the mind of the errors to which it is subject, we shall give a *general method* for conducting the search after truth.

III. The specific plan of the first book.

We are going to begin by explaining the errors of our senses, or rather the errors into which we fall by not using our senses in the way we should; and we shall deal not so much with particular errors, which are almost infinite, as with the general cause of these errors and the things we take to be necessary for knowing the nature of the human mind.

BOOK ONE: THE SENSES
Chapter Five

The senses. I. Two ways of explaining how our senses are corrupted by sin. II. That it is not our senses, but our freedom that is the real cause of our errors. III. A rule for avoiding error in the use of our senses.

When we carefully consider man's senses and passions, we find them to be so well suited to the end for which they are given us that we cannot agree with those who say that they are entirely corrupted by Original Sin. But in order to ascertain whether our disagreement with them is correct, we need to explain how we might conceive of the order found in the faculties and passions of our first father in his original state, as well as the changes and disorders that befell him after his sin. These matters can be conceived in two ways; here is the first.

I. Two ways of explaining the corruption of the senses by sin.

It seems to be a common notion that for things to be well ordered, the soul should feel pleasure in proportion to the amount of good it enjoys. Pleasure is a natural instinct, or, to speak more clearly, an impression from God Himself directing us toward some good, which impression must be proportionately stronger as the good is greater. According to this principle, it seems that as he was created before his sin, our first father undoubtedly found no more pleasure in the most concrete goods than in others. Since God had created him that he might love Him, and since God was his true good, we can therefore say that God made Himself pleasing to him, that He brought him to His love by a sensation of pleasure, and that, counterbalancing the greatest sensuous pleasures, He gave him interior satisfaction in his duty, which men no longer experience after Original Sin without some special grace.

Nevertheless, as he had a body that God willed he should preserve, and which he regarded as part of himself, God must also have made him experience pleasures through the senses like those we enjoy in the use of things conducive to the preservation of life.

We do not presume to decide whether before his fall the first man was able to avoid having agreeable or disagreeable sensations when the principal part of his brain was set in motion by the use of sensible things. Perhaps he had this power

over himself due to his submission to God, though the contrary seems more probable. For although Adam might have been able to arrest the agitation in the spirits and blood, as well as disturbances in the brain that objects aroused in him (because his body, being in order, was necessarily dominated by his mind), nonetheless it is unlikely that he could have avoided having sensations of objects as long as he had not arrested the motion they produced in the part of his body to which the soul is immediately joined. For the union of soul and body, which consists primarily of a mutual relation between sensations and motion in the organs, would seem to be more arbitrary than natural had Adam been able to sense nothing when the main part of his body received some impression from the bodies surrounding him. Nevertheless, I shall opt for neither of these views.

The first man, then, experienced pleasure in what improved his body, just as he sensed pleasure in what improved his soul; and because he was in a perfect state, he found that of the soul much greater than that of the body. Thus it was infinitely easier for him to preserve his righteousness than it is for us to do so without the grace of Jesus Christ, since without it, we no longer find pleasure in our duty. Yet he unfortunately let himself be seduced, and he lost this righteousness through his disobedience.[a] Thus, the main change he underwent, which produced all the disorder of the senses and passions, was that, as a just punishment, God withdrew from him and no longer willed to be his good, or rather no longer made him feel the pleasure that indicated that He was his good. As a result, the sensible pleasures, which lead only to the goods of the body, were left isolated, no longer counterbalanced by those that heretofore had led him to his true good. The close union he had with God was extremely weakened, and that with his body was greatly increased. Being dominant, sensible pleasure corrupted his heart by attaching it to all sensible objects; and the corruption of his heart darkened his mind by leading it away from the light that had illumined it, and by leading him to judge things only according to the relations they might have to his body.

But at bottom, the change cannot be said to have been very great on the side of the senses. For just as when I have removed one of two balanced weights the other immediately tips the scale to its side without being changed or increased, so after the Fall sensible pleasures lowered the soul toward sensible things because there were lacking those inner *delights* that before the Fall counterbalanced our inclination for the good of the body—but, again, without so great a change on the part of the senses as is commonly supposed.

The second explanation, which seems to me the true one. Here is the second way of explaining the disorders due to sin, which is certainly more reasonable than the one we have just discussed. It is quite different because its principle is different; but yet these two ways are in perfect agreement as far as the senses are concerned.

Being composed of a mind and a body, we have two kinds of goods to look for, those of the mind and those of the body. We also have two ways of recognizing a thing to be good or bad: by employing the mind alone, or by employing the

[a]St. Gregory *Hom. on the Gospels* 39.

mind in conjunction with the body. We can recognize our good through clear and evident knowledge; we can also recognize it through confused sensation. I realize through reason that justice ought to be esteemed; I also know through the sense of taste that a given fruit is good. The beauty of justice is not sensed; the goodness of fruit is not known. The goods of the body do not deserve the attention of a mind, which God made only for Him. The mind, then, must recognize this sort of good without examination, and by the quick and indubitable proof of sensation. Stones do not provide nourishment; the proof of this is convincing, and taste alone produces universal agreement.

I grant, then, that pleasure and pain are the natural and indubitable characteristics of good and evil: but (1) this holds only for those things that, being neither good nor bad by themselves, cannot also be recognized as such through clear and evident knowledge; and (2) this holds only for those things that, being below the mind, can neither reward nor punish it; finally, (3) this holds only for those things that do not merit the mind's attention, and since God does not will that we attend to them, He leads us to these things only by *instinct*, i.e., by pleasant or unpleasant sensations.

But God—who alone is the true good of the mind, who alone is above it, who alone can reward it in a thousand different ways, who alone is worthy of its attention, and who has no fear that those who know Him will not find Him worthy of esteem—He is not content to be loved with a blind and *instinctive* love; He wishes to be loved with an enlightened love, with a love through *choice*.

If the mind saw in bodies only what is really in them, without being aware of what is not in them, it would neither love objects nor make use of them without great pain; thus it is necessary, as it were, that objects should appear to be pleasant by producing sensations they themselves lack. The same is not true of God. One has only to see Him as He is to be brought to love Him, and He need not avail Himself of the instinct of pleasure as a kind of strategem to attract our love without deserving it.

This being so, Adam cannot be said to have been brought to love of God and to his duty by a prevenient pleasure,[a] because his knowledge of God, like that of his good, and the joy he unceasingly felt as a necessary result of the perception of his happiness in being united to God could have sufficed to attract him to his duty and to make him act more meritoriously than if he had been determined, as it were, by some prevenient pleasure. Thus he was fully free. And it is in this state perhaps that Sacred Scripture would have represented him to us with the words: "God made man from the beginning, and having given him His commandments, left him to himself,"[b] that is, without determining him by the enjoyment of some prevenient pleasure, but by keeping him drawn to Him through the clear perception of his good and duty. But to the shame of free will and to the glory of God alone, experience has revealed the weakness that Adam was capable of even in so ordered and happy a state as was his before his sin.

[a]See the *Elucidations* [4].

[b]"Deus ab initio constituit hominem & reliquit illum in manu consilii sui, adjecit mandata & praecepta sua, &c." Eccl. 15:14.

But Adam cannot be said to have been led to seeking out and using sensible things through exact knowledge of the relation they might have had to his body. For in the final analysis, had it been necessary for him to examine the configurations of the parts of some fruit, then those of the parts of his body, and then the resultant relation between them, in order to judge whether, with the present temperature of his blood and the thousand other dispositions of his body, the fruit was nourishing, then clearly things unworthy of its attention would have exhausted his mind's capacity; to do so would have even been useless enough, because he would not have preserved himself for long by this means alone.

Given, then, that Adam's mind was not infinite, no fault will be found in our saying that he did not know all the properties of the bodies surrounding him, since it is certain that these properties are infinite. And if what is undeniable be agreed, that his mind was not made for examining the motion and configurations of matter but to be continually applied to God, we shall not be found amiss in claiming that it would have been a disorder or an irregularity in a time when everything was necessarily perfectly ordered if he had been obliged to turn his mind from the contemplation of the perfections of his true good in order to examine the nature of some fruit with regard to its nutritive value.

Adam, then, had the same senses as we do, by which he was advised of what was necessary for his body, but without being distracted from God. Like us, he sensed pleasures and even pains, or involuntary and prevenient displeasure. But these pleasures and pains could neither enslave him nor make him unhappy, as they do us, because as absolute master of the motions generated in his body, he stopped them, if he so wished, as soon as they had performed their advisory function (and no doubt he always wished to do so with regard to pain). Happy would he, and we, have been had he done the same thing with regard to pleasure, and had he not voluntarily turned himself away from the presence of his God by allowing his mind's capacity to be exhausted by the beauty and anticipated sweetness of the forbidden fruit, or perhaps by the rash joy excited in his soul by the contemplation of his natural perfections, or finally by his natural fondness for his wife and the inordinate fear of displeasing her, all of which apparently contributed to his disobedience.

But after he had sinned, the pleasures that had served only to advise him respectfully, and the pains that, without disturbing his felicity served only to inform him that he might lose it and become unhappy, no longer had the same significance for him. His senses and passions revolted against him; they no longer obeyed his orders, and they enslaved him, as they do us, to sensible things.

Thus, not the senses and passions themselves were generated by sin, but rather only their power of victimizing sinners; and this power is not so much a disorder on the part of the senses as on the part of the mind and will of men, who, having lost the power they had over their bodies, and no longer being so closely united to God, no longer receive from Him that enlightenment and strength by means of which they had preserved their freedom and happiness.

Incidentally, we must conclude from these two ways of explaining the disorders of sin that two things are needed to restore us to order.[a]

First, the weight that burdens us and inclines us toward sensible goods must be cast off by continually avoiding pleasures, by mortifying the sensitivity of our senses through penances, and by circumcision of the heart.

Second, we must ask God for the weight of his grace and for that *prevenient delight*[b] which Jesus Christ has individually merited for us and without which the weight that inclines us toward sensible goods will always, however we might struggle, be a burden and, however light it might be, will inevitably lead us into sin and disorder.

These two things are absolutely necessary to restore us to, and preserve us in, our duty. As can be seen, reason is in perfect agreement with the gospel—both teach us that privation, self-denial, and the diminution of the influence of sin are necessary preparations in order that the influence of God's grace should rectify our situation and unite us with Him.

But though we have in our present state an obligation to struggle continually against our senses, it should not be concluded from this that the senses are altogether corrupted and disordered. For if it be considered that they are given us for the preservation of our body, it will be seen that they fulfill their purpose perfectly well, and that they conduct us in so faithful and appropriate a fashion to their end that it seems wrong to accuse them of being corrupt and disordered. Through pleasure and pain, through agreeable and disagreeable tastes, and by other sensations, they so quickly advise the soul of what ought and ought not to be done for the preservation of life that it cannot correctly be maintained that this order and precision are a consequence of sin.

II. It is not our senses, but the improper use of our freedom that plunges us into error.

Our senses, then, are not as corrupt as might be imagined; rather, it is the most inward part of our soul, our freedom, that has been corrupted. We are deceived not by our senses but by our will, through its precipitous judgments. When, for example, we see light, it is quite certain that we see light; when we feel heat, we are not mistaken in believing that we feel heat, whether before or after the fall. But we are mistaken in judging that the heat we feel is outside the soul that feels it, as we shall explain in the following.

The senses, then, would not plunge us into error if we used our freedom properly and if we did not rely on their reports in order to judge matters too precipitously. But because it is very difficult to avoid this, and because we are almost forced into it due to the close union between our body and soul, I shall indicate the way we ought to use them in order to avoid falling into error.

[a]Remedy for the disorder in the world caused by Original Sin, and the foundation of Christian morality.

[b]See the *Elucidations* [5].

III. A rule for avoiding error in the employment of the senses.

We must follow this rule exactly. *Never judge by means of the senses as to what things are in themselves, but only as to the relation they have to the body* because, in fact, the senses were given to us, not to know the truth of things in themselves, but only for the preservation of our body.

But in order to make a clean breast of the natural inclination toward following the senses in the search after truth, we shall in the following chapters deduce the chief and most general errors into which they plunge us, and then the truth of what has just been claimed will be clearly recognized.

BOOK ONE: THE SENSES
Chapter Six

I. The errors of vision with regard to absolute extension [*étendue en soi*]. *II. The consequence of these errors with regard to invisible objects. III. The errors of vision with regard to relative extension* [*étendue considérée par rapport*].

Of all the senses, vision is the first, the most noble, the most extensive; accordingly, if they were given to us for discovering truth, it would have a greater role by itself than all the others combined. Thus, in order to set ourselves aright and to bring ourselves to a general distrust of all the senses, it will suffice to overthrow the authority our eyes have over our reason.

We shall make it clear, then, (1) that we should rely on the testimony of sight not in order to judge concerning the truth of things in themselves but only to discover the relation they have to the preservation of the body; (2) that our eyes generally deceive us in everything they represent to us: in the size of bodies, in their figure and motion, and in light and colors, which are the only things we see; (3) that all these things are not as they appear to us, that everyone errs regarding them, and that as a result we are plunged into an infinite number of other errors. We begin with extension; the following are the arguments that lead us to believe that our eyes never make us see it just as it is.

I. The errors of vision with regard to absolute extension.

With magnifying glasses, we can easily see animals much smaller than an almost invisible grain of sand;[a] we have seen some even a thousand times smaller. These living atoms walk as well as other animals. Thus, they have legs and feet, and bones in their legs to support them (or rather on their legs, for the skin of an insect is its skeleton). They have muscles to move them, as well as tendons and an infinity of fibers in each muscle; finally, they have blood or very subtle and delicate animal spirits to fill or move these muscles in succession. Without this, it is impossible to conceive how they should live, nourish themselves, and move their tiny bodies from place to place according to the various

[a] *Journal des Sçavans*, 12 Nov. 1668.

impressions of objects—or rather, it is impossible for those who have spent their whole lives in anatomy and the study of nature to imagine the number, diversity, and delicacy of all the parts of which these little bodies are necessarily composed in order to live and carry out the things we see them do.

The imagination boggles at the sight of such an extreme smallness. It can neither arrive at nor grasp these parts that have no handle for it, and although reason convinces us of what has just been said, the senses and the imagination oppose it and often make us doubt it.

Our vision is very limited; but it must not limit its object. The idea it gives us of extension has very narrow limits; but it does not follow from this that extension is so limited. Undoubtedly, it is in a sense unlimited; and this small section of matter, which is hidden from our eyes, can contain an entire world in which would be found as many things, though proportionately smaller, as are found in this larger world we live in.

For the tiny animals of which we have just spoken, there are perhaps other animals that prey upon them and that, on account of their awesome smallness, are to them as imperceptible as they themselves are to us. What a mite is compared with us, these animals are to a mite; and perhaps there are in nature things smaller and smaller to infinity, standing in that extreme proportion of man to mite.

We have clear mathematical demonstrations of the infinite divisibility of matter, and although our imagination is shocked at the thought, this leads us to believe that there might be smaller and smaller animals to infinity. God made matter only to fashion His wonderful creation from it, and since we are certain that there is nothing whose smallness could limit His power of forming these tiny animals, why limit it and thus diminish without reason the idea we have of an infinite craftsman by measuring his power and skill with our finite imagination?

Experimentation has already partially rectified our errors by enabling us to see animals a thousand times smaller than a mite—why would we have them be the last and smallest of all? For my part, I see no reason to imagine it so. On the contrary, it is much more plausible to believe that there are many things yet smaller than those already discovered, for in the final analysis, there are always tiny animals to be found with microscopes, but not always microscopes to find them.

When one examines the seed of a tulip bulb in the dead of winter with a simple *magnifying lens* or convex glass, or even merely with the naked eye, one easily discovers in this seed the leaves that are to become green, those that are to make up the flower or tulip, that tiny triangular part which contains the seed, and the six little columns that surround it at the base of the flower. Thus it cannot be doubted that the seed of a tulip bulb contains an entire tulip.

It is reasonable to believe the same thing of a mustard seed, an apple seed, and generally of the seeds of every sort of tree and plant, though all this might not be seen with the naked eye or even with a microscope; and it can be said with some assurance that all trees are in the seeds of their seeds in miniature.

Nor does it seem unreasonable to believe even that there is an infinite number of trees in a single seed, since it contains not only the tree of which it is the seed but also a great number of other seeds that might contain other trees and other seeds, which will perhaps have on an incomprehensibly small scale other trees and other seeds and so to infinity. So that according to this view, which will appear strange and incongruous only to those who measure the marvels of God's infinite power by the ideas of sense and imagination, it might be said (1) that in a single apple seed there are apple trees, apples, and apple seeds, standing in the proportion of a fully grown tree to the tree in its seed, for an infinite, or nearly infinite number of centuries; (2) that nature's role is only to unfold these tiny trees by providing perceptible growth for that outside its seed, and imperceptible yet very real growth in proportion to their size, for those thought to be in their seed—for it cannot be doubted that there are bodies sufficiently small to get in between the fibers of these trees thought to be in their seed and thus to serve as food for them.

What we have just said about plants and their seeds can be said also of animals and the seeds from which they are produced. An entire tulip is seen in the seed of a tulip bulb. Likewise, a chicken that is perhaps entirely formed is seen in the seed of a fresh egg that has not been hatched.[a] Frogs are to be seen in frogs' eggs, and still other animals will be seen in their seed when we have sufficient skill and experience to discover them.[b] But the mind need not stop with the eyes, for the mind's vision is much more extensive that the body's. We ought to accept, in addition, that the body of every man and beast born till the end of time was perhaps produced at the creation of the world. My thought is that the females of the original animals may have been created along with all those of the same species that they have begotten and that are to be begotten in the future.

This thought might be developed and might get at the truth, but we are justly apprehensive about wanting to enter too deeply into the works of God. In these works, nothing but infinities are found everywhere; and not only are our senses and imagination too limited to comprehend them, but even the mind, as pure and detached from matter as it is, is too coarse and feeble to penetrate the smallest of God's works. It loses itself, is distracted and dazzled, and is afraid at the sight of what according to the language of the senses is called an atom. But the pure mind always has this advantage over the senses and the imagination, that it recognizes its weakness and the greatness of God, and is conscious of the infinity in which it is lost; our senses and imagination, meanwhile, would depreciate God's works and inspire us with a foolish confidence that casts us blindly into error. Our eyes furnish us with none of the ideas of these things that we discover with microscopes or by reason. Through sight we perceive nothing smaller than a mite. Half a mite is nothing if we accept the testimony of vision. As far as vision is

[a]The germ of the egg is under a tiny white spot that is on the yolk. See the *Liv. de formatione pulli in ovo*, by Malpighi.

[b]See the *Miraculum naturae*, by Swammerdam.

concerned, a mite is only a mathematical point. It cannot be divided without being annihilated. Our sight, then, does not represent extension to us as it is in itself, but only as it is in relation to our body; and because half a mite has no significant relation to our body, and can neither preserve nor destroy it, our sight hides it from us entirely.

But if we had eyes constructed like microscopes, or rather, if we were as small as mites, our judgments about the size of bodies would be quite different. For these tiny animals undoubtedly have eyes that can see both what surrounds them and their own body as though much larger, or as composed of a greater number of parts, than we see it, since otherwise they would not receive the impressions necessary for the preservation of their life, and thus the eyes they do have would be entirely useless to them.

But to reassure ourselves about all this, we must realize (1) that our own eyes are in effect only natural spectacles; (2) that their humors have the same effect as the lenses in spectacles; (3) that depending on the distance between them, the shape of the *crystalline lens*, and its distance from the *retina*,[a] we see objects differently. As a result of this, we cannot be certain that there are two men in the world who see objects as having precisely the same size, or as being composed of the same number of parts, since we cannot be certain that their eyes are altogether alike.

All men see objects as having the same size in the sense that they see them as described by the same limits or by equal angles. For they see their edges as straight lines making up a visual angle that is perceptually equal when the objects are seen from an equal distance. But it is not certain that the ideas they have of the size of a given object are equal, because the means they have for judging distance, upon which the size of the idea depends, are not equal. Furthermore, those whose optical nerve fibers are smaller and more delicate are able to notice many more parts in an object than those whose nerve is of a coarser tissue.

Nothing would be easier than a geometrical demonstration of these matters;[b] and if they were not already so well known, we would first stop to prove them. But because several people have already treated of these matters, those who wish to be instructed in them are asked to consult their works.

Since it is not certain that there are two men who view the same object as having the same size, and since sometimes even the same man sees things larger with the left eye than with the right,[c] according to observations reported in the *Giornale de' letterati*, January 1669, it is clear that we must not rely on the testimony of our eyes to make judgments about size. It would be better to listen to reason, which proves to us that we do not know how to determine the absolute size of the bodies surrounding us, or what idea we ought to have of a square foot, or of our own body such that the idea would represent it to us as it is. For reason teaches us that the smallest of all objects would not be small by itself, since it is composed of an infinite number of parts from each one of which God could

[a]This is the optic nerve.

[b]See Descartes's *Dioptrics*.

[c]One of my friends always sees the letters of a book larger with the right eye than with the left.

fashion an earth that would be but a point in comparison to the others taken together. Thus the mind of man is incapable of framing an idea sufficiently great to encompass and comprehend the least extension in the world, since the mind is limited whereas the idea must be infinite.

It is true that the mind can more or less know the relations found among these infinities of which the world is composed, that, for example, one is twice the other, and that a fathom consists of six feet; but nonetheless, it cannot frame for itself an idea representing what these things are in themselves.

Yet I am willing to suppose that the mind is capable of ideas that match or approximate the extension of the bodies we see, for it is difficult enough to persuade men of the contrary. Let us examine, then, what can be concluded from this supposition. It will undoubtedly be concluded that God does not deceive us, that He has not given us eyes like glasses that magnify and diminish objects, and that we must therefore agree that our eyes represent things to us as they are.

It is true that God never deceives us, but we often deceive ourselves by judging things too hastily. For we often judge that the objects of which we have ideas exist, and even that they are altogether like these ideas. But it often turns out that these objects are not at all like our ideas, and even that they do not exist.

From the fact that we have an idea of a thing, it does not follow that the thing exists and still less that it is entirely like our idea of it. From the fact that God provides us with a given sensible idea of size, as when a fathom ruler is before our eyes, it does not follow that the ruler has only that extension represented to us by the idea. For in the first place, not all men have precisely the same sensible idea of the ruler, since not all men's eyes are disposed in the same way. Second, a given person sometimes does not have the same sensible idea of a fathom ruler when he views it with the right eye and then the left, as has already been said. Finally, it often happens that the same person has different ideas of the same objects at different times, according to whether he believes them to be more or less at a distance, as we shall explain elsewhere.

Thus it is a groundless prejudice to believe that we see objects as they are in themselves. For our eyes, which were given us only for the preservation of our body, perform their duty quite well by providing us with ideas of objects proportioned to the idea we have of the size of our body, although there are in these objects an infinite number of parts that they do not disclose to us.

But to understand better what we should judge concerning the extension of bodies on the basis of the testimony of our eyes, let us imagine that from a quantity of matter the volume of a ball God has made a miniature earth and sky, and men upon this earth having the same proportions observed in the larger world. These tiny men would see one another, the parts of their bodies, and even the little animals that might bother them, for otherwise their eyes would be useless for their preservation. It is obvious on this supposition, then, that these tiny men would have ideas of the size of objects quite different from ours, since they would regard their world, which is but a ball to us, as having infinite space, more or less as we judge the world we are in.

Or, if it is easier to conceive, suppose that God created an earth infinitely more vast than the one we inhabit, such that this other earth would stand to ours as ours

stood to the one we were just speaking about in the preceding supposition. In addition to this, let us suppose that God preserved among all the parts composing this other world the same proportion as among the parts composing ours. It is clear that the men of this other world would be larger than the space between our earth and the most distant star we see; this being so, it can be seen that if they had the same ideas of the extension of bodies as we have, they would be unable to discern certain parts of their own body, while they would see certain others as having an enormous bulk. As a result, it is ridiculous to suppose that they see things as having the same size as we see them.

It is obvious from these two suppositions we have just made that the men of the larger or smaller world would have ideas of the size of bodies quite different from our own, given that their eyes provide them with ideas of the objects surrounding them proportionate to the size of their own bodies. But if these men relied heavily on the testimony of their eyes that objects are such as they see them, it is clear that they would be mistaken; nobody can doubt this. Nonetheless, these men would certainly have as much reason as we to defend their opinion. Let us learn, then, by their example that we are quite uncertain as to the true size of the bodies we see, and that all we can know of size through sight is the relation between theirs and ours, a relation by no means exact—in a word, that our eyes were not given us to judge the truth of things, but only to let us know which things might inconvenience us or be of some use to us.

[*II. Continuation of the errors of sight with regard to things not under its jurisdiction* <This title found in first edition only>.]

Men, however, trust their eyes in judging not only about visible objects but also about objects that are invisible. As soon as they do not see certain things, they conclude that they do not exist, thus attributing to sight powers of penetration to some extent infinite. This is what prevents them from recognizing the true causes of an infinity of natural effects; for if they relate these effects to imaginary qualities and faculties, it is often because they do not see the real ones, which are a matter of the different configurations of these bodies.

For example, they do not see the particles of air and of flame, still less those of light or of other matter yet more subtle, and this leads them to believe that they do not exist or to judge that they are inert. They fall back on occult qualities or imaginary faculties to explain all the effects of which these imperceptible particles are the natural cause.

To explain the elevation of water in pumps, they prefer to resort to the horror of the void, rather than to the weight of air. They resort to qualities of the moon, rather than to the pressure of the air surrounding the earth in order to explain the tides, and to forces of *attraction* in the sun, rather than to the impulses caused by the particles of subtle matter it continuously diffuses, in order to explain the rising of vapors.

They consider it incongruous that the movement of animals as well as the habits and corporeal memory of men can be explained through appeal to blood and flesh alone. This derives in part from their conception of the brain as very

small and consequently as incapable of preserving the traces of the almost infinite number of things found there. They prefer to recognize, without understanding it, a soul in beasts that would be neither mind nor body, as well as qualities and intentional species for the memory and habits of men, or other such things of which they have no specific notion at all in mind.

It would take too long to enumerate the errors into which this prejudice leads us; there are very few errors in physics that it has not occasioned, and the results of some serious thought on this matter would perhaps be astonishing.

Although we do not wish to delay too long over these matters, we can hardly ignore the disdain men ordinarily have for insects and other tiny animals produced from matter they call corrupt. The disdain is inappropriate and is founded only on ignorance of the thing they disdain as well as on the prejudice just mentioned. Nothing in nature is despicable, and all the works of God deserve to be respected and admired, especially if one notices the simplicity of the ways in which God makes and preserves them. The tiniest gnats are as perfect as the largest of animals. The proportion of their members is as correct as that of other animals, and it even seems as though God has willed to bejewel them in compensation for their lack of size. They have crowns, plumes, and other attire upon their heads against which anything invented by the riches of men must pale; and I can assert with confidence that those who have used only their eyes have never seen anything so beautiful, so fitting, or even so magnificent in the houses of the greatest princes as what can be seen with magnifying glasses on the head of a simple fly. Man, for example, has only one crystalline lens in each eye, the fly has more than a thousand—but arranged with a marvelous order and precision.

It is true that these things are quite small, but this makes it even more surprising that so much beauty is found concentrated in so small a space; although they are quite common, these animals are nonetheless remarkable, and they are no less perfect in themselves—rather, on their account God appears more admirable, God who in producing them in such numbers and with so much magnificence performed an almost infinite number of miracles.

Yet vision hides all these beautiful things from us; it makes us scorn these works of God so worthy of our admiration; and because these animals are small in relation to our bodies, we are led to view them as absolutely small, and consequently as despicable because of their smallness, as if bodies could be small in themselves.

Let us try, then, not to follow sense impressions in judgments we make about the size of bodies; and when we say, for example, that a bird is small, let us not understand this absolutely, for nothing is either large or small in itself. Even a bird is large in relation to a fly, and if it is small in relation to our bodies, it does not follow that it is so absolutely, since the body is not an absolute standard against which one should measure other things. The body is itself quite small in relation to the earth, and the earth quite small in relation to the circle that the sun or the earth describes about the other, and this circle in relation to the space between us and the fixed stars, and so on, for we can always imagine greater and greater spaces to infinity.

III. The error of our eyes concerning the extension of bodies in relation to each other.

It must not be imagined, however, that our senses correctly inform us of the relation that other bodies have to our own, for exactitude and precision are not essential to sense knowledge, which need serve only for the preservation of life. It is true that we know with sufficient precision the relation that bodies close to us have to our own body, but the further they are from us the less we know them, because they then have less of a relation to our body. The idea or sensation of size we have upon viewing some object diminishes as that object is less in a position to harm us, and the idea or sensation increases as the object approaches us, or rather as its relation to our body increases. Finally, if this relation ceases altogether, that is, if an object is so small or so distant from us that it cannot harm us, we no longer have any sensation of it at all. As a result, we can sometimes judge through sight the approximate relation bodies have to our own as well as among themselves; but we must never believe that they have the size they seem to us to have.

Our eyes represent the sun and the moon, for example, as having a diameter of a foot or two, but we must not imagine, as did Epicurus and Lucretius, that they are really of this size. According to our perception of it, the same moon appears to us much larger than the largest of stars, yet no one doubts that it is incomparably smaller. We likewise see daily on the earth two or more things whose size or relation we are unable to determine precisely, because in order to judge their size, their exact distance must be known, and this is very difficult to determine.

We can hardly even judge with any certainty about the relation between two bodies quite close to us; they must be picked up and held against each other for a comparison, and even then we often hesitate, being sure of nothing. This can be clearly seen in examining the size of coins that are almost equal; here we must place them on top of each other to see with assurance whether they correspond in size. If a line is drawn on paper and another is drawn at its end perpendicular and equal to it, they will appear roughly equal. But if the perpendicular is drawn at its middle, the perpendicular will appear perceptibly longer, and the closer to the middle it is drawn the longer it will appear. The same experiment can be performed with two straws, so that to know if they are equal, or which is longer, they must be laid one upon the other, as is ordinarily done. Our eyes, therefore, deceive us not only with regard to the size of bodies in themselves but also with regard to the relation bodies have among themselves.

Note

Those who are ignorant of the eye's structure and the principles of its construction would do well to read the appendix found at the end of this work before reading this chapter.

BOOK ONE: THE SENSES
Chapter Seven

I. The errors of our eyes concerning figures. II. We have no knowledge of the smallest ones. III. That the knowledge we have of larger figures is inexact. IV. Explanation of certain natural judgments by which we avoid error. V. That even these judgments mislead us in certain instances.

I. The errors of sight concerning figures.

Our sight is less liable to mislead us when representing figures to us than when representing anything else, because figure in itself is nothing absolute, and because its nature consists in the relation between the limits of some space and a given straight line, or a point conceived of as in that space, which might be termed, as in the case of a circle, the center of that figure. Nevertheless, we are mistaken in a thousand ways about figures, and we never know any of them with complete precision through the senses.

II. That we have no knowledge of the smallest figures.

We have just proved that our sight does not reveal to us every sort of extension but only that which has some significant relation to our body, and that for this reason, we do not see each part of the smallest animals nor those parts that make up both solid and liquid bodies. Thus, unable to perceive these parts on account of their size, we consequently cannot perceive their figures, since the figure of a body is but its limiting boundary. Here we already have an almost infinite number of figures, the greatest part of which remain unnoticed by our eyes, which even lead the mind, relying too much on their capacity and not investigating things carefully enough, to believe that these figures do not exist.

III. That the knowledge we have of larger figures is inexact.

We can approximate the figures of bodies proportioned to our vision, which are quite few in comparison with all the rest, but their figures cannot be known exactly through the senses. Through sight we cannot even ascertain whether a circle and a square, the simplest of figures, are not in fact an ellipse and a parallelogram, although these figures might be in our hands and very close to our eyes.

Furthermore, we cannot determine exactly whether a line is straight or not, especially if it is of some length—for that a ruler is required. But what am I saying? We do not know whether the ruler itself is as we suppose it ought to be, and we have no way of being entirely certain on the matter. Nevertheless, without knowledge of the line, we can never, as we all realize, have knowledge of any figure.

This is all that can be said in general about figures at hand and close to our eyes; but if they are at a distance from us, how much change shall we find in the projection they make on the fundus of our eyes? I do not wish to stop here to describe them; they can easily be learned from some book of optics, or by examining figures found in paintings. Since painters, in order to make them appear natural, are almost always forced to change them and to paint circles, for example, as ovals, we have a sure sign that the way we see non-painted objects is erroneous. But these errors are corrected by new sensations that ought to be regarded as a kind of natural judgment, and that can be called judgments of sense.

IV. Explanation of certain natural judgments by which we avoid error. I call them "natural" because they are given to us by the Author of Nature.

When we look at a cube, for example, it is certain that the sides of it that we see almost never project an image of equal size in the fundus of our eyes. This is so because the image of each of its sides that appears on the *retina*, or optic nerve, is very like a cube painted in perspective; and consequently the sensation we have of it ought to represent the faces of the cube to us as being unequal, since they are unequal in a cube in prespective. Nonetheless, we see them as equal, and we are not deceived.

Now it might be said that this happens by a kind of judgment we naturally make, to wit, that the faces of the cube, that are farthest away and that are viewed obliquely should not form images on the fundus of the eye as big as those formed by the faces that are closer. But as it is given to the senses only to sense and never, properly speaking, to judge, it is clear that this natural judgment is but a compound sensation that consequently can sometimes be mistaken. I call it compound because it depends on two or more impressions occurring in the eye at the same time. When I look at a man walking toward me, for example, it is certain that, as he approaches, the image or impression of his height traced in the fundus of my eyes continuously increases and is finally doubled as he moves from ten to five feet away. But because the impression of distance decreases in the same proportion as the other increases, I see him as always having the same size. Thus the sensation I have of the man always depends on two different impressions, not counting the change in the eyes' position and other matters of which I shall speak in the following.

Nevertheless, since what in us is but a sensation can be considered in relation to the Author of Nature who excites it in us as a kind of judgment, I speak of sensations as natural judgments, because this way of speaking makes sense of

certain things, as can be seen here, toward the end of chapter nine, and in several other places.

V. That even these judgments mislead us in certain instances.

Although these judgments I speak of serve to correct our senses in a thousand different ways, and although without them we would almost always be deceived, they can still be occasions of error for us. If it happens, for example, that we see the top of a bell tower behind a high wall, or behind a mountain, it will appear to us rather near and small. If afterward we see it at the same distance, but with several fields and houses between us and it, it will undoubtedly appear larger and farther away, even though the projection of rays from the bell tower or the image of the bell tower formed at the fundus of the eye is exactly the same in both cases. Now it might be said that we see it larger due to a judgment we naturally make, to wit, that since there are so many fields between us and the bell tower, it must be farther away and hence larger.

But if, on the other hand, we see no fields between us and the tower, although we know by other means that there are many, and that the tower is quite distant (which is important), the tower appears very near and small, as I have just said. And it can be further stated that this occurs as a result of a kind of judgment natural to our soul, which sees the tower in this way because it judges the tower to be five or six hundred feet away. For our imagination ordinarily does not represent great distance between objects unless it is aided by the sight of other objects between them, beyond which it can imagine more objects.

This is why we see the moon much larger when it is rising or setting than when it is well above the horizon;[a] for when the moon is high, we see no objects between us and it whose size we might know in order to judge the size of the moon by comparison. But when it has just risen or is about to set, we see between us and it the countryside, whose approximate size we know, and thus we judge it to be farther away and as a result we see it larger.

It should be noted that when the moon has risen above our heads, although we might know for certain through reason that it is at a great distance, we cannot help but see it as quite near and small, because these natural judgments of vision occur in us, independently of us, and even in spite of us. Likewise, although we might know that the moon does not travel in a path of our choosing, nevertheless, if we look at it while running, we shall see it running along with us and in the same direction. The reason for this is that the moon's image (by image I always mean the impression the object makes at the fundus of the eye) does not perceptibly change place in the fundus of the eye, even though we are running; and this is so because of its great distance, as can easily be shown. Thus, aware that we are running, we must naturally judge that it runs along with us. But when we run while looking at objects near us, we naturally judge that they are stationary, i.e., we see them stationary, since their images do not change place at the fundus of our eyes, or increase proportionately to the motion we feel in ourselves. Now

[a]See chapter 9 near the end and my *Réponse à M. Régis* below [vol. 17(I):263–78].

these natural judgments, although quite useful, often involve us in error of some sort, by making us form free judgments in perfect agreement with them. For when we judge as we sense, we are always to some degree mistaken, though we are never mistaken in anything if we judge as we conceive, because the body informs only for the sake of the body, while God alone always teaches the truth, as I shall show elsewhere.

These natural judgments deceive us not only with regard to the size and distance of objects but also by making us see their figures other than as they are. We see the moon and the sun, for example, and other very distant spherical bodies as if they were flat and circular. This is because at that great distance we cannot distinguish whether the part near the center of [the visual face of] these bodies is closer to us than the others, and because of this we judge it to be at an equal distance. For the same reason we judge all the stars and the blue sky to be at roughly the same distance as their neighbors and in, as it were, a perfectly elliptical, convex vault, because our mind always supposes equality where it sees no inequality. But unless it is seen clearly, this equality should not be positively admitted.

Since instruction in these matters can be had from any book on optics, we shall not delay further with the errors of sight. The science of optics in fact teaches only how to deceive the eyes, and its technique consists only of finding ways of imposing on us at inappropriate moments those compound sensations or natural judgments of which I have just spoken. This can occur in so many different ways that of all the figures in the world, there is not a single one that cannot be represented in a thousand different ways. As a result, vision is invariably in error with regard to them. But this is not the place for a complete explanation of these matters. What has been said suffices to show that the eyes are not to be trusted when they represent to us the figure of bodies, though they are more faithful with regard to figures than with anything else.

BOOK ONE: THE SENSES
Chapter Eight

I. That our eyes do not inform us of the magnitude or speed of motion in itself. II. That duration, which is necessary for knowledge of motion, is unknown to us. III. An example of visual error concerning motion and rest.

We have already discovered the principal and most general errors of sight with regard to extension and figure; we must now correct those errors in which this same sense involves us concerning the motion of matter. After what has been said about extension, this will hardly be difficult, for there are so many connections between these two things that if we err with regard to the size of bodies, it is absolutely necessary that we also err with regard to their motion.

But in order to avoid anything that is not clear and distinct, an equivocation on the word motion must first be eliminated. Ordinarily, this term signifies two things: the first is a certain force imagined to be in the body moved and that is the cause of its motion; the second is the continual transport of a body approaching or receding from another object taken to be at rest.

When, for example, one ball is said to have communicated some of its motion to another, the word is taken in its first sense; but if we simply say that a ball is seen to have great motion, it is taken in the second. In short, this term *motion* signifies both the cause and the effect, which are nevertheless two quite different things.

There seem to abound very great and even dangerous errors concerning the force that produces motion and transports bodies. Those lovely terms *nature*, and *impressed* qualities, seem to be appropriate only for hiding the ignorance of counterfeit scholars and the impiety of freethinkers, as is easy to show. But this is not the place to discuss the force that moves bodies—it is not visible and I am speaking here only of the errors of the eyes. I postpone the issue till the proper occasion.[a]

Motion taken in the second sense, as the movement of one body away from another, is something visible and is the subject of this chapter.

[a] See bk. 6, pt. 2. ch 3.