Margaret Cavendish

Observations upon Experimental Philosophy

Abridged, with Related Texts

From the Second Edition, published
in 1668, in London, by A. Maxwell.

Edited, with an Introduction, by

Eugene Marshall

Hackett Publishing Company, Inc.
Indianapolis/Cambridge

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2016

CHAPTER 1

OF HUMAN SENSE AND PERCEPTION

BEFORE I deliver my observations upon that part of philosophy which is called experimental, I thought it necessary to premise some discourse concerning the perception of human sense.

It is known that man has five exterior senses, and every sense is ignorant of each other. For the nose knows not what the eyes see, nor the eyes what the ears hear, neither do the ears know what the tongue tastes. And as for touch, although it is a general sense, yet every several[1] part of the body has a several touch, and each part is ignorant of each other's touch: and thus there is a general ignorance of all the several parts, and yet a perfect knowledge in each part, for the eye is as knowing as the ear, and the ear as knowing as the nose, and the nose as knowing as the tongue, and one particular touch knows as much as another, as least is capable thereof. Nay, not only every several touch, taste, smell, sound or sight, is a several knowledge by itself, but each of them has another's many particular knowledges or perception as there are objects presented to them. Besides, there are several degrees in each particular sense; as for example, some men (I will not speak of other animals) their perception of sight, taste, smell, touch, or hearing, is quicker to some sorts of objects, than to others, according either to the perfection or imperfection or each object proper to each sense, for if their presentation of the objects be imperfect, either through variation or obscurity, or any other ways, the sense is deluded. Neither are all objects proper for one sense but as there are several senses, so there are several sorts of objects proper for each several sense.

Now if there be such variety of several knowledges, not only in one creature, but in one sort of sense, to wit, the exterior senses of one human creature, what may there be in all the parts of nature? It is true, there are some objects which are not at all perceptible by any of our exterior senses, as for example, rarified air, and the like. But although they be not subject to our exterior sensitive perception, yet they are subject to our rational perception, which is much purer and subtler than the sensitive—nay, so pure and subtle a knowledge, that many believe it to be immaterial, as if it were some god, when as it is only a pure fine and subtle figurative

1. Cavendish uses the adjective "several" to mean something like "distinct."

motion or perception. It is so active and subtle, as it is the best informer and reformer of all sensitive perception; for the rational matter is the most prudent and wisest part of nature, as being the designer of all productions, and the most pious and devoutest part, having the most perfect notions of God—I mean, so much as nature can possibly know of God. So that whatsoever the sensitive perception is either defective in, or ignorant of, the rational perception supplies.

But, mistake me not: by rational perception and knowledge, I mean regular reason, not irregular, where I do also exclude art,[2] which is apt to delude sense, and cannot inform us so well as reason does; for reason reforms and instructs sense in all its actions. But both the rational and the sensitive perception being dividable as well as composable, it causes ignorance as well as knowledge among nature's creatures. For, though nature is but one body and has no sharer or co-partner but is entire and whole in itself, as not composed of several different parts or substances and consequently has but one infinite natural knowledge and wisdom, yet by reason she is also divided and composable, according to the nature of a body; we can justly and with reason say, that, as nature is divided into several parts, so each several part has a several and particular knowledge and perception, both sensitive and rational, and again that each part is ignorant of the other's knowledge and perception; when as otherwise, considered altogether and in general, as they make up but one infinite body of nature, so they make also but one infinite general knowledge.

And thus nature may be called both *individual*, as not having single parts subsisting without her, but all united in one body, and *dividable*, by reason she is portable in her own several corporeal figurative motions, and not otherwise. For there is no vacuum in nature, neither can her parts start or remove from the infinite body of nature, so as to separate themselves from it. For there's no place to flee to, but body and place are all one thing; so that the parts of nature can only join and disjoin to and from parts, but not to and from the body of nature. And since nature is but one body, it is entirely wise and knowing, ordering her self-moving parts with all facility and ease, without any disturbance, living in pleasure and delight, with infinite varieties and curiosities, such as no single part or creature of hers can ever attain to.

2. By "art," Cavendish has in mind "artificial means," in particular, observations gained through the use of microscopes and telescopes, to which she generally refers as "glasses," and not the visual or performing arts such as painting or theater, for example.

CHAPTER 2

OF ART, AND EXPERIMENTAL PHILOSOPHY

SOME are of the opinion, that,

> "by art there may be a reparation made of the mischiefs and imperfections mankind has drawn upon itself by negligence and intemperance, and a willful and superstitious deserting the prescripts and rules of nature; whereby every man, both from a derived corruption, innate and born with him, and from his breeding and converse with men, is very subject to slip into all sorts of errors."

But the all-powerful God, and his servant nature, know that art, which is but a particular creature, cannot inform us of the truth of the infinite parts of nature, being but finite itself. For though every creature has a double perception, rational and sensitive, yet each creature or part has not an infinite perception. Nay, although each particular creature or part of nature may have some conceptions of the infinite parts of nature, yet it cannot know the truth of those infinite parts, being but a finite part itself, which finiteness causes errors in perceptions: wherefore it is well said, when they confess themselves, that,

> "The uncertainty and mistakes of human actions proceed either from the narrowness and wandering of our senses, or from the slipperiness or delusion of our memory, or from the confinement or rashness of our understanding. But," say they, "it is no wonder that our power over natural causes and effects is so slowly improved, seeing we are not only to contend with the obscurity and difficulty of the things whereon we work and think, but even the forces of our minds conspire to betray us. And, there being the dangers in the process of human reasoning, the remedies can only proceed from the real, the mechanical, the experimental philosophy; which has this advantage over the philosophy of discourse and disputation, that, whereas that chiefly aims at the subtlety of its deductions and conclusions, without much regard to the first ground-work, which ought to be well laid on the sense and memory; so this intends the right ordering of them all, and making them serviceable to each other."[3]

3. These two quotations are taken from the Preface of Robert Hooke's *Micrographia*, though Cavendish slightly edits the passages.

In which discourse I do not understand, first, what they mean by our power at all over natural causes and effects. For we have no power at all over natural causes and effects, but only one particular effect may have some power over another, which are natural actions. But neither can natural causes nor effects be over-powered by man so, as if man was a degree above nature, but they must be as nature is pleased to order them. For man is but a small part, and his powers are but particular actions of nature, and therefore he cannot have a supreme and absolute power.

Next, I say, that sense, which is more apt to be deluded than reason, cannot be the ground of reason, no more than art can be the ground of nature. Wherefore discourse shall sooner find or trace nature's corporal figurative motions, than deluding arts can inform the sense; for how can a fool order his understanding by art, if nature has made it defective? Or, how can a wise man trust his senses, if either the objects be not truly presented according to their natural figure and shape, or if the senses be defective, either through age, or sickness, or other accidents, which do alter the natural motions proper to each sense? And hence I conclude that experimental and mechanical philosophy cannot be above the speculative part, by reason most experiments have their rise from the speculative, so that the artist or mechanic is but a servant to the student.

CHAPTER 3

OF MICROGRAPHY, AND OF MAGNIFYING AND MULTIPLYING GLASSES

ALTHOUGH I am not able to give a solid judgment of the art of micrography, and the several dioptrical instruments belonging thereto, by reason I have neither studied nor practiced that art. Yet of this I am confident, that this same art, with all its instruments, is not able to discover the interior natural motions of any part or creature of nature. Nay, the question is whether it can represent yet the exterior shapes and motions so exactly, as naturally they are, for art does more easily alter than inform.

As for example: art makes cylinders, concave and convex glasses, and the like, which represent the figure of an object in no part exactly and truly, but very deformed and misshaped; also a glass that is flawed, cracked,

or broke, or cut into the figure of lozenges, triangles, squares, or the like, will present numerous pictures of one object. Besides, there are so many alterations made by several lights, their shadows, refractions, reflections, as also several lines, points, mediums, interposing and intermixing parts, forms and positions, as the truth of an object will hardly be known; for the perception of sight, and so the rest of the senses, goes no further than the exterior parts of the object presented; and though the perception may be true, when the object is truly presented, yet when the presentation is false, the information must be false also.

And it is to be observed, that art, for the most part, makes hermaphroditical, that is, mixed figures, partly artificial, and partly natural. For art may make some metal, as pewter, which is between tin and lead, as also brass, and numerous other things of mixed natures; in the like manner, may artificial glasses present objects, partly natural, and partly artificial. Nay put the case they can present the natural figure of an object, yet that natural figure may be presented in as monstrous a shape, as it may appear misshapen rather than natural. For example, a louse by the help of a magnifying glass, appears like a lobster, where the microscope enlarging and magnifying each part of it, makes them bigger and rounder than they naturally are. The truth is the more the figure by art is magnified, the more it appears misshapen from the natural, in so much as each joint will appear as a diseased, swelled and tumid body, ready and ripe for incision.

But mistake me not; I do not say, that no glass presents the true picture of an object, but only that magnifying, multiplying, and the like optic glasses, may, and do oftentimes present falsely the picture of an exterior object. I say, the picture, because it is not the real body of the object which the glass presents, but the glass only figures or patterns out the picture presented in and by the glass, and there mistakes may easily be committed in taking copies from copies. Nay, artists do confess themselves, that flies, and the like, will appear of several figures or shapes, according to the several reflections, refractions, mediums and positions of several lights, which, if so, how can they tell or judge which is the truest light, position, or medium, that does present the object naturally as it is? And if not, then an edge may very well seem flat, and a point of a needle a globe.[4] But if the edge of a knife, or a point of a needle were naturally and really so as the microscope presents them, they would never be so

4. Cavendish here is referencing the microscopic work of Robert Hooke. To see some of that work, as well as one of the illustrations that accompanied his famous work *Micrographia*, to

useful as they are; for, a flat or broad plain-edged knife would not cut, nor a blunt globe pierce so suddenly another body, neither would nor could they pierce without tearing and rending, if their bodies were so uneven. And if the picture of a young and beautiful lady should be drawn according to the representation of the microscope, or according to the various refraction and reflection of light through such like glasses, it would so far from being like her, as it would not be like a human face, but rather a monster, than a picture of nature.

Wherefore those that invented microscopes, and such like dioptrical glasses, at first, did, in my opinion, the world more injury than benefit; for this art has intoxicated so many men's brains, and wholly employed their thoughts and bodily actions about phenomena, or the exterior figures of objects, as all better arts and studies are laid aside. Nay, those that are not as earnest and active in such employments as they, are, by many of them, accounted unprofitable subjects to the commonwealth of learning. But though there be numerous books written of the wonders of these glasses, yet I cannot perceive any such, and at best, they are but superficial wonders, as I may call them.

But could experimental philosophers find out more beneficial arts than our fore-fathers had done, either for the better increase of vegetables and brute animals to nourish our bodies, or better and commodious contrivances in the art of architecture to build us houses, or forth advancement of trade and traffic to provide necessaries for us to live, or for the decrease of nice distinctions and sophistical disputes in churches, schools, and courts of judicature, to make men live in unity, peace, and neighborly friendship, it would not only be worth their labor, but as much praise as could be given to them. But, as boys that play with watery bubbles, or fling dust into each others' eyes, or make a hobby-horse of snow,[5] are worthy of reproof rather than praise, for wasting their time with useful sports, so those that addict themselves to unprofitable arts spend more time than they reap benefit thereby. Nay, could they benefit men either in husbandry, architecture, or the like necessary and profitable employments. Yet before the vulgar sort would learn to understand them, the world

which Cavendish is in many ways responding here, see the excerpt from *Micrographia* included in this volume.

5. Cavendish herself notes that she means glass tubes, atoms, and exterior figures here—a clear dig at the experimental philosophers.

would want bread to eat, and houses to dwell in, as also clothes to keep them from the inconveniences of inconstant weather.

But truly though spinsters were most experienced in their art, yet they will never be able to spin silk, thread, or wool, etc. from loose atoms; neither will weavers weave a web of light from the sun's rays; nor an architect build a house of the bubbles of water and air (unless they be poetical spinsters, weavers and architects). And if a painter should draw a louse as big as a crab, and of that shape as the microscope presents, can anybody truly imagine that a beggar would believe it to be true? But if he did, what advantage would it be to the beggar? For it does neither instruct him how to avoid breeding them, or how to catch them, or to hinder them from biting. Again, if the painter should paint birds according to those colors the microscope presents, what advantage would it be for fowlers to take them? Truly, no fowler will be able to distinguish several birds through a microscope, neither by their shapes nor colors; they will be better discerned by those that eat their flesh, than by micrographers that look upon their colors and exterior figures through a magnifying glass.

In short, magnifying-glasses are like a high heel to a short leg, which if it be made too high, it is apt to make the wearer fall, and at the best, can do not more than represent exterior figures in a bigger and so in a more deformed shape and posture than naturally they are. But as for the interior forms and motions of a creature, as I said before, they can no more represent them than telescopes can the interior essence and nature of the sun, and what matter it consists of; for if one that never had seen milk before, should look upon it through a microscope, he would never be able to discover the interior parts of milk by that instrument, were it the best that is in the world, neither the whey, or the butter, nor the curds.

Wherefore the best optic is a perfect natural eye, and a regular sensitive perception; and the best judge is reason; and the best study is rational contemplation joined with the observations of regular sense, but not deluding arts. For art is not only gross in comparison to nature, but, for the most part, deformed and defective, and at best produces mixed or hermaphroditical figures, that is, a third figure between nature and art. Which provides that natural reason is above artificial sense, as I may call it. Wherefore, those arts are the best and surest informers, that alter nature least, and they the greatest deluders that alter nature most, I mean, the particular nature of each particular creature (for art is so far from altering infinite nature, that it is no more in comparison to it, than a little fly to an

elephant; no not so much, for there is no comparison between finite and infinite). But wise nature taking delight in variety, her parts, which are her creatures, must of necessity do so too. . . .

CHAPTER 5

OF PORES

AS I have mentioned in my former discourse, that I do verily believe all or most natural creatures have some certain kind of respiration, so do I also find it most probable, that all or most natural creatures have pores. Not empty pores, for there can be no vacuum in nature, but such passages as serve for respiration, which respiration is some kind of receiving and discharging of such matter as is proper to the nature of every creature. And thus the several organs of animal creatures, are, for the most part, employed as great large pores, for nature being in perpetual motion, is always dissolving and composing, changing and ordering her self-moving parts as she pleases.

But it is to be well observed, that there is a difference between perception and respiration, for perception is only an action of figuring or patterning, when as the rational and sensitive motions do figure or pattern out something. But respiration is an action of drawing, sucking, breathing in, or receiving any ways outward parts, and of venting, discharging, or sending forth inward parts. Next, although there may be pores in most natural creatures, by reasons that all, or most, have some kind of respiration, yet nature has more ways of dividing and uniting of parts, or of ingress and egress, than the way of drawing in, and sending forth by pores. For nature is so full of variety, that not any particular corporal figurative motion can be said the prime or fundamental, unless it be self-motion, the architect and creator of all figures. Wherefore, as the globular figure is not the prime or fundamental of all other figures, so neither can respiration be called the prime or fundamental motion; for, as I said, nature has more ways than one, and there are also retentive motions in nature which are neither dividing nor composing, but keeping and holding together. . . .

CHAPTER 15

OF THE SEEDS OF VEGETABLES

. . . IT is also an argument, that no creature or part of nature can subsist singly and divided from all the rest, but that all parts must live together. And since no part can subsist or live without the other, no part can also be called prime or principal. Nevertheless all seeds have life as well as other creatures. Neither is it a paradox to say, seeds are buried in life, and yet do live; for what is not in present act, we may call buried, entombed or inured in the power of life. As for example, a man, when his figure is dissolved, his parts dispersed, and joined with others, we may say his former form or figure of being such a particular man is buried in its dissolution, and yet lives in the composition of other parts, or, which is all one, he does no more live the life of a man, but the life of some other creature he is transformed into by the transforming and figuring motions of nature. Nay, although every particle of his former figure were joined with several other parts and particles of nature, and every particle of the dissolved figure were altered from its former figure into several other figures, nevertheless, each of these particles would not only have life, by reasons it has motion, but also the former figure would still remain in all those particles, though dispersed, and living several sorts of lives, there being nothing in nature that can be lost or annihilated, but nature is and continues still the same as she was, without the least addition or diminution of any the least thing or part, and all the varieties and changes of natural productions proceed only from the various changes of motion. . . .

Nevertheless, although there be such variety, not only in the general kinds of creatures, but in every particular, yet there is but one ground or principle of all this variety, which is self-motion, or self-moving matter. And I cannot enough admire the strange conceits of some men, who perceiving and believing such a curious variety and various curiosity of nature in the parts of her body, and that she is in a perpetual motion, and knows best her own laws, and the several properties of bodies, and how to adapt and fit them to her designed ends, nay, that God has implanted a faculty of knowing in every creature, do yet deny, nay, rail against nature's self-moving power, condemning her as dull, inanimate, senseless and irrational body. As if a rational man could conceive, that such a curious variety and contrivance of natural works should be produced by a senseless

and irrational motion, or that nature was full of immaterial spirits, which did work natural matter into such various figures, or that all this variety should be caused by immaterial motion, which is generated out of nothing, and annihilated in a moment. For no man can conceive or think of motion without body; and if it be above thought, then surely it is above act. . . .

Truly it is no consequence to deny the being of that which we do not see or perceive; for this were to attribute a universal and infinite knowledge to our weak and imperfect senses. And therefore I cannot believe that the omnipotent creator has written and engraved his most mysterious designs and counsels only in one sort of creatures, since all parts of nature, their various productions and curious contrivances, do make known the omnipotency of God, not only those of little, but also those of great sizes. For in all figures, sizes and actions, is apparent the curious variety of nature, and the omnipotency of the creator, who has given nature a self-moving power to produce all these varieties in herself, which varieties do evidently prove, that nature does not work in all creatures alike, nor that she has but one primary or principal sort of motions, by which she produces all creatures. . . . For this is a very wild and extravagant conceit, to measure the infinite actions of nature according to the rule of one particular sort of motions, which anyone that has the perfect use of his sense and reason may easily see, and therefore I need not to bring any arguments to contradict it.

CHAPTER 16

OF THE PROVIDENCE OF NATURE, AND OF SOME OPINIONS CONCERNING MOTION

CONCERNING those that speak of the providence of nature, and the preserving of vegetables, to wit, that nature is very curious and careful in preserving their seminal principles, and lays them in most convenient, strong and delicate cabinets for their safer protection from outward danger. I confess, nature may make such protections, that one creature may have some defense from the injuries and assaults of its fellow creatures, but these assaults are nothing but dissolving motions, as friendly and

amiable associations are nothing else but composing motions. Neither can anything be lost in nature, for even the least particle of nature remains as long as nature her self.

And if there be any providence in nature, then certainly nature has knowledge and wisdom. And if she has knowledge and wisdom, then she has sense and reason. And if sense and reason, then she has self-motion. And if nature has self-motion, then none of her parts can be called inanimate or soulless, for motion is the life and soul of nature, and of all her parts. If the body be animate, the parts must be too, there being no part of the animate body that can be dead, or without motion, whereof an instance might be given of animal bodies, whose parts have all animal life, as well as the body itself. Wherefore those that allow a soul, or an informing, actuating and animating form or faculty in nature and her parts, and yet call some parts inanimate or soulless, do absolutely contradict themselves. And those that say, all the varieties of nature are produced, not by self-motion, but that one part moves another, must at last come to something that moves itself. Besides, it is not probable that one part moving another should produce all things so orderly and wisely as they are in nature. . . .

But my intention is not to plead for other men's opinions, but rather to clear my own, which is that motion is material, for figure, motion and matter are but one thing; and that no particular motion is or can be lost in nature, nor created anew, as I have declared more at large elsewhere.

CHAPTER 17

DESCARTES'S OPINION OF MOTION, EXAMINED

. . . NEXT, as for his opinion of transferring and imparting motion to other bodies, and that that body which imparts motion to other bodies, loses as much as it gives, I have answered in my *Philosophical Letters*, to wit, that it is most improbable. Because motion, being material and inseparable from matter, cannot be imparted without matter; and if not, then the body that receives motion would increase in bulk and the other that loses motion would decrease, by reason of the addition and diminution of the parts of matter, which must of necessity increase and lessen the bulk of the Body, the contrary whereof is sufficiently known. . . .

CHAPTER 19

OF THE PORES OF A CHARCOAL; AND OF EMPTINESS

. . . SURELY God, the fullness and perfection of all things, would not suffer any vacuum in nature, which is a pure nothing. . . . But, some may say, if there be no emptiness in nature, but all fullness of body, or bodily parts, then the spiritual or divine soul in man, which inhabits the body, would not have room to reside in it. I answer the spiritual or divine soul in man is not natural, but supernatural, and has also a supernatural way of residing in a man's body; for place belongs only to bodies, and a spirit being bodiless, has no need of bodily place. But then they will say, that I make spirit and vacuum all one thing, by reason I describe spirit to be a natural nothing, and the same I say of vacuum; and hence it will follow, that particular spirits are particular emptiness and an infinite spirit an infinite vacuum. My answer is, that although a spirit is a natural nothing, yet it is a supernatural something; but a vacuum is a pure nothing, both natural and supernatural. And God forbid I should be so irreligious, as to compare spirits, and consequently God, who is an infinite spirit, to a vacuum. . . .

CHAPTER 20

OF COLORS[6]

ALTHOUGH the sensitive perception does pattern out the exterior figure of colors as easily as any other object, yet all perceptions of colors are not made by patterning. For as there are many perceptions which take

6. Much of this chapter is a response to another of Robert Boyle's works, *Experiments and Considerations Touching Colours,* published in 1664. One doctrine that Boyle advocated, and a view he shared with a variety of mechanical philosophers, including Descartes and John Locke, is that certain properties of our experience, such as our experiences of color and heat, are not caused by properties in the world that straightforwardly resemble our experiences of them. Rather, they are caused in us by the shape and motion of corpuscles. Heat and color, therefore, are a power of the shape and motion of a body to cause in us certain experiences. Or so some of these thinkers might say.

no patterns from outward objects, so there are also perceptions of colors which never were presented to our sensitive organs. Neither is any perception made by exterior objects, but by interior, corporeal, figurative motions. For the object does not print or act any way upon the eye, but it is the sensitive motions in the eye which pattern out the figure of the object. And it is to be observed that as the parts of some bodies do consist of several different figures, which the learned call heterogeneous, one figure being included within another, and of some again, the parts are but of one kind of figure, which they call homogenous bodies, as for example, water, so it may be with colors. For in some, their parts may be quite thorough of one color, and others again, may be of several colors. And indeed, most creatures, as they have different parts, so those different parts have also different colors, and as those parts do alter, so do their colors. For example, a man that is in good health looks of a sanguine complexion, but being troubled with the yellow or black jaundice, his complexion is of the color of the humor, either black or yellow. Yet it does not proceed always from the overflowing of the humor towards the exterior parts, for many times, when the humor is obstructed, it will cause the same effect. But then the corporeal motions in the extreme parts alter by way of imitation or metamorphosing, as from a sanguine color, into the color of the predominant humor. Wherefore it is no more wonder to see colors change in the tempering of steel (as some are pleased to allege this experiment) than to see steel change and reaching its temper from being hard, to soft, from tough, to brittle, etc. . . . which changes prove, that colors are material, as well as steel, so that the alteration of the corporeal parts is the alteration of the corporeal figures of colors.

They also prove that light is not essential to colors. For although some colors are made by several reflections, refractions and positions of light, yet light is not the true and natural cause of all colors, but those colors that are made by light, are most inconstant, momentary and alterable, by reason light and its effects are very changeable. Neither are colors made by bare motion, for there is no such thing as bare or immaterial motion in nature, but both light and colors are made by corporeal figurative motions of nature. And according to the various changes of those motions, there are also various and different lights and colors. And the perception of the lights and colors is made and dissolved by the sensitive figurative motions in the optic sensorium, without the exchange of exterior objects. But as the slackest, loosest or rarest parts, are of least solid or composed corporeal

figures, so are the most apt to change and reaching upon the least disorder, as may well be observed in colors raised by passions, as fear, anger, or the like, which will change not the complexion and countenance, but the very features will have some alteration for a short time. And many times the whole body will be so altered, as not to be rightly composed again for a good while. Nay, often there follows a total dissolution of the whole figure, which we call death.

And at this we need not wonder, if we do but consider that nature is full of sense and reasons, that is, of sensitive and rational perception, which is the cause that oftentimes the disturbance of one part causes all other parts of a composed figure to take alarm. For, as we may observe, it is so in all other composed bodies, even in those composed by art. As for example, in the politic body of a commonwealth, one traitor is apt to cause all the kingdom to take arms and although every member knows not particularly of the traitor, and of the circumstances of his crime, yet every member, if regular, knows its particular duty, which causes a general agreement to assist each other. And as it is with a commonwealth, so it is also with an animal body; for if there be factions amongst the parts of an animal body, then straight there arises a civil war.

Wherefore to return to colors: a sudden change of colors may cause no wonder, by reason there is oftentimes in nature a sudden change of parts, that is, an alteration of figures in the same parts. Neither is it more to be admired that one color should be within another, than one figurative part is within another, for colors are figurative parts. And as there are several creatures, so there are also several colors, for the color of a creature is as well corporeal, as the creature itself. And (to express myself as clearly as I can) color is as much a body, as place and magnitude, which are but one thing with body. Wherefore when the body, or any corporeal part varies, whether solid or rare, place, magnitude, color, and the like must of necessity change or vary also—which change is no annihilation or perishing, for as no particular of matter can be lost in nature, nor no particular motion, so neither can color.

And therefore the opinion of those who say, that when flax or silk is divided into very small threads, or fine parts, those parts lose their colors, and being twisted, regain their colors, seems not conformable to truth. For the division of their parts does not destroy their colors, nor the composing of those parts regain them, but they being divided into such small and fine parts, it makes their colors, which are the finest of their exterior

parts, not to be subject to our optic perception. For what is very small or rare is not subject to the human optic sense wherefore there are these following conditions required to the optic perception of an exterior object. First, the object must not be too subtle, rare, or little, but of a certain degree of magnitude; next, it must not be too far distant, or without the reach of light; then, the medium must not be obstructed, so as to hinder perception; and lastly, our optic sensorium must be perfect, and the sensitive motions regular; of which conditions, if any be wanting, there is either no perception at all, or it is an imperfect perception. For the perception of seeing an exterior object is nothing else but a patterning out of the figure of that same object by the sensitive figurative and perceptive motions. But there are infinite parts that are beyond human perception, and it would be but a folly for us to deny that which we cannot see or perceive. And if the perceptive motions be not regular in our optic sense, we may see different colors in one object. Nay, the corporeal figurative motions in the eye may make several figurative colors, even without the patterns of outward objects.

And as there are several colors, so there are also several corporeal figurative motions that make several colors in several parts, and the more solid the parts are, the more fixed are their inherent natural colors. But superficial colors are more various, though not so various as they would be, if made by dusty atoms, flying about as flies in sunshine. For, if this opinion were true, all colors, and other creatures would be composed or made by chance, rather than by reason. And chance being so ignorantly inconstant, not any two parts would be of the like color, nor any kind of species would be preserved. But wise nature, although she be full of variety, yet she is also full of reason, which is knowledge, for there is no part of nature that has not sense and reason, which is life and knowledge. And if all the infinite parts have life and knowledge, infinite nature cannot be a fool or insensible. But mistake me not, for I do not mean that her parts in particular are infinitely knowing, but I say, infinite nature has an infinite knowledge; and by reason nature is material, she is dividable as well as composable, which is the cause that there is an obscurity in her parts, in particular, but not in general, that is, in nature herself. Nay, if there were not an obscurity in the particulars, men would not endeavor to provide inherent and natural figures by superficial phenomena.

But as for color, some do mention the example of the blind man, who could discover colors by touch. And truly I cannot account it a wonder,

because colors are corporeal figurative motions, and touch being a general sense, may well perceive by experience (which is gained by practice) some notions of other sensitive perceptions. As for example, a blind man may know by relation the several touches of water, milk, broth, jelly, vinegar, vitriol, etc., as well as what is hot, cold, rare, dense, hard, soft, or the like. And if he have but his touch, hearing, speaking and smelling, perfectly, he may express the several knowledges of his several senses, by one particular sense, or he may express one sense's knowledge by another; but if the senses be imperfect, he cannot have a true knowledge of any object. The same may be said of colors, for several colors being made by several corporeal figurative motions, may well be perceived by general sense, which is touch.

I will not say that touch is the principle of all sensitive knowledge, for then I should be of the opinion of those experimental philosophers, which will have one principle motion or figure to be the cause of all natural things. But I only say, animal touch may have some notion of the other animal senses, by the help of rational perception. All which proves that every part is sensible, and every sense knowing, not only in particular, but that one sense may have some general notion or knowledge of the rest. For there are particular and general perceptions in sensitive and rational matter, which is the cause of both the variety and order of nature's works, and therefore it is not necessary that a black figure may be rough, and a white figure smooth. Neither are white and black the ground figures of colors, as some do conceive, or as others do imagine, blue and yellow, for no particular figure can be a principle, but they are all but effects.

And I think it is as great an error to believe effects for principles, as to judge of the interior natures and motions of creatures by their exterior phenomena or appearances, which I observe in most of our modern authors, whereof some are for incorporeal motions, others for prime and principal figures, others for first matter, others for the figures of dusty and insensible atoms, that move by chance. When as neither atoms, corpuscles or particles, nor pores, light, or the like, can be the cause of fixed and natural colors; for if it were so, then there would be no stayed or solid color, insomuch as a horse, or any other creature, would be of more various colors than a rainbow. But that several colors are of several figures was always and is still my opinion, and that the change of colors proceeds from the alteration of their figures, as I have more at large declared in my

other philosophical works. Indeed art can no more force certain atoms or particles to meet and join to the making of such a figure as art would have, than it can make by a bare command insensible atoms to join into a uniform world.

I do not say this as if there could not be artificial colors, or any artificial effects in nature. But my meaning is only this, that although art can put several parts together, or divide and disjoin them, yet it cannot make those parts move or work so as to alter their proper figures, or interior natures, or to be the cause of changing and altering their own or other parts, any otherwise than they are by their natures.

Neither do I say that no colors are made by light, but I say only that fixed colors are not made by light. And as for the opinion that white bodies reflect the light outward, and black bodies inward, as some authors do imagine, I answer, it is probable some bodies may do so, but all white and black colors are not made by such reflections. The truth is, some conceive all colors to be made by one sort of motion, as some do believe that all sensation is issued by pressure and reaction, and all heat by parts tending outward, and all cold by parts tending inward.[7] When as there are not only several kinds of heat and cold, as animal, vegetable, mineral and elemental heat and cold, but several sorts in each kind, and different particulars in each sort. For there is a moist heat, a dry heat, a burning, a dissolving, a composing, a dilating, a contracting heat, and many more. The like for colds, all which several kinds, sorts and particulars, are made by the several changes of the corporeal figurative motions of nature, and not by pressure and reaction, or by tending inward or outward. And as there is so great a variety and difference amongst natural creatures, both in their perceptions and interior natures, so there are also varieties of their colors, the natural colors of men being different from the natural colors of beasts, birds, fish, worms, flies, etc.

Concerning their interior natures, I'll allege but few examples: although a peacock, parrot, pie, or the like, are gay birds, yet there is a difference in their gaiety. Again, although all men have flesh and blood, and are of one particular kind, yet their interior natures and dispositions are so different that seldom any two men are of the same complexion. And as there is a difference in their complexions, so in the extra shapes and features of

7. In addition to Boyle, Cavendish also here likely has Hobbes in mind, who proposes something like this in his *Elements of Philosophy*. A passage from another of his works, *Leviathan*, is included in this volume.

their exterior parts, insomuch that it is a wonder to see two men just alike. Nay, as there is a difference in the corporeal parts of their bodies, so in the corporeal parts of their minds, according to the old proverb, *so many men, so many minds.* For there are different understandings, fancies, conceptions, imaginations, judgments, wits, memories, affections, passions, and the like.

Again, as in some creatures there is difference both in their exterior features, and interior natures, so in others there is found a resemblance only in their exterior, and a difference in their interior parts, and in others again, a resemblance in their interior, and a difference in their exterior parts. As for example, black ebony and black marble are both of different natures, one being wood, and the other stone. And yet they resemble each other in their exterior color and parts; also, white, black and grey marble, are all of one interior nature, and yet do differ in their exterior color and parts. . . .

All which proves the infinite variety in nature, and that nature is a perpetually self-moving body, dividing, composing, changing, forming and transforming her parts by self-corporeal figurative motions. And as she has infinite corporeal figurative motions, which are her parts, so she has an infinite wisdom to order and govern the infinite parts. For she has infinite sense and reason, which is the cause that no part of hers is ignorant, but has some knowledge or other, and this infinite variety of knowledge makes a general infinite wisdom in nature. . . .

CHAPTER 21

WHETHER AN IDEA HAVE A COLOR, AND OF THE IDEA OF A SPIRIT

I have declared in my former discourse that there is no color without body, nor a body without color, for we cannot think of a body without we think of color too. To which some may object, that if color be as proper to a body as matter, and if the mind be corporeal, then the mind is also colored. I answer, the mind, in my opinion, has as much color as other parts of nature. But then perhaps they will ask me, what color the mind is of? My answer is, that the mind, which is the rational part of nature, is no more subject to one color, than the infinite parts of nature are subject

to one corporeal figurative motion, for you can no more confine infinite matter to one particular color, or all colors to one particular figure. Again, they may ask, whether an idea have a color? And if so, whether the idea of God be colored? To which I answer, if the ideas be of corporeal finite figures, they have colors according to the nature, or property, or figure of the original. But as for the idea of God, it is impossible to have a corporeal idea of an infinite incorporeal being, for though the finite parts of nature may have a perception or knowledge of the existence of God, yet they cannot possibly pattern or figure him, he being a supernatural, immaterial, and infinite being.

But put the case (although it is very improbable, nay, against sense and reason) there were natural immaterial ideas. If those ideas were finite, and not infinite, yet they could not possibly express an infinite, which is without limitation, by a finite figure which has a circumference. Some may say an immaterial idea has no circumference. But then I answer, it is not a finite idea, and it is impossible for an idea to be infinite. For I take an idea to be the picture of some object, and there can be no picture without a perfect form. Neither can I conceive how an immaterial can have a form, not having a body. Wherefore it is more impossible for nature to make a picture of an infinite God than for man, which is but a part of nature, to make a picture of infinite nature. For nature, being material, has also figure and matter, they being one, so that none can be without the other, no more than nature can be divided from herself.

Thus it is impossible for man to make a figure or picture of that which is not a part of nature, for pictures are as much parts of nature, as any other parts. Nay, were they monstrous, as we call them, for nature being material, is also figurative, and being a self-moving matter or substance, is dividable, and composable. And as she has infinite, corporeal, figurative motions, and infinite parts, so she has infinite figures, of which some are pictures, others originals. And if any one particular creature could picture out those infinite figures, he would picture out nature. But nature, being infinite, cannot be pictured or patterned by any finite and particular creature, although she is material; nevertheless she may be patterned in parts.

And as for God, he being indivisible and immaterial, can neither be patterned in part, nor in whole, by any part of nature which is material, nay, not by infinite nature herself. Wherefore the notions of God can be no otherwise but of his existence, to wit, that we know there is something

above nature, who is the author, and god of nature. For though nature has an infinite natural knowledge of the infinite God, yet, being dividable as well as composable, her parts cannot have such an infinite knowledge or perception, and being composable as much as dividable, no part can be so ignorant of God, as not to know there is a God.

Thus nature has both an infinite and finite perception; infinite in the whole (as I may say for better expression's sake) and finite in the parts. But mistake me not, I do not mean that either the infinite perception of nature or the finite perceptions of natural parts and creatures are any otherwise of that supernatural and divine being than natural. But yet they are the most purest parts, being of the rational part of nature, moving in a most elevating and subtle manner, as making no exact figure or form, because God has neither form nor figure. But that subtle matter or corporeal perception motion patterns out only an over-ruling power. Which power all the parts of nature are sensible of, and yet know not what it is, like as the perception of sight sees the ebbing and flowing of the sea, or the motion of the sun, yet knows not their cause, and the perception of hearing hears thunder, yet knows not how it is made. And if there be such ignorance of the corporeal parts of nature, what of God? For whatsoever is corporeal, has being, but what being an immaterial has, no corporeal can perceive. Wherefore no part of nature (her parts being corporeal) can perceive an immaterial, because it is impossible to have a perception of that which is not perceptible, as not being an object fit or proper for corporeal perception. Indeed, an immaterial is no object, because it is not a body.

But some may say that a corporeal may have a conception, although not a perception of an immaterial. I answer that a corporeal cannot have a conception of that which in nature is not a body. Thus far the corporeal motions can conceive somewhat above nature, but can conceive no more than what that is which is above or is more powerful than nature. And, for proof, how many several opinions is there concerning God, as of his being, existence, attributes, and the like? Insomuch that there are few of one and the same opinion. But such a conception as that there is something more powerful than nature all the parts of nature (which are infinite) certainly have. And so God, being an infinite and eternal God, has an infinite and eternal worship, for every part conceiving something about itself, and above its nature, worships that supreme, either through fear, or love, or both, yet knows not what the supreme being is.

But to conclude, my opinion is that, as the sensitive perception knows some of the other parts of nature by their effects, so the rational perceives some effects of the omnipotent power of God, which effects are perceptible by finite creatures, but not his infinite nature, nor essence, nor the cause of his infiniteness or omnipotency.

Thus, although God's power may be perceived by nature's parts, yet what God is cannot be known by any part. And nature being composable, there is a general acknowledgement of God in all her parts, but being also dividable, it is the cause there are particular religions and opinions of God, and of his divine worship and adoration. . . .

CHAPTER 25

OF THE MOTIONS OF HEAT AND COLD

. . . BUT concerning heat and cold, my opinion is, that they are like several colors, some natural, and some artificial; of which the artificial are very inconstant, at least not so lasting as those that are not made by art.[8]

And they which say, that both heat and cold are not made by the sensories, or sensitive organs, are in the right, if their meaning be, that both heat and cold, in their natures, and with all their properties, as they are particular creatures, are not made or produced by human or animal senses.

Nevertheless, the sensitive animal perception of heat and cold is made by the sensitive motions in their sensitive organs. For what heat and cold soever an animal creature feels, the perception of it is made in the sense of touch, or by those sensitive motions in the parts of its body. For, as the perception of any other outward object is not made by a real entrance of its parts into our sensors, so neither is all perception of heat or cold made by the intermixture of their particles with our flesh, but they are patterned and figured out by the sensitive motions in the exterior parts of the body, as well as other objects.

I will not say that cold or heat may not enter and intermix with the parts of some bodies, as fire does intermix with fuel, or enters into its

8. For a famous instance of the view against which Cavendish argues here, see Galileo's *The Assayer*, in which he provides a mechanical account of heat as the motion of tiny particles.

part. But my meaning is that the animal perception of heat and cold is not made this way, that is, by an intermixture of parts of the agent with parts of the patient, as the learned call them, that is, of the exterior object and the sentient. Or else the perception of all exterior objects would be made by such an intermixture, which is against sense and reason. And therefore even in such a commixture, where the parts of the object enter into the body of the sentient, as fire does into fuel, the perception of the motions of fire in the fuel, and the fuel's consumption or burning, is not made by the fire, but by the fuel's own perceptive motions, imitating the motions of the fire. So that fire does not turn the fuel into ashes, but the fuel does change by its own corporeal figurative motions, and the fire is only an occasion for it. The same may be said of cold.

Neither is every creature's perception alike, no more than it can be said, that one particular creature, as (for example) man, has but one perception. For the perceptions of sight and smelling, and so of every sense, are different; nay, one and the same sense may have as many several perceptions as it has objects. And some sorts of perceptions in some creature are either stronger or weaker than in others, for, we may observe, that in one and the same degree of heat or cold, some will have quicker, and some slower perceptions than others. . . .

Thus the variety of nature is a stumbling-block to most men, at which they break their heads of understanding, like blind men, that run against several posts or walls. And how should it be otherwise, since nature's actions are infinite, and man's understanding finite? For they consider not so much the interior natures of several creatures, as their exterior figures and phenomenas, which makes them write many paradoxes, but few truths, supposing that sense and art can only lead them to the knowledge of truth—when as they rather delude their judgments, instead of informing them.

But nature has placed sense and reason together, so that there is no part or particle of nature which has not its share of reason, as well as of sense. For, every part having self-motion, has also knowledge, which is sense and reason, and therefore it is fit we should not only employ our senses, but chiefly our reason, in the search of the causes of natural effects. For sense is only a workman, and reason is the designer and surveyor. And as reason guides and directs, so ought sense to work. But seeing that, in this age, sense is more in fashion than reason, it is no wonder there are so many irregular opinions and judgments among men. However, although it be

the mode, yet I, for my part, shall not follow it. But leaving to our moderns their experimental, or mode-philosophy, built upon deluding art, I shall addict myself to the study of contemplative philosophy, and reason shall be my guide. . . .

The truth is, our exterior senses can go no further than the exterior figures of creatures, and their exterior actions; but our reason may pierce deeper, and consider their inherent natures, and interior actions. And although it does sometimes err (for there can be no perfect or universal knowledge in a finite part, concerning the infinite actions of nature) yet it may also probably guess at time, and may chance to hit the truth. Thus sense and reason shall be the ground of my philosophy, and no particular natural effects, nor artificial instruments; and if any one can show me a better and surer ground or principle than this, I shall most willingly and joyfully embrace it.

CHAPTER 26

OF THE MEASURES, DEGREES, AND DIFFERENT SORTS OF HEAT AND COLD

. . . BUT some of the learned conceive the degrees of heat and cold are made by bare divisions; when as, in my opinion, they are made by the several degrees of their corporeal figurative motions. They also do imagine, that there's no degree but must ascend from one to two; from two, to three; and so further, through all the numbers, and that from one to twenty, there be so many degrees as there be numbers. When as, in my opinion, there's no more but one degree required from one to a million, or more. For though both in nature and in art there are degrees from one single figure to another, yet there may also be but one degree from one to a million, without reckoning any intermediate degrees or figures. So that a body, when it moves quick or slow, needs not go through all the intermediate degrees of quickness or slowness, as to move quicker and quicker, slower and slower, but may immediately move from a very slow to a very quick degree. The truth is, no man is able to measure the infinite degrees of natural motions, for though nature consists of particular finites,

yet it does also consist of infinite particulars, finite in figure, infinite in number—and who can number from finite to infinite?

But having discoursed hereof elsewhere, I return to heat and cold. And let others dispute whether the degrees of heat and cold in the air be the same with the degrees of animal perceptions, or with the degrees of animal cold and heat. My opinion is that there being several sorts and several particular heats and colds, they cannot be just alike each other, but there's some difference betwixt them. As for example, there are shaking, chilly, windy, numb, stiff, rare, dense, moist, dry, contracting, dilating, ascending, descending, and other numerous sorts of colds; nay, there are some sorts of candied figures made by heat, which appear as if they were frozen. Also, there are fluid colds which are not wet, as well as fluid heats that are not dry. . . .

For if men conceive there is but one heat and cold in nature, they are mistaken—and much more, if they think they can measure all the several sorts of heat and cold in all creatures, by artificial experiments. For as much as a natural man differs from an artificial statue or picture of a man, so much differs a natural effect from an artificial, which can neither be so good, nor so lasting as a natural one. . . . Artificial things are pretty toys to employ idle time. Some are very useful for our convenience, but yet they are but nature's bastards or changelings, if I may so call them. Though nature takes so much delight in variety, that she is pleased with them, yet they are not to be compared with her wise and fundamental actions. For, nature being a wise and provident lady, governs her parts very wisely, methodically, and orderly. Also, she is very industrious and hates to be idle, which makes her employ her time as a good housewife does, in brewing, baking, churning, spinning, sewing, etc. as also in preserving, for those that love sweetmeats, and in distilling, for those that take delight in cordials. For she has numerous employments, and being infinitely self moving, never want work.

But her artificial works are her works of delight, pleasure and pastime. Wherefore those that employ their time in artificial experiments, consider only nature's sporting or playing-actions. But those that view her wise government in ordering all her parts and consider her changes, alterations, and tempers in particulars and their causes, spend their time more usefully and profitably.

And truly, to what purpose should a man beat his brains and weary his body with labors about that wherein he shall lose more time than gain

knowledge? But if any one would take delight in such things, my opinion is that our female sex would be the fittest for it. For they most commonly take pleasure in making of sweet-meats, possets, several sorts of pies, puddings, and the like; not so much for their own eating, as to employ their idle time. And it may be they would prove good experimental philosophers, and inform the world how to make artificial snow by their creams or possets beaten into broth; and ice, by their clear, candied, or crusted quiddities, or conserves of forts; and frost, by their candied herbs and flowers; and hail, by their small comfits made of water and sugar, with whites of eggs; and many other the like figures, which resemble beasts, birds, vegetables, minerals, etc. . . .

But the men should study the causes of those experiments and by this society, the commonwealth would find a great benefit. For the woman was given to man not only to delight, but to help and assist him; and I am confident women would labor as much with fire and furnace as men. For they'll make good cordials and spirits. But whether they would find out the philosophers-stone, I doubt; for our sex is more apt to waste than to make gold. However, I would have them try, especially those that have means to spend. For who knows but women might be more happy in finding it out, than men, and then would men have reason to employ their time in more profitable studies than in useless experiments.

CHAPTER 31

OF THE PARTS OF NATURE, AND OF ATOMS

ALTHOUGH I am of opinion that nature is a self-moving, and consequently a self-living and self-knowing infinite body, divisible into infinite parts, yet I do not mean that these parts are atoms. For there can be no atom, that is, an indivisible body in nature, because whatsoever has body, or is material, has quantity, and what has quantity, is divisible.

But some may say, if a part be finite, it cannot be divisible into infinite. To which I answer that there is no such thing as one finite single part in nature. For when I speak of the parts of nature, I do not understand that those parts are like grains of corn or sand in one heap, all of one figure or magnitude, and separable from each other, but I conceive nature to

be an infinite body, bulk or magnitude, which by its own self-motion, is divided into infinite parts—not single or indivisible parts, but parts of one continued body, only discernible from each other by their proper figures, caused by the changes of particular motions.

For, it is well to be observed, first, that nature is corporeal, and therefore divisible; next, that nature is self-moving, and therefore never at rest. I do not mean exteriorly moving, for nature being infinite, is all within itself, and has nothing without, or beyond it, because it is without limits or bounds, but interiorly, so that all the motions that are in nature, are within herself. And being various and infinite in their changes, they divide the substance or body of nature into infinite parts. For the parts of nature, and changes of motion, are but one thing; for, were there no motion, there would be no change of figures.

It is true, matter in its own nature would be divisible, because wheresoever is body, there are parts. But, if it had no motion, it would not have such various changes of figures as it has. Wherefore it is well to be considered, that self-motion is throughout all the body of nature, and that no part or figure, how small soever, can be without self-motion. And according as the motions are, so are the parts. For infinite changes of motions make infinite parts. Nay, what we call one finite part may have infinite changes, because it may be divided and composed infinite ways.

By which it is evident, first, that no certain quantity or figure can be assigned to the parts of nature, as I said before of the grains of corn or sand. For infinite changes of motions produce infinite varieties of figures, and all the degrees of density, rarity, levity, gravity, slowness, quickness, nay, all the effects that are in nature.

Next, that it is impossible to have single parts in nature, that is, parts which are indivisible in themselves, as atoms, and may subsist single, or by themselves, precise or separated from all other parts. For, although there are perfect and whole figures in nature, yet they are nothing else but parts of nature, which consist of a composition of other parts, and their figures make them discernible from other parts or figures of nature. For example: an eye, although it be composed of parts, and has a whole and perfect figure, yet it is but a part of the head, and could not subsist without it. Also the head although it has a whole and perfect figure, yet it is a part of the body, and could not subsist without it. The same may be said of all other particular and perfect figures. As for example, an animal, though it be a whole and perfect figure, yet it is but a part of Earth, and some other

elements, and parts of nature, and could not subsist without them. Nay, for any thing we know to the contrary, the elements cannot subsist without other creatures.

All of which proves, that there are no single parts, no vacuum, nor any composition of loose atoms in nature. For if such a whole and perfect figure should be divided into millions of other parts and figure, yet it is impossible to divide it into single parts, by reason there is as much composition as there is division in nature. And as soon as parts are divided from such or such parts, at that instant of time, and by the same act of division, they are joined to other parts. And all this, because nature is a body of continued infiniteness, without any wholes or vacuities.

Nay, were it possible that there could be a single part, that is, a part separated from all the rest, yet being a part of nature, it must consist of the same substance as nature herself. But nature is an infinite composition of rational, sensitive and inanimate matter, which although they constitute one body, because of their close and inseparable conjunction and commixture, nevertheless, they are several parts, (for one part is not another part) and therefore every part or particle of nature, consisting of the same commixture, cannot be single or indivisible.

Thus it remains firm that self-motion is the only cause of the various parts and changes of figures, and that when parts move or separate themselves from parts, they move and join to other parts, at the same point in time. I do not mean, that parts do drive or press upon each other, for those are forces and constraint actions, when as natural self-motions are free and voluntary. And although there are pressures and reactions in nature, yet they are not universal actions. Neither is there any such thing as a stoppage in the actions of nature, nor do parts move through empty spaces. But as some parts join, so others divide by the same act. For, although some parts can quit such or such parts, yet they cannot quit all parts.

For example, a man goes a hundred miles, he leaves or quits those parts from when he removes first. But as soon as he removes from such parts, he joins to other parts, were his motion no more than a hair's breadth. So that all his journey is nothing else but a division and composition of parts. Wheresoever he goes, by water, or by land, for it is impossible for him to quit parts in general, although it be in his choice to quit such or such particular parts, and to join to what parts he will.

When I speak of motion, I desire to be understood that I do not mean any other but corporeal motion. For there is no other motion in

nature. So that generation, dissolution, transformation, nay, all the actions of sense and reason, both interior, and exterior, and what motions soever in nature, are corporeal, although they are not all perceptible by our exterior senses. For our senses are too gross to perceive all the curious and various actions of nature. And it would be but a folly to deny what our senses cannot perceive. For, although sense and reason are the same in all creatures and parts of nature, not having any degree in themselves, no more than self-knowledge has (for self-knowledge can but be sense and reasons) yet they do not work in all parts of nature alike, but according as they are composed. And therefore it is impossible for any human eye to see the exterior motions of all creatures, except they be of some grosser bodies. For who can see the motion of the air and the like? Nay, I believe not, that all exterior motions of grosser bodies can be perceived by our sight, much less their interior actions.

And by this, I exclude rest. For, if matter, or corporeal nature, be in perpetual motion, there can be no rest in nature. But what others call rest is nothing else but retentive motion, which retentive motions are as active as dispersing motions. For Mr. Descartes says well, that it requires as much action or force to stay a ship as to set it afloat, and there is as much action required in keeping parts together as in dispersing them.[9] Besides, interior motions are as active as some exterior, nay, some more. And I believe, if there were a world of gold, whose parts are close and dense, it would be as active interiorly as a world of air, which is fluid and rare, would be active exteriorly.

But some may say, how is it possible that there can be a motion of bodies, without an empty space, for one body cannot move in another body? I answer, space is a change of division, as place is a change of magnitude, but division and magnitude belong to body. Therefore space and place cannot be without body, but wheresoever is body, there is place also. Neither can a body leave a place behind it. So that the distinction of interior and exterior place, is needless, because no body can have two places, but place and body are but one thing. And whensoever body changes, its place changes also.

But some do not consider that there are degrees of matter. For nature's body does not consist of one degree, as to be all hard and dense like a stone. But as there are infinite changes of motion, so there are in nature

9. Descartes discusses this in his *Principles of Philosophy*, Part II, section 26.

infinite degrees of density, rarity, grossness, purity, hardness, softness, etc., all caused by self-motion. Which hard, gross, rare, fluid, dense, subtle, and many other sorts of bodies, in their several degrees, any more easily move, divide and join, from and with each other, being in a continued body, than if they had a vacuum to move in. For were there a vacuum, there would be no successive motions, nor no degrees of swiftness or slowness, but all motions would be done in an instant. The truth is, there would be such distances of several gaps and holes, that parts would never join, if once divided. In so much as a piece of the world would become a single particular world, not joining to any part besides itself, which would make a horrid confusion in nature, contrary to all sense and reason.

Wherefore the opinion of vacuum is, in my judgment, as absurd as the opinion of senseless and irrational atoms, moving by chance. For it is more probable that atoms should have life and knowledge to move regularly, than that they should move regularly by chance, and without life and knowledge, for there can be no regular motion, without knowledge, sense and reason. And therefore those that are for atoms had best to believe them to be self-moving, living and knowing bodies, or else their opinion is very irrational.

But the opinion of atoms is fitter for a poetical fancy than for serious philosophy. And this is the reason that I have waved it in my philosophical works. For, if there can be no single parts, there cannot be atoms in nature, or else nature would be like a beggar's coat full of lice; neither would she be able to rule those wandering and straggling atoms, because they are not parts of her body by itself, having no dependence upon each other. Wherefore, if there should be a composition of atoms, it would not be a body made of parts, but of so many whole and entire single bodies, meeting together as a swarm of bees. The truth is, every atom being single, must be an absolute body by itself, and have an absolute power and knowledge, by which it would become a kind of deity. And the concourse of them would rather cause a confusion, than a conformity in nature, because all atoms being absolute, they would all be governors, but none would be governed.

. . .

But to conclude this discourse, I desire it may be observed,

1. That whatsoever is body, were it an atom, must have parts; so that body cannot be without parts.

2. That there is no such thing as rest or stoppage in infinite matter, but there is self-motion in all parts of nature, although they are not all exteriorly, locally moving to our perception, for reason must not deny what our senses cannot comprehend. . . .

3. That, without motion, parts could not alter their figures; neither would there be any variety in infinite nature.

4. If there were any such thing as atoms, and vacuum, there would be no conformity, nor uniformity in nature.

Lastly, as there is a perpetual self-motion in nature and all her parts, so is it impossible that there can be perfect measures, constant figures, or single parts in nature.

CHAPTER 35

OF KNOWLEDGE AND PERCEPTION IN GENERAL

SINCE natural knowledge and perception is the grounded principle not only of philosophy both speculative and experimental, but of all the other arts and sciences, nay of all the infinite particular actions of nature, I thought it not amiss to join to the end of this part a full declaration of my opinion concerning that subject.

First, it is to be observed that matter, self-motion and self-knowledge are inseparable from each other, and make nature one material, self-moving, and self-knowing body. To say *inseparable from each other,* in my opinion, seems as if they were different parts, and not different properties of the same part.

2. Nature being material, is dividable into parts, and being infinite in quantity or bulk, her parts are infinite in number.

3. No part can subsist singly, or by itself, precised from the rest, but they are all parts of one infinite body. For though such parts may be separated from such parts, and joined to other parts, and by this means may undergo infinite changes, by compositions and divisions, yet no part can be separated from the body of nature.

4. Hence it follows, that the parts of nature are nothing else but the particular changes of particular figures, made by self-motion.

5. There can be no annihilation, so there can neither be a new creation of the least part or particle of nature, or else nature would not be infinite.

6. Nature is purely corporeal or material and there is nothing that belongs to, or is a part of nature which is not corporeal. So that natural material, or corporeal, are one and the same. And therefore spiritual beings, beings, mixed beings, and whatsoever distinctions the learned do make, no ways belonging to nature. Neither is there any such thing as an incorporeal motion, for all actions of nature are corporeal, being natural. And there can be no abstraction of motion or figure, from matter or body, but they are inseparably one thing. No spiritual being can have local motion.

7. Infinite matter is divided into infinite parts, so infinite knowledge is divided into infinite particular knowledges, and infinite self-motion into infinite particular self-actions.

8. There is no other difference between self-knowledge and particular knowledges, than betwixt self-motion in particular self-actions, betwixt a whole and its parts, a cause and its effects. For self-knowledge is the ground and principle of all particular knowledges, as self-motion is the ground and principle of all particular actions, changes and varieties of natural figures.

9. As infinite nature has an infinite self-motion and self-knowledge, every part and particle has a particular and finite self-motion and self-knowledge, by which it knows its self, and its own actions, and perceives also other parts and actions, later is properly called perception. Not as if there were two different principles of knowledge in every particular creature or part of nature, but they are two different acts of one and the same interior and inherent self-knowledge, which is a part of nature's infinite self-knowledge.

10. Thus perception, or a perceptive knowledge, belongs properly to parts, and may also be called an exterior knowledge, by reason it extends to exterior objects.

11. Though self-knowledge is the ground and principle of all the particular knowledges and perceptions, yet, self-motion, since it is the cause of all the variety of natural figures and of all the various compositions and divisions of parts, is also the cause of all perceptions.

12. There is a double degree of corporeal self-motion, viz. rational and sensitive, so there is also a double degree of perception, rational and sensitive.

13. A whole may know its parts, and an infinite a finite, but no particular parts can know its whole nor one finite part of that which is finite. I say no particular part, for, when parts are regularly composed, they may by a general conjunction or union of their particular knowledges and perceptions, know more, and so judge more probably of the whole or of infinite. Although by the division of parts, those composed knowledges and perceptions may be broke asunder like a ruined house or castle, kingdom or government, yet some of the same materials may chance to be put to the same uses, and some may be joined to those that formerly employed themselves other ways. And hence I conclude that no particular parts are bound to certain particular actions, no more than nature herself, which is self-moving matter. For, as nature is full of variety of motions or actions, so are her parts, or else she could not be said self-moving, if she were bound to certain actions, and had not liberty to move as she pleases. For, though God, the author of nature, has ordered her, so that she cannot work beyond her own nature, that is, beyond matter, yet she has the freedom to move as she will. Neither can it be certainly affirmed that the successive propagation of the several species of creatures is decreed and ordained by God, so that nature must of necessity work to their continuation and can do no otherwise.

But human sense and reason may observe that the same parts keep not always to the same particular actions, so as to move the same species or figures. For those parts that join the composition of an animal alter their actions in its dissolution and in the framing of other figures, so that the same parts which were joined in one particular animal may, when they dissolve from that composed figure, join severally to the composition of other figures, as for example, of minerals, vegetable, elements, etc. And some may join with some sorts of creatures, and some with others, and so produce creatures of different sorts, when as before they were all united in one particular creature. For particular parts are not bound to work or move to a certain particular action, but they work according to the wisdom and liberty of nature, which is only bound by the omnipotent god's decree, not to work beyond herself, that is, beyond matter. And since matter is dividable, nature is necessitated to move in parts, for matter can be without parts no more than parts can be without a whole. Neither

can nature, being material, make herself void of figure, not can she rest, being self-moving, but she is bound to divide and compose her several parts into several particular figures, and dissolve and change those figures again in infinite ways. All which provides the variety of nature, which is so great, that even in one and the same species, none of the particulars resemble one another so much, as not to be discerned from each other.

But to return to knowledge and perception. I say, they are general and fundamental actions of nature, it being not probable that the infinite parts of nature should move so variously, nay, so orderly and methodically as they do, without knowing what they do, or why, and whether they move. And therefore all particular actions whatsoever in nature, as respiration, digestion, sympathy, antipathy, division, composition, pressure, reaction, etc. are all particular perceptive and knowing actions. For, if a part be divided from other parts, both are sensible of their division. The like may be said of the composition of parts. And as for pressure and reaction, they are as knowing and perceptive as any other particular actions. But yet this does not prove that they are the principle of perception, and that there's no perception but what is made by pressure and reaction, or that at least they are the ground of animal perception.[10] For as they are no more than particular actions, so they have but particular perceptions. And although all motion is sensible, yet no part is sensible but by its own motions in its own parts. That is, no corporeal motion is sensible but of or by itself. Therefore when a man moves a string, or tosses a ball, the string or ball is no more sensible of the motion of the hand than the hand is of the motion of the string or ball, but the hand is only an occasion that the string or ball moves thus or thus. I will not say, but that it may have some perception of the hand, according to the nature of its own figure, but it does not move by the hand's motion, but by its own. For there can be no motion imparted without matter or substance.

Neither can I certainly affirm that all perception consists in patterning out external objects. For, although the perception of our human senses is made that way, yet nature's actions being so various, I dare not conclude from thence, that all the perceptions of the infinitely various parts and figures of nature are all made after the same manner. Nevertheless, it is probable to sense and reasons, that the infinite parts of nature have not only interior self-knowledge, but also exterior perception of other figures

10. Cavendish is targeting the mechanical account of perception, as found in Hobbes, among others. See the excerpt from Hobbes included in this volume.