Descartes is usually classed among the rationalists, those philosophers who privilege reason over experience. And indeed he belongs there. On the other hand, though, Descartes was also very interested in experiment. The *Dioptrique* and *Météores* make a number of references to Descartes’ experiments; the *Discours* discusses the importance of experiments at some length. In the *Principia*, written starting in early 1641 and published in 1644, Descartes refers to a number of experimental results to support his views, most visibly in the discussion of the magnet. And at the end of that book, he goes so far as to suggest that his vision of the world is ultimately supported by the fact that it is capable of explaining observed phenomena, and nothing more. Where is the real Descartes? Is he mathematician or experimenter? rationalist or empiricist?

This is the larger question that I would like to explore in this essay. But I would like to address it in a rather particular and somewhat special way. Generally, discussions of Descartes’ views about knowledge and experience concentrate on texts like the *Meditations*, and on issues concerned with knowledge of the kinds of grand questions that he takes up there, the knowledge of self, body, the distinction between mind and body, God, and so on. What I want to focus on is something much more mundane. The water we drink every day has a nature, from which follow certain well-known properties; water is wet and liquid at room temperature, solid when very cold, quenches thirst, admits light, but causes certain illusions, like the famous bent-stick illusion. All of this is somehow connected with its structure. The question I want to address is this: how did Descartes think that we could know the internal
structures, the natures of particular things like water and wine, gold and wood?

To appreciate Descartes’ problem here we must make a few background remarks. The view about individual natures that Descartes and his contemporaries learned in school was straightforwardly based on Aristotelian principles. According to Aristotle, water (maybe not the water we encounter in everyday life, but *pure* water) is an element, defined by a particular substantial form. That form, joined to bare matter, gives water the characteristic properties that it has. And so, on this view, water is just the kind of stuff that *by its nature* tends to be cold, wet, and liquid, that tends *by its nature* to fall below the sphere of air and above that of earth, to name two others of the Aristotelian elements; these are just its innate tendencies to behavior. And that is all the explanation that one can give, period. Mixtures of the elements and their properties add considerable complexity to the question. But even then, the idea that things have natures, substantial forms that give them innate tendencies to exhibit the manifest properties they do is basic to the Aristotelian scheme of things.

But Descartes and his mechanist friends take another view altogether. According to Descartes, all body is of the *same* nature; everything in the physical world is extended substance, and its tendencies to behavior are defined by the laws of motion. Descartes writes in the *Principia*:

> The matter existing in the entire universe is thus one and the same, and it is always recognized as matter simply in virtue of its being extended. All the properties which we clearly perceive in it are reducible to its divisibility and consequent mobility in respect of its parts, and its resulting capacity to be affected in all the ways which we perceive as being derivable from the movement of the parts.¹

How then are we to explain the special properties water has? As Descartes suggests, we can only appeal to “its divisibility and consequent mobility in respect of its parts”. That is, the special properties this water has can only be explained in terms of the size, shape, and motion of the tiny parts that make it up. Different samples of water presumably have a common structure of smaller bodies, corpuscles, whose

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characteristic size, shape, and motion give it its characteristically observed properties. Let us call this particular nature its “corpuscular substructure.”

This, then, is the problem I would like to explore in Descartes. For the scholastic scientist, the characteristic properties of a thing derive from a form, often a hidden form, an occult quality. For Descartes, there are no such occult qualities. But there are hidden natures, corpuscular substructures that are hidden from our view. How can they be found?

There are actually a number of questions here that we might separate. First of all, how do we discover these hidden mechanisms? And having conjectured a particular candidate for a corpuscular substructure, how do we justify the claim that we have found the correct one? And in this argument, I want to ask, what role does experience and/or experiment play? And finally, what are the limits of certainty with respect to our knowledge and belief in the corpuscular substructures of particular kinds of things?

In order to answer these questions, we must, I shall argue, distinguish the positions that Descartes takes at different times in his career. And so, we shall proceed chronologically. First we shall examine the views Descartes seems to have had in mid-1630s, when he was completing his first works for publication, the Discours and the accompanying Essais. Then we shall turn to his views a few years later, in the early 1640s, composing the Principia. Despite appearances, there is, I shall argue, a radical change between Descartes’ views at the one time and the other. Descartes, I shall claim, moves from the position that we can have genuine certain knowledge of the corpuscular substructure, to the rather different view that our conjectures about corpuscular substructures are at best devices that enable us to predict future experience, and in that way prolong our lives.

1. Knowledge of Particulars in the Discours and Essais

First, then, let us turn to Descartes in the period of the Discours and Essais. The most extensive discussion of the issues connected with knowledge of particulars takes place in Part VI of the Discours, where Descartes goes to some length to talk about the need for experiments, and argues that his program could progress only if he had sufficient funds for doing experiments. (Even 350 years ago, scientists had to beg for the money they needed to keep up their laboratories!) The passage
begins with a lengthy account of where experiment is not really necessary. Descartes reports that he began his investigations with “the first principles or first causes” of everything, which can be discovered from “certain seeds of truth which are naturally in our souls.” From this Descartes derived “the first and most ordinary effects that one can deduce from these causes,” the heavens, stars, the earth, water, air, fire, etc. The passage then continues as follows, and addresses more directly how it is that we can come to know the corpuscular substructures that underlie the greatest part of the particulars we know from everyday experience:

Then when I wanted to descend to those which were more particular, I was presented with so many different kinds of things that I did not think that it was possible for the human mind to distinguish the forms or kinds of bodies which are on the earth from an infinity of others that could have been there, if God had wanted to put them there, nor, consequently, to make them useful to us, unless one proceeded to the causes through their effects, and attended to many particular experiments.2

It is not easy to interpret this passage. But it is not surprising that this is often read as endorsing a certain conception of how we can know the natures of particular things by way of what we might call hypothetical argument.3

What I call hypothetical argument is suggested later in the Discours where Descartes discusses a curious feature of the Météores and Dioptrique. In both of these treatises, Descartes begins by making certain “suppositions,” assumptions or hypotheses about the nature of light, the make-up of water, oils, etc., from which he then derives various features of the world. In the Météores, for example, Descartes writes, in a chapter entitled De la nature des cors terrestres:

2 AT VI 64.
I assume that the small particles of which water is composed are long, smooth, and slippery like little eels, which are such that however they join and interlace, they are never thereby so knotted or hooked together that they cannot easily be separated; and on the other hand, I assume that nearly all particles of earth, as well as of air and most other bodies, have very irregular and rough shapes, so that they need be only slightly intertwined in order to become hooked and bound to each other, as are the various branches of bushes that grow together in a hedgerow.⁴

In a slightly later passage in *Discours* VI, Descartes writes about these suppositions as follows:

Should anyone be shocked at first by some of the statements I make at the beginning of the *Dioptrique* and the *Météores*, because I call them “suppositions” and do not seem to care about proving them, let him have the patience to read the whole book attentively, and I trust that he will be satisfied. For I take my reasonings to be so closely interconnected that just as the last are proved by the first, which are their causes, so the first are proved by the last, which are their effects. . . . For as experience makes most of these effects [i.e., observed phenomena] quite certain, the causes from which I deduce them serve not so much to prove them as to explain them; indeed, quite to the contrary, it is the causes which are proved by the effects.⁵

To say that the causes are “proved by effects,” as Descartes does, suggests very strongly the causes conjectured are established as true by the fact that they are capable of explaining the observed phenomena. There are many other passages from this period, both in the published texts and in the letters that suggest much the same. But the view comes out most clearly in the writings of one of Descartes’ followers, the French physicist Jacques Rohault. Writing in his *Traité de physique* of 1671, only a bit more than 20 years after Descartes’ death, he gives his version of the proper way of building a natural philosophy:

In order to find out what the Nature of any Thing is, we are to search for some one Particular in it, that will account for all the Effects which Experience shows us it is capable of producing. Thus, if we would know what the Heat of the Fire is, we must endeavour to find out some particular Thing, by means of which, it is capable of producing in us that Sort of Tickling, or pleasant agreeable Heat which we feel at a little distance from it. . . . In a word, it must explain all the Effects that Fire produces. . . . What is now said of Heat, may be applied to all other Things: And by this Rule, every Thing hereafter

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⁴ AT VI 233.
⁵ AT VI 76; cf. AT II 141–144, 199–200; AT VI 334.
is to be examined, If that which we fix upon, to explain the particular Nature
of any Thing, does not account clearly and plainly for every Property of that
Thing, or if it be evidently contradicted by any one Experiment; then we are
to look upon our Conjecture as false; but if it perfectly agrees with all the
Properties of the Thing, then we may esteem it well grounded, and it may
pass for very probable.6

This illustrates what I earlier called hypothetical argument. An hypo-
thetical argument for some conclusion proceeds as follows. We are
trying to explain some feature of the physical world, say fire and its
heat. We first conjecture a structure of smaller particles in motion; this
is the hypothesis about the nature of the fire that is under considera-
tion. We might hypothesize, for example, that fire is made up of small,
dagger-shaped corpuscles that move very, very fast. This hypothesis is
then tested against experience; if it is capable of explaining all experi-
ments that we can make on fire, and clearly contradicts none, then the
conjecture is esteemed “well grounded, and it may pass for very prob-
able.” For example, we may imagine that the pain we experience when
putting a finger in the fire is explained by the dagger-like shape and
motion of the particles that make up the fire. But if a conjecture “be
evidently contradicted by any one Experiment; then we are to look
upon our Conjecture as false,” says Rohault.

But, I must insist, it is quite wrong to attribute this view to Descartes
in the period of the *Discours*. Immediately after the above quoted
passage, Descartes writes:

> And I have called them “suppositions” simply to make it known that I think
> that I can deduce them from the primary truths I have expounded above;
> but I have deliberately avoided carrying out these deductions in order to
> prevent certain ingenious persons from taking the opportunity to construct,
> on what they believe to be my principles, some extravagant philosophy for
> which I shall be blamed.7

But if it is not the procedure of hypothetical argument that Descartes
is espousing here, then what is it? And how does his evident interest
in experiment fit in, if it isn’t an hypothetical argument that is at
issue here? What kind of deduction does Descartes have in mind
here?

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6 J. Rohault, *A System of Natural Philosophy, Illustrated with Dr. Samuel Clarke’s Notes . . . Done into
7 AT VI 76; cf. AT I 563; AT II 200; AT III 39.
Let me begin with a brief example from an earlier work, the *Regulae ad Directionem Ingenii*. The assumption behind the method Descartes presents in that book is that real knowledge, knowledge worthy of the name, derives from intuition and deduction. Intuition is a faculty we have by virtue of which we are capable of grasping truths directly; deduction is a complementary faculty, by virtue of which we can intuit the connections between one proposition and another.\(^8\) Descartes’ method in the *Regulae* consists of a reduction, followed by an intuition, followed by a construction, that is, a deduction of the answer to the question originally posed, starting from the intuition that we have attained.\(^9\) This is what we might call the appeal to intuition and deduction, or, more simply, the appeal to intuition, as distinct from the sort of hypothetical argument I noted earlier. If Descartes is right, then all knowledge is derived by deduction from intuition.

In the text of Rule 8 Descartes gives an example of his celebrated method.\(^10\) The question at issue is the shape of a particular lens, one that is capable of focusing parallel rays to a single point. The reduction starts with the question posed, the shape of the lens in question, and leads us back from that by posing a series of presupposed questions. In order to determine the shape of the lens in question, we must determine the law of refraction, i.e., the law that governs the bending of light. But in order to determine that, we must determine the way light is altered when it passes from one medium to another. But to determine that we must determine how light passes through a medium. Ultimately, we are led back to the question of the nature of a natural power. Intuiting the answer to that question, we then pass back the other way, intuiting from the nature of a natural power the answers to such questions as the nature of light, the way it passes through a medium, and ultimately, the law of refraction and the shape of the lens in question.

Although he is not terribly explicit about it, I think that this procedure is what is behind the view in the *Discours* and the *Essais*. This comes out reasonably clearly in Descartes’ treatment of the rainbow in the eighth discourse of the *Météores*.\(^11\) There also it is more evident just how

\(^8\) See *Regula* III, AT X 366 ff.
\(^9\) See *Regula* V and VI, AT X 379 ff.
\(^10\) See AT X 393 ff.
important experiment is to Descartes. The problem posed is the explanation in corpuscular terms of the phenomenon of the rainbow. Descartes begins with the experimental and observational fact that the rainbow consists of two bows of color that are always at a characteristic angle with respect to sunlight, 42 and 52 degrees, to be exact. Experiment is then appealed to, again, to reduce the question, the cause of the observed phenomena, to simpler questions. For example, the fact that color can be produced in a prism shows that the cause of color has nothing to do with a curved surface, and arises when light passes from one medium into another; in this way, the question of the genesis of color is “reduced” to the question as to how light is changed in passing from one medium to another. One proceeds in this way until reaching something about which one has direct intuitive knowledge, in this case the nature of a natural power. The causal explanation is completed when one can do a derivation of the observed phenomena from the intuition of the most general principles, using the causal paths suggested by the auxiliary experiments and observations that constitute the reduction (“from the way in which light changes when passing from one medium to another, it follows that color is . . .”); the derivation of the phenomena from the most general causes then displays the causal explanation.¹² In this case, Descartes uses this kind of procedure to establish, with certainty, presumably, the corpuscular substructure that constitutes the rainbow: it is an arrangement of water droplets of appropriate size and arrangement to reflect and refract the incoming sunlight and cause the bands of color that we see in the sky.

This obviously uses experiment, like hypothetical argument, and like hypothetical argument, the point seems to be to fit a hypothesis to the phenomena. But there are important differences. First of all, the microstructure of the rainbow is not hypothesized to fit the phenomena; it is derived making use of the phenomena. At no point in the procedure does one make a hypothesis; when properly used, observation is supposed to lead us directly to the underlying mechanism. But more important, unlike hypothetical argument, the phenomena have no validity independent of the causal explanation proposed. Descartes’ account of the rainbow begins with an observation about the characteristic angles of the two bows that make up the rainbow; at the end of the argument, these angles are derived from his causal account. Descartes remarks, though, that other observers have observed differ-

ent values for these angles. His comment is very significant: “This shows how little faith one should have in observations that are not accompanied by the true reason.”\textsuperscript{13} It is only after we give an explanation, a derivation of the phenomena from first principles that the phenomena enter the realm of genuine facts, despite the fact that it was the observed phenomena that started the process in the first place. Observation and experiment may pose problems for us, and may suggest causal paths for their explanation, but they are not facts until they are successfully deduced from first principles. This is a use of experiment, to be sure, but not an hypothetical argument. Experience is used rather in the way in which we use diagrams in geometry. We can carefully draw diagrams on paper, carefully measure sides, angles, and arcs, and hypothesize relationships. But it is only the actual proof of a theorem that establishes anything as true.

But why didn’t Descartes want to make the direct appeal to intuition more visibly than he did in the \textit{Discours} and \textit{Essais}? Why did he think it necessary to use hypothetical argument if it was intuition that he really preferred?

Let me remind you of a passage I cited earlier. Referring to the suppositions he actually used in the \textit{Météores} and the \textit{Dioptrique}, Descartes writes:

\begin{quote}
And I have called them “suppositions” simply to make it known that I think that I can deduce them from the primary truths I have expounded above; but I have deliberately avoided carrying out these deductions in order to prevent certain ingenious persons from taking the opportunity to construct, on what they believe to be my principles, some extravagant philosophy for which I shall be blamed.\textsuperscript{14}
\end{quote}

Now it is clear enough how the appeal to intuition involves us in the foundations of Descartes’ philosophy; the intuitions that he leads us to will reveal the very foundations of his natural philosophy, the nature of body, the nature of a natural power, the nature of light, etc. But why would he want to hide that? Why shouldn’t he, on the contrary, want to proclaim his new ideas to the world in the most public way?

To understand why not, we must put ourselves back into Descartes’ shoes in the mid-1630s. Descartes knew that matters were somewhat delicate as far as he was concerned. He knew that his philosophy was in contradiction with the official Aristotelian philosophy, taught both

\textsuperscript{13} AT VI 340. \textsuperscript{14} AT VI 76.
at Catholic universities, like the University of Paris, and at Protestant schools, like the University of Utrecht. That didn’t seem to bother him when he wrote *Le Monde* in the early 1630s, explicitly attacking the sterility of the Aristotelian orthodoxy, indeed, even mocking the Aristotelian definition of motion! But Descartes was seriously taken aback by the condemnation of Galileo in 1633. He withdrew *Le Monde*, and, indeed, renounced any ambitions to publish his thought. That did not last long, though, and within a short time, Descartes was making plans for a new publication, the *Discours* and *Essais*. But there was to be a crucial difference between *Le Monde* and this later work. *Le Monde* told all, and gave the foundations of Descartes’ thought, which made it clear that he rejected forms and qualities, and placed the sun at the center of the planetary system, making the earth just another planet. But in the *Discours* and *Essais*, all of this was to be hidden. In writing the *Essais*, Descartes hoped only to “choose some topics which would not be too controversial, which would not force me to divulge more of my principles than I wished to, and which would demonstrate clearly enough what I could or could not do in the science.”

In the mid- and late 1630s, then, we have a rather clear answer to the questions posed about the knowledge of particulars. While it may be hypothetical argument that Descartes chooses for presenting his conclusions in his published works, it is really the appeal to intuition that is close to his heart. Intuition, the immediate apprehension of truth, and its coordinate faculty, deduction, lead us to a comprehension of the particular nature, the corpuscular substructure that is the ground of the manifest properties of things. While experiment comes in, it is just an auxiliary to the intuition and deduction. Reason would seem to reign, with experiment in the subordinate position of a trusted advisor, at best.

Or so it would seem. But all is not well. The intuition that is at the core of Descartes’ solution to the problem of particular natures and corpuscular substructures at this time is profoundly mysterious. Can we really intuit the nature of a natural power? The nature of light? Understanding deduction in the strict sense Descartes intends, can we really deduce from these things that we are supposed to know the way in which color arises in the rainbow from the passage of light from one medium to another? As attractive as the view in the *Regulae* and *Discours*

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15 AT VI 75. For a fuller account of the story, see D. Garber, *Descartes’ Metaphysical Physics*, chapter 1.
may seem to be at first glance, I find it ultimately very unsatisfying. Though it promises to reveal the hidden nature of things, to make occult qualities and hidden mechanisms manifest, the process by which such hidden natures and mechanisms are supposed to be revealed, the intuition and deduction to which Descartes appeals are themselves hidden and occult in the extreme. This is particularly so when applied to the knowledge of particular natures. And, I suspect, Descartes himself came to realize that as well.

2. Knowledge of Particulars in the *Principia Philosophiae*

Now I would like to turn away from the period of the *Discours* and *Essais*, and toward the later period, in the early 1640s, when Descartes was working on his *Principia Philosophiae*. From the very title it is evident that he had set aside his earlier scruples, and had decided that he would present his whole system, his true views grounded in their proper metaphysical foundations. The *Discours* had been published, as had the *Meditations*, and the sky had not fallen on Descartes’ head. So, he judged, it was the time to reveal all. And so, in the *Principia* Descartes begins with his first philosophy (Part I), proceeding from there to the general part of his physics (Part II), including the nature of body, motion, and the laws of motion, before descending to particulars in the final two parts, cosmology and the heavens (Part III) and terrestrial physics (Part IV). In the *Principia*, especially the final two parts, Descartes is very much concerned with the nature of particulars, their corpuscular substructures, and offers a number of specific analyses. But, we might ask, how does he claim to have knowledge of such particular natures and corpuscular substructures?

There is reason to believe that Descartes was still, in a way, attracted by the appeal to intuition that we saw displayed in the case of the lens from the *Regulae* or the rainbow example in the *Météores*, and still somewhat suspicious of hypothetical argument, at least as a preferred way of establishing his conclusions. For example, in the opening sections of Part III, Descartes presents a variety of astronomical phenomena to consider. Before presenting them, though, he writes:

Our purpose is not to use these phenomena as the basis for proving anything [*ad aliquid probandum*], for we aim to deduce an account of effects from their causes, not to deduce an account of causes from their effects. The intention is simply to direct our mind to a consideration of some effects rather than
others from among the countless effects which we take to be producible from
the selfsame causes.\textsuperscript{16}

Similarly, in the middle of Part IV, Descartes presents an account of
the nature and corpuscular substructure of the magnet. Some sections
after presenting his account of the magnet, he gives a list of thirty-four
phenomena that he thinks can be explained by his theory. This list of
experimental facts is preceded by the following remarks:

All these things [i.e., the previously presented account of the nature of the
magnet] follow from the principles of Nature expounded above, in such a
way that even if I were not considering those magnetic properties which I
have undertaken to explain here [i.e., the experimental phenomena that he
is about to present], I nonetheless would not judge these things to be other-
wise. However, we shall see that with their help [i.e., the help of the account
of the magnet, iron, etc., that which follows from his principles] a reason for
all those properties is furnished so clearly and perfectly that this fact also
would seem sufficient to convince us of the truth of these things, even if we
did not know that they followed from the principles of Nature.\textsuperscript{17}

Descartes here does admit that the properties of the magnet discov-
ered by experiment certainly do support the account he earlier gave of
the nature of the magnet on other grounds, and had he not had such
a priori grounds, the experimental fit would have sufficed. As in the
\textit{Discours} and \textit{Essais}, it does seem as if hypothetical argument is, at best,
a second-best form of argument, and, one might suppose, the appeal
to intuition is to be preferred.

But I think things are more complex than that. Indeed, there is very
good reason to believe that in the \textit{Principia}, Descartes ends by com-
mitting himself to the very sort of hypothetical argument that he so
clearly rejected in his earlier writings.

Descartes turns to the question of the knowledge of particular
natures and corpuscular substructure at the very end of the book, in
Part IV. Descartes reminds us that on his view, bodies are made up of
small particles, corpuscles too small for us to see. “Who can doubt,” he
writes, “that there are many bodies so minute that we do not detect
them by any of our senses?”\textsuperscript{18} But, as Descartes realizes, this raises an
important epistemological question: “In view of the fact that I assign
determinate shapes, sizes, and motions to the imperceptible particles
of bodies just as if I had seen them, but nonetheless maintain that they
cannot be perceived, some people may be led to ask how I know what

\textsuperscript{16} \textit{Principia}, III 4. \textsuperscript{17} Ibid. IV 145. \textsuperscript{18} Ibid. IV 201.
these particles are like.”19 His answer is this (at least in the Latin edition of 1644, a bit expanded in the French edition of 1647):

First of all I took the simplest and best-known principles, knowledge of which is naturally implanted in our minds; and working from these I considered, in general terms, first, what are the principal differences which can exist between the sizes, shapes, and positions of bodies which are imperceptible by the senses merely because of their small size, and second, what observable effects would result from their various interactions. Later on, when I observed just such effects in objects that can be perceived by the senses, I judged that they in fact arose from just such an interaction of bodies that cannot be perceived — especially since it seemed impossible to think up any other explanation for them.20

The view seems quite clearly to be what I called hypothetical argument earlier. We begin by conjecturing an hypothetical substructure that, we hope, explains the phenomena. For example, we suppose that water is made of eel-shaped particles of a particular size and shape, or that earth is made up of branch-shaped particles that interconnect with one another. From the conjectured structure we then derive observational consequences, consequences which are compared against experience. To the extent, then, that the observable consequences tally against what we actually observe in the world, the conjectured structure, the conjectured cause, is “proved by the effects.” After a brief exposition of what would appear to be hypothetical argument, Descartes adds a further refinement of this:

But we shall know that we have determined such causes correctly afterwards, when we notice that they serve to explain not only the effects which we were originally looking at, but all these other phenomena, which we were not thinking of beforehand.21

In this way, the proof is stronger to the extent that the effects explained were not known at the time that the hypothesis was first put forward.

Descartes also notes the way in which he came to formulate the hypotheses that he puts to the test. He writes:

In this matter I was greatly helped by considering artifacts. For I do not recognize any difference between artifacts and natural bodies except that the operations of artifacts are for the most part performed by mechanisms which are large enough to be easily perceivable by the senses. . . . The effects

19 Ibid. IV 203.  20 Ibid. IV 203.  21 Ibid. III 42.
produced in nature, by contrast, almost always depend on structures which are so minute that they completely elude our senses.22

And so, Descartes proposes:

No one who uses his reason will, I think, deny the advantage of using what happens in large bodies, as perceived by our senses, as a model [exemplum] for our ideas about what happens in tiny bodies which elude our senses merely because of their small size.23

Putting all these considerations together, the procedure seems to be this, in the end. We begin with our experience of everyday things in the world, machines of various sorts, perhaps bushes whose branches become entangled, grapes in vats, eels in buckets. On the basis of this experience we conjecture possible substructures to explain the behavior of things. For example, we might conjecture that the particles of earth are branched like bushes, to explain why it is that earth coheres in solid clumps, or that water is made up of eel-shaped particles that can easily pass over one another, to explain why water is liquid. We then derive new observable phenomena from our conjectured structure. If the consequences so derived are actually observed, then the conjecture is proved, or, at least, made credible.

So far so good. But while Descartes seems reasonably clear about the new way of finding knowledge of these substructures, he is not so clear about the status of such knowledge. How certain can we be of particular natures discovered and “proved” in this way? Here there seems to be at least some ambivalence in Descartes’ view.

At one extreme, Descartes seems on at least one occasion to suggest that this procedure gives us genuinely certain knowledge of the inner structure of things. He writes:

*It could scarcely happen that a cause from which all phenomena can clearly be deduced might be false.* . . . We would seem to be doing God an injustice if we suspected that the causes of things discovered in this way were false, as if He had given us such an imperfect nature that we could be deceived by reason, even when we were using it properly.24

22 Ibid. IV 203. 23 Ibid. IV 201.
24 Ibid. III 43. This is a very strong reading of this passage. The words omitted in the quotation in the text are as follows: “Suppose, then, that we use only principles which we see to be utterly evident, and that all our subsequent deductions follow by mathematical reasoning.” . . . This suggests that Descartes may have intended to make the somewhat weaker point that if we begin with intuition, and proceed by deduction, then we are entitled to certainty.
Sometimes, though, Descartes suggests more modestly that while we may lack the absolute certainty we have in God, mathematics, and the distinction between mind and body, we still have what he calls moral certainty about the conjectured corpuscular substructure of particular things. He writes:

It would be disingenuous, however, not to point out that some things are considered as morally certain, that is, as having sufficient certainty for application to ordinary life, even though they may be uncertain in relation to the absolute power of God.\textsuperscript{25}

Descartes then goes on to compare our situation with respect to the hidden natures of particular things with the person trying to decode a letter. If by replacing some letters with others in an orderly way, someone can turn the text into one that makes sense,

he will be in no doubt that the true meaning of the letter is contained in these words. It is true that his knowledge is based merely on a conjecture, and it is conceivable that the writer [intended] a different message; but this possibility is so unlikely . . . that it doesn’t seem credible.\textsuperscript{26}

What Descartes is talking about here is not just the corpuscular substructures of particular things, but also the general principles on which they are based. But his remarks here would seem to hold true for the particular substructures that Descartes is positing in the \textit{Principia}.

Elsewhere still in the \textit{Principia} Descartes takes a step beyond even moral certainty when he suggests that the particular natures he posits may well be false, however useful they may be as a guide to life. He writes:

\textit{With regard to the things which cannot be perceived by the senses, it is enough to explain their possible nature, even though their actual nature may be different. However, although we can understand how all the things in nature could have arisen in this way, it should not therefore be inferred that they were in fact made in this way. Just as the same craftsman could make two clocks which tell the time equally well and look completely alike from the outside but have completely different assemblies of wheels inside, so the supreme craftsman of the real world could have produced all that we see in several different ways . . . I shall think that I have achieved enough provided only that what I have written is such as to correspond accurately with all the phenomena of nature. [French version: We shall achieve our aim irrespective of whether these

\textsuperscript{25} Ibid. IV 205. \textsuperscript{26} Ibid.
imagined causes are true or false, since the result is taken to be no different, as far as the observable effects are concerned.] This will indeed be sufficient for application to ordinary life, since medicine and mechanics, and all the other arts which can be fully developed with the help of physics are directed only toward items that can be perceived by the senses and are therefore to be counted among the phenomena of nature.27

Similarly, Descartes writes that he wants the causes he sets out to be mere hypotheses, whose truth is irrelevant. Even if one of his hypotheses is taken to be false, he writes,

I think that I shall have achieved something sufficiently worthwhile if everything deduced from it agrees with our observations; for if this is so, we shall see that our hypothesis yields just as much practical benefit for our lives as we would have derived from knowledge of the actual truth.28

Indeed, he then goes on to make a hypothesis that he knows to be false, that God created the world not as is set out in *Genesis*, but in an initial state of chaos, from which everything we see around us follows out by way of the laws of nature alone.29 This is not the first time that Descartes has said such things. In the beginning of the *Dioptrique*, when setting out the “suppositions” that he will use in the course of that work, Descartes notes:

In this I am imitating the astronomers, whose assumptions 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.30

Like the astronomers, he argues, what counts is the ability to predict new phenomena, and not the truth of the hypothesis. In 1637 this was only to justify using hypothetical argument as a provisional mode of exposition, a way of presenting the results of Descartes’ physics without having to present its foundations. But in 1644 Descartes seems to be saying that this is all we can expect from his physics as far as knowledge of particulars is concerned, conjectures that we have every reason to believe may well be false, but which are useful in the prediction of phenomena. What is extremely interesting here is Descartes’ rather cavalier attitude toward truth when it comes to the corpuscular sub-

27 Ibid. IV 204, Latin version with French variant inserted.
28 Ibid. III 44.
29 See ibid., III 45.
30 AT VI 83; for other discussions of the use of false or questionable hypotheses among the astronomers, see AT VII 349; AT X 417; AT II 198–99.
structures and particular natures that he is discussing: It simply does not matter if the conjectures are false, as long as they agree with the phenomena of experiment and observation. What is important for Descartes is now simply that the consequences of his conjectured particular natures agree with experience. For if they do, then whether true or false, they can be used to predict future experience, and in that way serve as reliable guides to life. In this way we can say that for Descartes, experience doesn’t confirm the truth of conjectures about the corpuscular substructure, but their reliability as predictors of future experience.

The claim that the beliefs about corpuscular substructure arrived at through hypothetical argument are only morally certain, or even false is highly significant. In his very early Regulae, Descartes was quite certain that anything less than absolutely certain knowledge was simply not worth having. In Rule 1 he declares that “the aim of our studies should be to direct the mind with a view to forming true and sound judgments about whatever comes before it.” Rule 2 is even more demanding: “We should attend only to those objects of which our minds seem capable of having certain and indubitable cognition.”31 This strict view of what we as investigators are seeking is, I think, reflected in the official view of the Discours and Essais. Descartes’ insistence that he is using hypothetical argument only as a convenient way of presenting his view without divulging its full foundations, and his at least implicit claim that his conclusions really come from intuition and deduction is, I think, connected with this earlier commitment to certainty; Descartes, I think, was under the illusion that his appeal to intuition yielded certain knowledge of the inner nature of things. But Descartes is clear that whatever its virtues, hypothetical argument does not yield certainty, and in endorsing it in the Principia, he is clearly changing his view in a very significant way.

Indeed, in treating our knowledge of the inner structure of things in the way in which he does, as arguing that it provides us not with certainty but only with a guide to life, Descartes is placing our knowledge of the inner nature of things at an epistemological level no higher than that of sensation itself, and perhaps even lower. In the Meditations, Descartes characterizes sensation as follows:

The proper purpose of the sensory perceptions given me by nature is simply to inform the mind of what is beneficial or harmful for the composite of

31 AT X 359, 362.
which the mind is a part; and to this extent they are sufficiently clear and distinct. But I misuse them by treating them as reliable touchstones for immediate judgments about the essential nature of the bodies located outside us; yet this is an area where they provide only very obscure information.\textsuperscript{32}

This, in a way, is the most that we can hope for from our hypotheses about the inner nature of particular things as well, that they will provide us predictions about what to expect in the world, and in that way, help us to survive in this uncertain world; this is just what it means for a belief to have moral certainty. But perhaps even this is too much to expect. Descartes infers from his account of sensation that since it is given to us as a guide of life, we know that it is, in a sense, trustworthy: “I know that in matters regarding the well-being of the body, all my senses report the truth much more frequently than not.”\textsuperscript{33} But we can’t even say this about our conjectures about hidden natures; for all we know they may be genuinely false. Nor does it really matter to us, as long as the phenomena they entail constitute a reliable guide to life. Regarded in this way, the hidden mechanism, the corpuscular substructure, the real nature of a body has become a mere calculating device for predicting future phenomena, and lost the status of even being a candidate for knowledge or ignorance; all that really seems to count are the phenomena.

The progression here is very significant. We began in the early \textit{Regulae} and the later \textit{Discours} with certain knowledge, and progressed in the \textit{Principia} to mere moral certainty and genuine ignorance; from the certainty of intuition to the lesser grade of certainty associated with the senses, good enough for guiding life, but not for finding truth. But, at the same time, we also passed from a certain knowledge of hidden natures, obtained through a hopelessly obscure cognitive process (intuition), to a clear and manifest cognitive process (analogy and hypothetical argument) that claims to give us not truth, but only utility.

Why the change? In defending his use of hypothetical argument, it is important to remember that Descartes can’t appeal to the need to hide his views any more; he has made the decision to go public with the foundations of his physics, and cannot use the need to hide them as a justification for his use of this apparently inferior way of arguing. One can only suppose that Descartes adopts hypothetical argument as
a way of finding particular natures because he genuinely believes that this is the best that he can do. Perhaps he came to appreciate the obscurity of the appeal to intuition, his earlier conception of how corpuscular substructures are to be found, and saw in hypothetical argument the clarity he sought, even if it meant sacrificing certainty. Perhaps in actually working out and defending his views on the inner nature of things, he came to appreciate the sheer complexity of nature, and saw in hypothetical argument a better way of coming to grips with the world. But for whatever reason, Descartes was led to give up his earlier extravagant claims about what we can know and how, in favor of the relatively more modest claims in the *Principia.*