, or so I argued, the reason why Descartes drives our attention to his practice: it is much more informative. His practice can show in more detail how the general guidelines of his method are followed and how they can lead to great discoveries. His method never changed substantially, and that is why he found no problem in publishing his old ideas ten years later in the *Discours*. The varying aspects of his researches do not concern the method *per se*, as Descartes understands it, but are various ways of dealing with specific difficulties in different disciplines. Though minimal, the method guides a whole transformation on the very notion of what an explanation should be like. In this sense, Descartes' minimal method is far from uninteresting, and that is why he regarded it so highly.

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