An Inquiry into the Human Mind

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[Brackets] enclose editorial explanations. Small ·dots· enclose material that has been added, but can be read as though it were part of the original text. Occasional •bullets, and also indenting of passages that are not quotations, are meant as aids to grasping the structure of a sentence or a thought. Every four-point ellipsis . . . . indicates the omission of a short passage that seems to present more difficulty than it is worth. Longer omissions are reported beween square brackets in normal-sized type.

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Chapter 6: Seeing

1. The excellence and dignity of this faculty

The advances made in the knowledge of optics in the last age and in the present—chiefly the discoveries of Sir Isaac Newton—reflect credit not only on philosophy [here = 'science'] but also on human nature. Such discoveries ought for ever to put to shame the low attempts of our modern sceptics to downgrade the human understanding and to discourage men in their search for truth by representing the human faculties as no good for anything except to lead us into absurdities and contradictions.

Sight is certainly the noblest of the faculties called 'the five senses'. The rays of light that serve this sense, and that we couldn't have had the least conception of if we *didn't* have this sense, are the most wonderful and astonishing part of the inanimate creation. We must be sure of this if we consider

- their extreme minuteness,
- their inconceivable speed,
- the regular variety of colours that they exhibit,
- the invariable laws according to which they are acted on by other bodies that reflect, diffract and refract them without changing their intrinsic properties, and
- the ease with which they pervade bodies of great density and of the closest texture (·bodies such as clear glass·): they aren't resisted, they don't crowd or disturb one another, and yet they don't push around even the lightest bodies.

The structure of the eye and of all its accessories, the admirable way in which nature has provided for it to perform all its various external and internal motions, and the way the eyes of different animals vary according to their various natures and ways of life—all this clearly demonstrates the eye to be one of nature's masterpieces. Someone who can seriously *wonder whether* the rays of light and the eye were made for one another—made with utter wisdom and perfect skill in optics—must either be very ignorant of what has been discovered about this or have a very strange kind of understanding.

Let us (·through this and the next two paragraphs·) imagine beings who have every human faculty but that of sight. How incredible it would appear to them, accustomed as they would be only to the slow input of information through touch, that by the addition of an organ consisting of a ball and socket of an inch diameter they could in an instant of time, without moving about, perceive the disposition of a whole army or the order of a battle, the shape of a magnificent palace, or all the variety of a landscape? If a man tried to discover through *touch* the shape of the peak of Teneriffe or even of St. Peter's church in Rome, it would be the work of a lifetime!

It would seem even more incredible to the beings we are imagining if they were informed of the discoveries that can be made by this little organ in things far beyond the reach of any other sense. That by means of it we can find our way in the pathless ocean; that we can go around the globe of the earth, discover its shape and dimensions and mark out every region of it. Indeed, that we can measure the planets and make discoveries as far away as the fixed stars.

Wouldn't it seem still more astonishing to our imagined beings if they were also told that by means of this same organ we can perceive our fellow-creatures' moods and

dispositions, passions and affections, even when they most want to conceal them? That when the tongue is taught most skillfully to lie and conceal, the hypocrisy will show in the face to a discerning eye? And that by this organ we can often perceive what is straight and what is crooked in the mind as well as in the body? If a blind man is to trust the reports of sighted people, what a lot of mysterious things he will have to believe! Surely he will need as strong a faith as is required of a good Christian. So there is good reason for the faculty of seeing to be regarded not only as •nobler than the other senses but as •being in some way *higher* than mere sensation. When reason makes something evident to us we call this 'seeing'—·how an argument works, that an explanation is confused·—not feeling, smelling or tasting. Indeed, we are given to speaking of God's knowledge as a matter of 'seeing', because this is the kind of knowledge that is most perfect in us.

2. Sight reveals almost nothing that the blind can't *comprehend*. The reason for this

Despite what I have said about the dignity and superior nature of this faculty, we should bear in mind that almost all of the knowledge acquired by sight can be communicated to ·and thus understood by· a man born blind. Someone who never saw light may be learned and knowledgeable in every science, even in optics; and may make discoveries in every branch of philosophy. He may understand as much as anyone else not only about the order, distances and motions of the heavenly bodies but about the nature of light and the laws of the reflection and refraction of its rays. He may have a firm grasp of how those laws produce the phenomena of the rainbow, the prism, the camera obscura and the magic lantern, and all the powers of the microscope and telescope. This is a fact sufficiently attested by experience. [Reid's use of 'visible' from here on calls for comment. Ordinarily to call a thing 'visible' is to say that it *can be seen*; but when Reid speaks of the 'visible appearance' of something he doesn't mean that the appearance is *seen*. He knows as well as we do that what is seen is the object 'suggested' by the appearance.] In order to see why it is so, we must distinguish the •appearance that objects make to the eye from the •things suggested by that appearance; and we must make a distinction *within* the visible appearance of objects, between the •appearance of colour and the •appearance of extension, shape and motion. Starting then with the visible appearance of the shape, motion and extension of bodies, I think that a man born blind can have a clear notion if not of those appearances themselves at least of something extremely like them. Can't a blind man be made to conceive that

- •a body moving directly from the eye or directly toward it may appear to be at rest?
- •the same motion may appear quicker or slower depending on whether it is nearer to the eye or further off, more direct or more oblique?
- •a plane surface with a certain orientation may appear as a straight line, and vary its apparent shape as its orientation or that of the eye is varied?
- •a circle seen obliquely will appear an ellipse; and a square seen obliquely will appear a rhombus or an oblong rectangle?

['Orientation' here replaces Reid's 'position'. He uses 'position' in this sense in sections 2-4, 7, 11-12. A few occurrences might mean 'orientation' but might mean 'place'.] Dr. Saunderson understood the projection of the sphere and the common rules of perspective, so he must have understood all the facts that I have listed. In case you have doubts about Dr. Saunderson's understanding of these things, I report that I once heard him talk about the

proposition that

> the angles made by the circles of the sphere are equal to the angles made by their representatives in the stereographic projection.

He said that had great difficulty understanding Dr. Halley's demonstration of that proposition; but 'when I laid aside that demonstration and considered the proposition in my own way, I saw clearly that it must be true'. . . .

A blind man must be more at a loss regarding •the appearance of colour because he has no perception that resembles •it. Yet he may partly make up for this lack by a kind of analogy. To those who see,

> a scarlet colour signifies an unknown quality in bodies that gives to the eye an appearance that they are well acquainted with and have often observed;

whereas to a blind man

> a scarlet colour signifies an unknown quality that gives to the eye an appearance that he is not acquainted with.

But he can conceive the eye to be differently affected by different colours, as the nose is by different smells, or the ear by different sounds. Thus he can conceive •scarlet to differ from •blue as •the sound of a trumpet differs from •the sound of a drum or as •the smell of an orange differs from •the smell of an apple. It is impossible to know whether a scarlet colour has the same appearance to me as to someone else, and if the appearances of it to different persons differed as much as colour does from sound, we might never be able to discover this difference. So it seems obvious that a blind man might talk about colours, clearly and relevantly, for a long time; and if you quizzed him in the dark about the nature, composition and beauty of colours, he might be able to answer without giving away the fact that he is blind.

We have seen how much a blind man can come to know about the appearances that things make to the eye. As to the ·external· things that are suggested by or inferred from those appearances, although he could never *discover* them on his own he may still *understand* them perfectly when others inform him about them. Everything of this sort that enters into our minds by the eye may enter into his by the ear. Thus, for instance, if left to the direction of his own faculties he could never have dreamed of any such thing as light; but he can be informed of everything we know about it. He can conceive as clearly as we can the minuteness and velocity of its rays, the different degrees to which they can be refracted and reflected, and all the magical powers and virtues of that wonderful element. He could never have found out for himself that there are such bodies as the sun, moon and stars; but he can be informed of all the noble discoveries of astronomers concerning the motions of these bodies and the laws of nature that regulate them. It seems, then, that there is very little knowledge acquired through the eye that couldn't be communicated by language to those who have no eyes.

Suppose it were as uncommon for men to see as it is in fact for men to be born blind. In that case, wouldn't the few who had this rare gift appear as prophets and inspired teachers to the many? Think about how we conceive inspiration:

> We think of a man's inspiration not as a new faculty, but as something that communicates to him in a new way, and by extraordinary means, •what the faculties common to mankind can take in and apprehend, and •what he can communicate to others by ordinary means.

On the present supposition ·of sightedness as rare and blindness as the norm·, sight would appear to the blind

to be very similar to this; for the few who had this gift could communicate the knowledge acquired by it to those who lacked it. They couldn't convey to the blind any clear notion of *how* they acquired this knowledge: to these blind people •a ball in a socket (·which is what an eye *is*·) would seem as unsuitable for acquiring such a variety and extent of knowledge as •a dream or •a vision. *How* a sighted man detects so many things by means of the eye is as unintelligible to the blind as *how* a man can be inspired with knowledge by God is unintelligible to us. Should this lead the blind man to dismiss as fraudulent all claims to be able to see, without putting them to any test? If he were fair and open-minded, mightn't he find reasonable evidence of the reality of this gift of eyesight in others, and get great advantages from it for himself?

To get a sound notion of nature's intention in giving us eyes, we must invoke the distinction I have drawn between •the visible appearances of the objects of sight and •things suggested by them. If we pay proper attention to how our mind operates in our use of this faculty, we shall become aware that •the visible appearance of objects is something we hardly ever notice. We don't think about it or reflect on it; all it does for us is to serve as a sign to introduce to the mind •something else, something that could also be clearly conceived by people who never saw.

Thus, the visible appearance of things in my room varies almost every hour depending on whether the day is clear or cloudy, whether the sun is in the east or south or west, whether my eye is in one part of the room or in another; but I never think about these variations as anything but signs of a clear or cloudy sky or of morning, noon, or night. A book or a chair has appears differently to the eye from different distances and seen at different angles; yet we think of it as still the same; and, overlooking the ·varying· appearance, we immediately conceive the real shape, distance and orientation of the body, of which its visible or perspective appearance is a sign and indication.

When I see a man at a distance of ten yards and later at a hundred yards, his visible appearance in its length, breadth and all its linear proportions is ten times less in the second case than in the first, but I don't think of him as one inch shorter because of this lessening of his visible appearance. Indeed, *I pay no attention at all* to this lessening, even when I draw from it the conclusion that he is now further away. For such is the subtlety of the mind's operation in this case that we draw the •conclusion without noticing that the •premises ever entered the mind! A thousand such instances might be produced, to show that the visible appearances of objects are intended by nature only as signs or indications; and that the mind passes *instantly* to the things that are signified, without reflecting in the least on the sign or even noticing that there is any such thing. In something like the same way, if we are familiar with a language we overlook its sounds and attend only to the things signified by them. So Berkeley said something true and important when he remarked that the visible appearance of objects is a kind of *language* used by nature to inform us of objects' distance, size and shape. And that ingenious writer has made good use of this point in explaining some phenomena in optics which had previously perplexed the greatest masters in that science. The point is further improved upon by the judicious Dr. Smith in his *Optics*, for explaining the apparent shape of the sky and the apparent distances and sizes of objects seen with glasses, or by the naked eye.

Trying not to repeat what has been said by these excellent writers, I shall avail myself of the distinction between •the signs that nature uses in this 'visual language' and •the things signified by them. Let us start with the signs.

3. The visible appearances of objects

In this section I have to talk about things that are never made the object of reflection, although at almost every moment they are presented to the mind. Nature intended them only as signs, and throughout our lives that is all we use them for. The mind has acquired an ingrained habit of *in*attention to them: no sooner do they appear than—quick as lightning—the thing signified takes over and occupies all our attention. Although we are conscious of the appearances when they pass through the mind, their passage is so fast and so familiar that it is absolutely unnoticed; and they leave no footsteps of themselves in the memory or in the imagination. They have no name in ·any· language. I showed in chapter 5 that all this holds with regard to the sensations of •touch; well, it holds just as much for the •visible appearances of objects.

So I haven't the slightest hope of being intelligible to readers who haven't through effort and practice acquired the habit of distinguishing •the appearances of objects to the eye from •the judgments that we form (on the basis of those appearances) of their colour, distance, size, and shape. The only profession in life where this distinction has to be made is that of *painting*. The painter has a need for an abstraction regarding visible objects somewhat similar to what we need here, and this is indeed the most difficult part of his art. For it is obvious that if he could fix in his imagination the visible appearance of objects, not confusing it with the things it signifies, it would be as easy for him to •paint from the life—giving every figure its proper shading and relief, and its perspectival proportions—as to •paint from a copy. Perspectival shading, giving relief, and colouring are merely *copying the appearance that things make to the eye*. So we may borrow some light on the subject of visible appearance from the art of painting.

Look at any familiar object, perhaps a book, at different distances and with different orientations; can't you say on the testimony of your sight that it is the same book, whether seen from one foot away or from ten, whether with one orientation or another? That the colour is the same, the dimensions the same, and the shape the same, as far as your eye can judge? Surely you will answer Yes. Well, then, we have one individual object presented to the mind from different distances and in different positions. Does this object have the same appearance to the eye at these different distances? Quite certainly it does not. Here are ·four· reasons for saying this.

(1) However certain our judgment may be that the colour is the same, it is equally certain that it *doesn't* have the same appearance at different distances. There is a certain degradation of the colour, and a certain confusion and indistinctness of the minute parts, which naturally results from the object's being moved to a greater distance. Those who are not painters or critics of painting overlook this fact, and can't easily be persuaded that the colour of one object has a different appearance at a distance of one foot and of ten, in the shade and in the light. But the masters of painting know how to degrade the colour and the confuse the minute parts so that figures that on the same canvas and at the same distance from the eye are made to represent objects that are at very different distances. They know how to make *the objects appear to be of the same colour* by making *their pictures really of different colours* depending on their distances or shades.

(2) Everyone who knows the rules of perspective knows that the appearance of the shape of the book must vary with every different orientation; but if you ask a man who has no notion of perspective 'Doesn't the shape of the book appear

to your eye to be the same in all its different orientations?' he can with good conscience answer that it does. He has learned to make allowances for the variety of visible shapes arising from the difference of orientation, and to draw the proper conclusions from it. But he draws these conclusions so smoothly and habitually that he loses sight of the premises; so when he has concluded that the shape has remained the same he thinks that the visible appearance must also have been the same.

(3) Let us consider the apparent size or dimensions of the book. Seen from one foot away or from ten, it seems to be about seven inches long, five wide, and one thick. I can judge these dimensions pretty accurately by the eye, and I judge them to be the same at both distances. Yet it is *certain* that at the distance of one foot its visible length and breadth are about ten times as great as they are at the distance of ten feet; so its ·visible· surface is about a hundred times as great. This great change in apparent size is overlooked entirely, and everyone is apt to imagine that it appears to the eye to be of the same size at both distances. Furthermore, when I look at the book it seems plainly to have three dimensions—length, width, and thickness—but it is *certain* that the visible appearance has no more than two and can be exactly represented on a canvas that has only length and width.

(4) Doesn't everyone, by sight, perceive the distance of the book from his eye? Can't he affirm with certainty that in one case it isn't more than one foot away and that in another it is ten? Nevertheless, it appears certain that distance from the eye is not an immediate object of sight. Certain things in the visible appearance are *signs of* distance from the eye, and I'll show later that from these signs we learn *by experience* to estimate that distance within certain limits. ·I emphasize 'by experience·: it seems beyond doubt that a man who had been born blind and was suddenly made to see could not *at first* form any judgment about the distance of the objects that he saw. The young man couched by Cheselden thought at first that everything he saw touched his eye, and learned only by experience to judge of the distance of visible objects. [Couching was a surgical procedure—displacing the opaque lens of the eye downwards into the vitreous by means of a needle.]

I have gone into all this detail in order •to show that the visible appearance of an object is *very* different from the notion of the object that experience teaches us to form by sight, and •to enable you to attend to the visible appearance of colour, shape and extension in visible things. Such an appearance is not a common object of thought, but it must be carefully attended to by those who want to enter into the philosophy ·and science· of the visual sense, or want to understand what others say about it. To a man who had just gained eyesight the •visible appearance of objects would be the same as to us, but he wouldn't see anything of their •real sizes as we do. With only his sight to go by, he couldn't form any conjecture concerning how many inches or feet they were in length, breadth or thickness. He could perceive little or nothing of their real shape; nor could he tell that this was a cube and that a sphere, that this was a cone and that a cylinder. His eye couldn't inform him that this object was near and that one further away. The clothing of a man or of a woman, appearing to us to be of one uniform colour but variously folded and shaded, would present to his eye no fold, no shading, but a variety of colour. In short, however perfect his eyes were they would at first give him almost no information about things in his environment. They would present the same appearances to him as they do to us, and speak the same 'language' ·as Berkeley called it·; but to him it would be an unknown language, ·a foreign tongue·; and therefore he would attend only to the signs themselves

without knowing what they signify, whereas to us it is a perfectly familiar language and therefore we take no notice of the signs but attend only to the things they signify.

4. Colour is a quality of bodies, not a sensation in the mind

Anyone who hasn't been tutored by modern philosophy understands 'colour' to be the name *not* of •a sensation in the mind that can't exist except when it is perceived but *rather* •a quality or state of bodies that continues to be the same whether or not it is seen. The scarlet rose that is in front of me now remains a scarlet rose when I shut my eyes, and was scarlet also at midnight when no eye saw it. The colour remains when the appearance ceases; it remains the same when the appearance changes. For when I view this scarlet rose through a pair of green spectacles the appearance is changed, but I don't conclude that the colour of the rose changed. To a person with jaundice it has still another appearance; but he is easily convinced that the change is in his eye and not in the colour of the object. Every difference in the brightness of light makes the rose have a different appearance, and total darkness takes away all appearance, but it doesn't make the least change in the colour of the rose. Through various optical experiments we can change the appearance of a body's shape and size as well of its colour; we can make one body appear to be ten. But no-one thinks that a multiplying glass produces ten guineas out of one, or that a microscope turns a guinea into a ten-pound piece; and similarly no-one thinks that a coloured glass changes •the real colour of the object seen through it when it changes •the appearance of that colour.

The common language of mankind shows clearly that we ought to distinguish •the colour of a body, which is conceived to be a fixed and permanent quality of it, from •the appearance of that colour to the eye, which may be varied a thousand ways depending on the light, the medium or the eye itself. The body's permanent colour is the *cause* of all this variety of appearances, which it causes through the mediation of various kinds and intensities of light and of various transparent bodies in between. When a coloured body is presented, there appears to the eye, or to the mind, something that I have called 'the appearance of colour'. Mr. Locke calls it 'an idea', and there is nothing wrong with that. This idea can't exist except when it is perceived. It is a kind of thought, and can only be an act *of* a perceiving or thinking being. Our natural constitution leads us to think of this idea as a sign of something external, and to be impatient until we learn its meaning. A thousand experiments for this purpose are made every day by children, even before they come to the use of reason. They look at things, they handle them, they put them in various orientations at different distances and in different lights. The ideas of sight thus come to be associated with, and readily to suggest, things that are external and altogether unlike them. In particular, the idea that I have called 'the appearance of colour' suggests the conception of and belief in some unknown quality in the body, which occasions the idea; and we give the name 'colour' to this quality and not to the idea. Although the various colours are in their nature equally unknown, we easily distinguish them in our thought and talk by associating them with the ideas they cause. In the same way such unknown qualities as gravity, magnetism and electricity are distinguished by their different effects. As we grow up, the mind becomes accustomed to passing so rapidly from the ideas of sight to the external things suggested by them that we don't pay the least attention to the ideas and don't give them names in common language.

When we think or speak of any particular colour, the notion that is presented to the imagination may seem to be perfectly simple, but it is really in a way compounded. ·That is, it seems not to have different parts, but it is really *complex* or made up of constituent elements, because· it involves •an unknown cause and •a known effect. The name 'colour'—·like the more specific names 'blue', 'yellow' and so on·—belongs only to the cause and not to the effect. But because the cause is unknown, our only way of thinking exclusively about *it* is by its relation to the known effect; so the two go together in the imagination, so tightly linked that they are mistaken for one simple object of thought. When I want to think about the colours of bodies that we call 'scarlet' and 'blue', if I conceived them only as unknown qualities I wouldn't be able to perceive any distinction between them. In order to keep them apart in my mind, therefore, I have to link each of them, in my imagination, with •some effect or some relation that it has and the other doesn't; and the most obvious candidate is •the appearance that it makes to the eye. So it comes about that in the imagination the appearance is so tightly linked with the quality called 'a scarlet colour' that they are apt to be mistaken for one and the same thing—different though they are in reality, one being an idea in the mind and the other a quality of body.

I conclude, then, that colour is not a sensation but a 'secondary quality' of bodies, in the sense I have explained; that it is a certain power in bodies which in full daylight exhibits to the eye an appearance that is very familiar to us although we have no name for it. Colour differs in one way from other secondary qualities: whereas ·with them· the name of the quality is sometimes given to the sensation that indicates it and is occasioned by it, we seem never to give the name of colour to the sensation but only to the quality. This may be because the appearances of the same colour are so various and changeable, depending on details of the light, the medium and the eye, that language couldn't afford names for them. And indeed they are of so little interest that they are never attended to, but serve only as signs to introduce the things signified by them. It shouldn't seem incredible that such frequent and familiar appearances have no names and are ·usually· not thought about; because I have already shown that the same is true of many sensations of *touch*, which are just as frequent and familiar.

5. An inference from the foregoing

From what I have said about colour we can infer two things, ·to which I shall devote a section each·. The first is that one of the most remarkable paradoxes of modern philosophy, which has been universally admired as a great discovery, turns out when thoroughly examined to be nothing but a misuse of words. I mean the paradox that

> colour isn't a quality of bodies but only an idea in the mind.

I have shown that the vulgar employ the word 'colour' to signify *not* an idea in the mind *but rather* a permanent quality of body. I have shown that there is really a permanent quality of body to which the common use of this word exactly agrees. Could you want a stronger proof that this quality is the one the vulgar call 'colour'? If you say 'This quality that *you* call "colour" is unknown to the vulgar, who therefore can't have any name for it', I reply:

> The quality is indeed known ·to the vulgar · only by its effects, i.e. by its causing a certain idea in us; but aren't there countless qualities of bodies that are known only by their effects, and which we nevertheless find it necessary to have names for? Medicine alone could provide us with a hundred examples;

> don't the words 'astringent', 'narcotic', 'epispastic' [= 'blister-producing'], 'caustic' and endless others signify qualities of bodies that are known only by their effects on animal bodies? So why shouldn't the vulgar have a name for a quality whose effects are every moment perceived by their eyes?

So we have all the reason that the nature of the thing admits, to think that the vulgar apply the name 'colour' to the quality of bodies that causes in us what the philosophers call the 'idea of colour'. That there *is* such a quality in bodies is agreed to by all philosophers who think there is any such thing as body. Philosophers have thought fit to

> •leave nameless the quality of bodies that the vulgar call 'colour', and to •give the name 'colour' to an idea or appearance that the vulgar leave nameless

because they never think about it or reflect on it. So it seems that when philosophers say that

> colour is not in bodies, but in the mind,

and the vulgar say that

> colour is not in the mind, but is a quality of bodies,

there is no difference between them about •things but only about •the meaning of a word. ·Even in a purely verbal disagreement, there can be a right side and a wrong, and in this case the philosophers are wrong·.The vulgar have an undoubted right to give names to things that they deal with daily, and it seems fair to accuse philosophers of misusing language when they change the meaning of a common word without giving warning ·that they are doing so·.

If it is a good rule—·as Berkeley said it is·—to 'think with philosophers and speak with the vulgar', it must be right to speak with the vulgar when we also think with them, and not to shock them by philosophical paradoxes which, when put into common language, express only the common sense of mankind.

If you ask a man who is not a philosopher 'What is colour?' or 'What makes one body appear white and another scarlet?' he can't tell. He leaves that inquiry to philosophers, and can embrace any hypothesis about it *except* the view of our modern philosophers who assert that colour is not in bodies but only in the mind.

Nothing strikes him as more shocking than that visible objects should have no colour, and that colour should be in something he thinks of as invisible! Yet this strange paradox is not only accepted by everyone but is considered as one of the finest discoveries of modern philosophy. The ingenious Addison, in the *Spectator* no. 413, says this about it:

> I have been assuming that my reader is acquainted with that great modern discovery, now universally accepted by all the inquirers into natural philosophy, namely, that light and colours as grasped by the imagination are only ideas in the mind and not qualities existing in matter. This is a truth that has been proved incontestably by many modern philosophers, and is indeed one of the finest theoretical achievements of that discipline. If the English reader wants to see this line of thought explained in detail, he could consult Locke's *Essay on the Human Understanding* Book II chapter 8.

Mr. Locke and Mr. Addison are writers who have deserved so well of mankind that one must feel uncomfortable disagreeing with them, and I wouldn't want to do less than justice to a 'discovery' that they value so highly. And indeed it is only fair to admit that Locke and other modern philosophers writing about secondary qualities have the merit of distinguishing more accurately than their predecessors did between •the sensation in the mind and •the constitution or quality of bodies that gives rise to the sensation. They have shown clearly that these two things are not only distinct ·from one

another· but altogether unalike; that there is no resemblance between the effluvia of an odorous body and the sensation of smell, or between the vibrations of a noise-making body and the sensation of sound; that there can be no resemblance between the feeling of heat and the constitution of the heated body that gives rise to it, or between the appearance a coloured body makes to the eye and the texture of the body that causes it.

It was a considerable achievement to distinguish these things accurately from one another; because, however different and unalike they are in their nature, they have been always so associated in the imagination as to coalesce (as it were) into one two-faced form whose dubiously double nature meant that it couldn't rightly be assigned either to body or mind; and neither body nor mind could be given due credit for this 'two-faced form' until it was properly sorted out into its different constituent parts. None of the ancient philosophers had made this distinction. The followers of Democritus and Epicurus thought the forms of heat and sound and colour to be in the mind only, but thought that our senses falsely represented them as being in bodies. The Aristotelians imagined that heat etc. are really in bodies, and that likenesses of them are conveyed to the mind by our senses.

One of these systems made the senses naturally false and deceitful; the other made the qualities of body resemble the sensations of the mind. To find a third system—·an alternative to both of these·—the distinction I have mentioned had to be made; and making it *did* avoid the errors of both those ancient systems, freeing us from the hard fate of having to believe either (·with the Aristotelians·) that our sensations are *like* the qualities of bodies or (·with Democritus·) that God has given us one faculty to deceive us and another to detect the deceit!

So it is a pleasure to do justice to the doctrine of Locke and other modern philosophers regarding colour and other secondary qualities, giving it the credit that is due; but I beg leave to criticize the language in which they have expressed their doctrine. When they had explained and established the distinction between •the appearance that colour makes to the eye and •the state of the coloured body which (by the laws of nature) causes that appearance, the question was whether to give the name 'colour' to •the cause or to •the effect. By giving it to the effect, as they have done, they have set philosophy apparently in opposition to common sense and exposed it to the ridicule of the vulgar. If only they had given the name 'colour' to the cause, as they ought to have done, they would then have had to join the vulgar in affirming that colour is a quality of bodies, and that there is no colour or anything *like* colour in the mind. Their language as well as their opinions would then have been perfectly agreeable to the ordinary thoughts of mankind, and true philosophy would have joined hands with common sense. Locke was no enemy to common sense, however; so we must presume that in this instance as in some others he was seduced by some generally accepted hypothesis; and in my next section I shall show that this was indeed the case.

6. None of our sensations resemble any of the qualities of bodies

Of the two inferences mentioned at the start of the preceding section, the second is that although colour is really a quality of body, it isn't represented to the mind by an idea or sensation that resembles it; on the contrary, it is suggested by an idea that doesn't resemble it even slightly. And this applies not only to colour but to all the qualities of body that I have examined.

It is worth noting that in the analysis I have so far given of the operations of the five senses and of the qualities of bodies discovered by them, there hasn't been a single instance of any sensation that resembles any quality of body, or of any quality of body whose image or resemblance is conveyed to the mind by means of the senses.

No phenomenon in nature is harder to explain than the transactions that are carried on between the mind and the external world; there is no phenomenon that philosophical minds have been more eager to dig into and to resolve. Everyone agrees that these transactions are carried on by means of the senses, and that's as much as the vulgar want to know; but philosophers want more. They must have some system, some hypothesis, that shows *how* our senses make us acquainted with external things. All the fertility of human invention seems to have produced only one hypothesis for this purpose, which therefore has been universally accepted. It is the theory that the mind, like a mirror, receives the images [= 'likenesses'] of things from outside it by means of the senses, so that the role of the senses is to convey these images into the mind.

These images of external things in the mind ·have been variously named·. We may call them 'sensible forms' or 'sensible species' with the Aristotelians; or 'ideas of sensation' with Locke; or with later philosophers (·especially Hume·) we may distinguish 'sensations', which are immediately conveyed by the senses, from 'ideas of sensation', which are faint copies of our sensations retained in the memory and imagination; but these are only differences about words. The hypothesis I have mentioned is common to all these different systems.

This hypothesis implies—and is agreed to imply—that no material thing or quality of material thing can be conceived by us or made an object of thought until its image has been conveyed to the mind by means of the senses. I shall examine this in detail later, and at present I merely point out two things that might be expected as the natural consequences of it:

- For every quality and attribute of bodies that we know or can conceive, there is a corresponding sensation which is the image and resemblance of that quality.
- Sensations that don't resemble bodies or any of their qualities can't give us any conception of a material world or of anything belonging to such a world.

Now I have already considered extension, shape, solidity, motion, hardness, roughness, as well as colour, heat and cold, sound, taste, and smell. I have tried to show, that our nature and constitution lead us to conceive these as qualities of bodies, as all mankind have always conceived them to be. I have likewise examined very attentively the various sensations we have by means of the five senses, and I couldn't find among them a single image [still = 'likeness'] of body or of any of its qualities. So those images of body and of its qualities that are ·allegedly· in the mind—where did they come from? Let philosophers answer this question. All I can say is that *they don't come through the senses*! I am sure that with proper attention and care I can know my sensations, and can say with certainty what they do and what they don't resemble. I have examined them one by one, comparing them with matter and its qualities, and I can't find *one* that shows up as having a resembling feature.

Our sensations are not images of matter or of any of its qualities—a truth as evident as *that* ought not to surrender to a hypothesis such as the one we are now considering, however ancient it may be or however universally accepted by philosophers. And there can't be any friendly reconciliation between the two—·i.e. between the evident truth and the time-honoured hypothesis·. To see that this is so, let us

reflect on the spirit of the ancient and modern philosophy concerning sensation.

During the reign of the Aristotelian philosophy, our sensations were not minutely or accurately examined. The attention of philosophers as well as of the vulgar was turned to the things signified by the sensations, with the result that in consequence of the ancient hypothesis it was taken for granted that all the sensations we have from external things are their forms or images. And thus the ·evident· truth I have mentioned surrendered entirely to the ·ancient· hypothesis and was altogether suppressed by it.

Descartes gave a fine example of turning our attention inward and examining our sensations, and this example has been very worthily followed by modern philosophers, particularly by Malebranche, Locke, Berkeley, and Hume [this is the first occurrence of Hume's name in Reid's text]. The effect of this scrutiny has been a gradual discovery of the truth that I have been discussing, namely that the sensations of our minds don't resemble the qualities or attributes of a non-sentient inert substance such as we conceive matter to be. But this valuable and useful discovery, in its different stages, has still been unhappily combined with the 'ancient hypothesis', and this unpromising pairing of two opinions that are so unfriendly and discordant in their natures has given rise to the monsters of paradox and scepticism of which the modern philosophy is all too fairly accused.

Locke saw clearly and proved conclusively that the sensations we have by taste, smell and hearing, as well as the sensations of colour, heat and cold, don't resemble anything in bodies; and in this he agrees with Descartes and Malebranche. Joining this opinion with the ·ancient· hypothesis, it follows necessarily that three of our five senses are cut off from telling us anything about the material world, as being altogether unfit for that task.

Smell and taste and sound, as well as colour and heat, can have no more relation to bodies than anger and gratitude do; and the former have no more right to be called qualities (whether primary or secondary) of bodies than do the latter. For it was natural and obvious to argue thus from that hypothesis:

- If heat etc. are real qualities of bodies, the sensations by which we perceive them must resemble those qualities;
- These sensations do not resemble any qualities of bodies;
- Therefore heat etc. are not real qualities of bodies.

We see then that Locke, having found that the ideas of secondary qualities are don't resemble any qualities of bodies, was compelled by a hypothesis common to all philosophers—·the 'ancient hypothesis'·—to deny that they are real qualities of body. It is harder to explain why after this he called them 'secondary qualities' (I gather that he invented this name for them). Surely he didn't mean that they were secondary qualities *of the mind*; and I don't see what could make it even slightly right to call them secondary qualities *of bodies* after concluding that they aren't qualities of bodies at all. In this he seems to have bowed down to common sense and to have been led by her authority even when it went against his hypothesis. The same supreme mistress of our opinions that led this philosopher to call things 'secondary qualities of bodies', when according to his own principles and reasonings they weren't qualities of bodies at all, has led not merely the vulgar of all ages but also philosophers—even the disciples of Locke—to believe them to be real qualities of bodies. She has led them to conduct experiments concerning the nature of colour, sound and heat, in bodies. If there had been no such thing in bodies, this investigation would have been fruitless, but in fact it has produced very noble and useful

discoveries that constitute a very considerable part of natural philosophy. If then natural philosophy is not a dream, there *is* something in bodies that we call 'colour', 'heat' and 'sound'. And if this is so, the hypothesis from which the contrary is concluded must be false; for an argument that leads to a false conclusion rebounds against its premise and directs its forces backwards. If the qualities of bodies were known to us only by sensations that resemble them, then colour etc. couldn't be qualities of bodies; but colour etc. *are* real qualities of bodies; therefore the qualities of bodies are not known only by means of sensations that resemble them.

Moving on now: what Locke had proved with regard to the sensations that we have by smell, taste and hearing, Bishop Berkeley proved just as conclusively with regard to all our other sensations—namely that *none* of them can in the least resemble the qualities of a lifeless and non-sentient being such as matter is conceived to be. Mr. Hume has confirmed this by his authority and reasoning. This ·new· opinion surely casts a very unfavourable light on the ancient hypothesis; yet that hypothesis has still been retained and been conjoined with the new opinion. And what a brood of monsters *this* has produced!

The firstborn of this union, and perhaps the most harmless, was ·the thesis that· the secondary qualities of body were mere sensations of the mind. Next comes Malebranche's notion of 'seeing all things in the ideas of the divine mind', but I shall pass that by as it was a foreigner who never became naturalized in this island. After that there was Berkeley's thesis that extension and shape and hardness and motion are nothing but ideas of the mind; that the same is true of land and sea and houses and our own bodies, as well as those of our wives and children and friends; and that there is nothing existing in nature but minds and ideas.

The offspring that followed are still more frightful; it is surprising that anyone could be found who had the courage to act as the midwife, bringing them through gestation and ushering them into the world! •No causes or effects; •no substances, material or spiritual; •no evident truth even in mathematical demonstration; •no liberty or active power; •nothing existing in nature except impressions and ideas following each other, without time, place, or subject. Surely no age ever produced such a system of opinions, soundly deduced—with great acuteness, clarity and elegance—from a universally accepted principle. The ·ancient· hypothesis that I have mentioned is the father of them all. The thesis that our sensations and feelings are unlike external things is the innocent mother of most of them.

It happens sometimes in an arithmetical calculation that two errors balance one another, so that they have little or no effect on the conclusion; but when one of them is corrected and the other left uncorrected, we are led further from the truth than by both together; and that seems to have been what happened in the Aristotelian philosophy of sensation when it was related to the modern. The Aristotelians adopted two errors; but the second served as a corrective to the first, making it mild and gentle, so that their system didn't tend to lead to scepticism. The moderns have retained the first of those two errors, but have gradually detected and corrected the second. The consequence has been that the light we have kindled has created darkness, and scepticism has advanced hand in hand with knowledge, spreading its gloom first over the material world and eventually over the whole face of nature. Such a phenomenon as this is likely to astonish even the lovers of light and knowledge while its cause is unknown; but when the cause is detected, it may give us hope that this darkness won't last for ever but will be followed by a more permanent light.

7. Visible shape and extension

Although there is no resemblance and (as far as we know) no necessary connection between the quality in a body that we call its 'colour' and the appearance that this colour makes to the eye, it is quite otherwise with regard to its shape and size. There is certainly a resemblance *and* a necessary connection between the visible shape and size of a body and its real shape and size. [See the note on 'visible' on page 49.] No-one can explain why a scarlet colour affects the eye in the way it does; no-one can be sure that it affects his eye in the same way as it affects someone else's, giving it the same appearance to him as it has to the other person; but we *can* explain why a circle placed obliquely to the eye appears in the form of an ellipse. The visible shape, size and orientation can be worked out by mathematical reasoning from the real shape, size and orientation; and it can be demonstrated that every eye that sees clearly and perfectly must in the same situation see it in the form of an ellipse and not in any other. Indeed, I venture to say that a man born blind, if he were instructed in mathematics, would be able to work out the visible shape of a body when he was told its real shape, distance and orientation. Dr. Saunderson understood the projection of the sphere, and he understood perspective. Well, for a blind man to be able to determine the visible shape of a body all he needs is to be able to project the outline of the body onto the surface of a hollow sphere whose centre is in the eye. This projection is the visible shape he wants, for it is the same shape as the one projected on the retina in vision.

A blind man can conceive lines drawn from every point on the object to the centre of the eye, making angles. He can conceive that the length of the object will appear greater or less in proportion to the angle that it makes at the eye; and that the breadth—and in general the distance of any one point on the object from any other point—will appear greater or less in proportion to the angles that those distances make at the eye. He can easily be made to conceive that the visible appearance has no thickness, any more than a projection of a sphere does, or a drawing in perspective. We could *tell* him that until the eye is aided by experience it doesn't represent one object as nearer or more remote than another. Indeed he would probably guess this on his own account, and tend to think that the rays of light must make the same impression on the eye, whatever distance they come from.

These are all the principles that we suppose our blind mathematician to have; and he can certainly acquire them all by information and reflection. If he is told the •real shape and size of a body, and its orientation and distance in relation to the eye, he can certainly, by means of these principles, find out its •visible shape and size. Using these principles he can demonstrate that the visible shape of any body will be the same as that of its projection on the surface of a hollow sphere with the eye at its centre. And he can demonstrate that a body's visible size will be greater or less depending on whether its projection occupies more or less of the surface of this sphere.

For another way of looking at this matter, let us distinguish the *position* [Reid's word] of objects in relation to the eye from their *distance* from it. Objects that lie on the same straight line drawn from the centre of the eye have the same position, however different their distances from the eye may be; but objects that lie on different straight lines drawn from the eye's centre have different positions; and this difference of position is proportionate to the size of the angle made at the eye by the straight lines in question. Having thus defined what we mean by *the position of objects in relation to the eye*, it is obvious that just as

> a body's real shape consists in the situation of its parts in relation to one another,

so also

> a body's visible shape consists in the position of its several parts in relation to the eye;

from which it follows that just as

> someone who has a distinct conception of the *situation* of the parts of a body in relation to one another must have a distinct conception of its real shape,

so also

> •someone who conceives distinctly the *position* of a body's parts in relation to the eye must have a distinct conception of its visible shape.

Now, there is surely nothing to prevent a blind man from conceiving the position of a body's parts in relation to the eye, any more than from conceiving their situation in relation to one another; so I conclude that a blind man can attain a distinct conception of the visible shape of bodies.

Although I think the above arguments are sufficient to prove that a blind man can conceive the visible extension and shape of bodies, I am still concerned to remove prejudices against this truth. For this purpose it will be useful to compare •the notion of visible shape that a blind mathematician might give himself with •that which is presented to the eye in vision, and to note ·three· differences.

(1) Visible shape is always presented to the eye in combination with colour. There is no intrinsic connection between shape and colour, but because they have so invariably kept company together we are hardly able to disconnect them even in our imagination. What makes this especially hard to do is the fact that we have never been accustomed to make visible shape an object of our thought. We use it only as a sign, and when it has served this purpose it passes away without leaving a trace behind. The draughtsman or designer whose business it is to hunt this fugitive form and to make a copy of it finds how hard it is to do this even after many years labour and practice. How good it is for him if at last he can acquire the skill of making it hold still in his imagination while he draws it! For then it is evident that he must be able to draw as accurately from the life as from a copy [meaning, presumably, 'from the real object as from a drawing of it']. But how few of the professed masters of designing are ever able to arrive at this degree of perfection! So it is no wonder that we find it so hard to •conceive shape apart from its constant associate ·colour·, when it is so difficult to •conceive it at all. But our blind man's notion of visible shape won't be associated with colour, of which he has no conception; but it may be associated with hardness or smoothness, with which he is acquainted by touch. These different associations that things have are apt to deceive us into making the things themselves seem different though in reality they are the same.

(2) [Up to here, 'shape' has replaced Reid's word 'figure' when that is clearly what it means. In some of what follows, 'figure' sounds better to our ears than 'shape', and will therefore be left untouched; but in these contexts too Reid's subject is indeed *shape*.] Secondly, the blind man forms the notion of visible shape by thought and by mathematical reasoning from principles, whereas the sighted man has it instantaneously presented to his eye by a kind of inspiration, without working at it or reasoning his way towards it. ·Consider these two people, whom we can suppose to have eyesight·. One of them

> (a) forms the notion of a parabola or a cycloid from the mathematical definition of those figures, without ever having seen them drawn;

while the other

(b) doesn't know the mathematical definitions of those figures but sees them drawn on paper, or feels them cut out in wood.

Each has a clear conception of the figures, (a) through mathematical reasoning and (b) through his senses. Now, the blind man forms *his* notions of visible figures in the same way as (a) formed his notion of a parabola or a cycloid without ever having seen one.

(3) Visible shape leads a sighted man directly to the conception of the real shape of which it is a sign. But the blind man's thoughts move in the opposite direction: he must first know the real shape, distance and situation of the body, and *from* that he slowly traces out the visible shape by mathematical reasoning. And his nature doesn't lead him to conceive this visible shape as a sign; it is—·and he knows it is·—a creature of his own reason and imagination.

8. Answers to some questions about visible shape

'What kind of thing is this visible figure? Is it a sensation, or an idea? If it is an idea, from what sensation is it copied?' These questions may seem trivial or irrelevant to someone who doesn't know that certain modern philosophers have set up a tribunal of inquisition to which everything in nature must answer! The questions the tribunal asks are few indeed, but very dreadful in their consequences. They are only these:

Is the prisoner ·in the dock· an impression or an idea?

If he is an idea, from what impression was he copied?

If it turns out that the prisoner is neither an impression nor an idea copied from some impression, he is immediately—without being allowed to offer any plea that might restrain the judgment—sentenced to pass out of existence and to be for ever afterwards an empty meaningless sound or the ghost of a departed entity.

This dreadful tribunal has tried and condemned •cause and effect, •time and place, •matter and spirit; so how can such a poor flimsy form as •visible shape stand before it? It must even plead guilty, and confess that it is neither an impression nor an idea. For, alas! it is notorious that visible shape is extended in length and breadth; it may be long or short, broad or narrow, triangular, quadrangular or circular; so unless ideas and impressions are extended and shaped it can't be an idea or impression.

'Well, then, to what category of beings *does* visible shape belong?' I can only answer by presenting some pointers which may enable visible shaped to be ·metaphysically· placed by people who are better acquainted with the categories than I am. •It is, as I have said, the position of the different parts of a shaped body in relation to the eye. •The different positions of the parts of the body in relation to the eye, when put together, make a real shape that is truly extended in length and breadth (·two dimensions·) and that represents a shape that is extended in length, breadth and thickness (·three dimensions·). •Similarly, a projection of the sphere is a real figure that has length and breadth but represents the sphere, which has three dimensions. •A projection of the sphere, or a perspectival view of a palace, is a 'representative' in the very same sense as visible shape is, and wherever *they* have their lodgings in the categories visible shape will be found to live next door to them.

'Is there any sensation that is specifically associated with visible shape—one that suggests it in vision? By what means is visible shape presented to the mind?' This is a question of some importance if we are to get a clear notion of the faculty of seeing. To throw as much light on it as I can, I shall have to compare this sense with other senses, and to make certain suppositions which may enable us to distinguish things that

are apt to be confused with one another although they are totally different.

Three of our senses give us information about things at a distance: •smell, •hearing and •sight. In smelling and hearing we have a sensation or impression on the mind, a sensation which our constitution makes us take to be a sign of something external; but the sensation is not accompanied by any information about the position of this external thing in relation to the organ of sense. When I •hear the sound of a coach, I can't tell whether the sounding body is above or below, on my right or on my left, unless I have had ·relevant· previous experience. In short: the sensation suggests to me some external object as its cause or occasion; but doesn't suggest anything about the position of the object, whether it lies in this direction or in that. The same holds for •smelling. But the case is quite different for seeing. When I •see an object, the appearance made by its colour may be called the sensation that suggests to me some external thing as its cause; and it *also* suggests the individual direction and position of this cause in relation to the eye. I know it is precisely in such-and-such a direction and in no other. At the same time, I am not conscious of anything that can be called 'sensation' except the sensation of colour. The position of the coloured thing is not a sensation, but by the laws of my constitution it is presented to the mind along with the colour, without any additional sensation.

Suppose that the ·human· eye were so constituted that the rays coming from any one point on the object were diffused over the whole retina rather than being, as they are in fact, collected at one point on the retina. Those who understand the structure of the eye will see that in that case the eye would show the colour of a body as our eyes do but that it wouldn't show either shape or orientation. The operation of that kind of eye would be exactly like that of hearing and smell, giving no perception of shape or extension but merely of colour. This supposition is in fact not entirely imaginary; for it nearly fits the situation of most people who have cataracts. In them the crystalline lens lets rays of light through but diffuses them over the retina, so that the person with a cataract sees things as one does through a glass of broken jelly—they perceive the colour of objects but not their shape or size.

Second supposition: suppose that smell and sound were conveyed in straight lines from the objects, and that every sensation of hearing and smell suggested the precise direction or position of its object. In that case the operations of hearing and smelling would be similar to that of seeing; we would smell and hear the shape of objects in the same sense as now we see it; and every smell and sound would be associated with some shape in the imagination, just as colour is in fact.

We have reason to believe that light-rays make some impression on the retina, but we aren't conscious of this impression and the anatomists and philosophers haven't been able to discover what it is or what its effects are—whether it produces •a vibration in the nerve, or •the motion of some subtle fluid contained in the nerve, or •something else again to which we can't give a name. Whatever it is, I shall call it the 'material impression', being careful to remember that it an impression on body, not on the mind, and that it isn't a sensation and can't be *like* any sensation. . . . Now when this material impression is made on a particular point on our retina, by the laws of our constitution it suggests two things to the mind—the colour and the position of some external object. No-one can give a reason why that same material impression couldn't have suggested sound or smell (or both) along with the object's position. Why does it in fact suggest colour and position and nothing else? We can

answer this only by saying 'That's how we are made' or 'That's how God wanted it to operate'. And since there is no necessary connection between these two things suggested by this material impression (·colour and position·), our Creator *could* have suggested one of them without the other if he had wanted to. Let us then make a third supposition: since it plainly appears to be possible, suppose that our eyes had been constructed in such a way that they suggested to us the position of the object, without suggesting its colour or any other quality. A consequence of this supposition, obviously, is that the person who had such an eye would perceive the visible figure of bodies without having any sensation or impression made on his mind. The figure he perceives is altogether external, so it would be a gross misuse of language to call it an impression 'on the mind'. If you say 'It is impossible to perceive a figure unless there is some impression of it on the mind' I beg leave not to admit the impossibility of this without some proof; and I can't find any. Nor can I conceive what is *meant* by 'impression of figure on the mind'. I can conceive an impression of figure on wax, or on any body that is fit to receive it; but an impression of it 'on the mind' is to me quite unintelligible; and although I form the clearest conception of the figure, I can't find any impression of it on my mind, however hard I look.

If, finally, we suppose that the eye regains its power of perceiving colour, I think you'll agree that now it perceives shape in the very same way as before, the only difference being that now colour is always joined with it.

In answer to the proposed question, therefore: there seems to be no sensation that is special to visible shape or whose job it is to suggest it. Visible shape seems to be suggested *immediately* by the material impression—of which we are not conscious—on the eye. And why can't a material impression on the •retina suggest •visible shape, as well as the material impression made on the •hand when we grasp a ball suggests •real shape? In the one case, one and the same material impression suggests both colour and visible shape; and in the other case, one and the same material impression suggests hardness, heat, or cold, and real shape, all at the same time.

'Given that the •visible shape of bodies is a real and external object to the eye, as their •tangible shape is to the touch, why is it so hard to attend to •the former and so easy to attend to •the latter?' This is the final question to be asked and answered in this section, ·and it is a good question, with a lot of bite·. It is certainly true that

- •visible shape is presented to the eye more often than tangible shape is to the touch,
- •visible shape is as distinct and determinate an object as tangible shape, and
- •visible shape seems in its own nature to be as proper a topic for theory as tangible shape.

Yet visible shape been attended to so little that it never had a name in any language until Bishop Berkeley gave it the name that I am using, following him, to distinguish it from the shape that is the object of touch.

The difficulty of attending to the visible shape of bodies and making it an object of thought seems to be similar to the difficulty we encounter in attending to our sensations—so similar that they probably have similar causes. Nature intended the visible shape as a sign of the tangible shape and situation of bodies, and has taught us by a kind of instinct to put it always to this use. And so the mind skims across it rapidly, to attend to the things signified by it. For the mind to stop at the visible shape and attend to it would be as unnatural as it would be for a spherical body to stop on slope. There is an inner force that constantly carries it forward and can't be overcome except by a contrary force.

There are other external things that nature intended as signs, and we find they have this in common: *the mind is inclined to overlook them and to attend only to the things they signify.* For example, certain states of the human face are natural signs of the person's present state of mind. Everyone understands the meaning of these signs, but not one person in a hundred ever attends to the signs themselves or knows anything about them. So you may find many an excellent practical face-reader who knows nothing about the proportions of a face and can't draw or describe the expression of any one emotion.

An excellent painter or sculptor can tell not only what the proportions are of a good face but what changes each passion makes in it. This, however, is one of the chief mysteries of his art, and it can't be acquired without infinite labour and attention as well as the right kind of intellect. But when he puts his art into practice and captures a passion by its proper signs, no-one needs skill or deep thought to understand the meaning of these signs.

What I have said about painting might easily be applied to all the fine arts. In each of them the difficulty consists in knowing and attending to natural signs whose meaning every man understands.

We pass easily and by a natural impulse from the sign to the thing signified, whereas it is hard and difficult work to go backwards from the thing signified to the sign. So because visible shape is intended by nature to be a sign we pass on immediately to the thing signified, and can't easily return to attend to the sign.

Nothing shows more clearly our tendency to ignore visible shape and visible extension than the fact that they have entirely escaped the notice of mathematicians, although mathematical reasoning is just as applicable to them as it is to tangible shape and extension. The shape and extension that are objects of touch have been tortured ten thousand ways for twenty centuries, and a very noble system of science—·namely geometry·—has been drawn out of them, whereas not a single ·mathematical· proposition do we find concerning the shape and extension that are the immediate objects of sight.

When a geometrician draws a diagram with the most perfect accuracy, and keeps his eye fixed on it while he goes through a long process of reasoning and demonstrates the relations of the different parts of his figure, it doesn't occur to him that the •visible figure presented to his eye is only *the representative of* a •tangible figure which is what he is really attending to; it doesn't occur to him that these two figures have really different properties, and that what he demonstrates to be true of the one is not true of the other.

This may seem so great a paradox—even to mathematicians!—that it won't be believed until it has been demonstrated. Well, it's not hard to demonstrate, if you will have the patience to enter just a little way into the mathematical consideration of visible shape, which I shall call 'the geometry of visibles'.

9. The geometry of visibles

In this geometry, the definitions of 'point', of 'line' (whether straight or curved), of 'angle' (whether acute, or right, or obtuse), and of 'circle' are the same as in common geometry. The mathematical reader will easily enter into the whole mystery of this geometry if he attends properly to these ·eight· evident principles.

1. Suppose an eye placed at the centre of a sphere, ·looking outwards·. Every great circle on the sphere will have the same appearance to the eye as if it were a straight line. This is because the eye won't perceive the curvature

of the circle because the curve is always turned directly towards the eye. For the same reason, any line that is drawn in the plane of a circumference of the sphere will appear straight to the eye, whether or not it is really so.

2. Every visible straight line will appear to coincide with some great circle of the sphere; and the circumference of that great circle, even when it is extended until it returns into itself, will appear to be a continuation of the same visible straight line. . . . Here is why.

> The eye perceives only the *positions* of objects in relation to itself, and not their *distances*. So any two points that have the same position in relation to the eye, no matter how different their distances from it may be, will be seen by the eye in a single visible place. Now, since a plane passing through the eye and a given visible straight line, will be the plane of some great circle of the sphere, every point on the visible straight line will have the same position as some point on the great circle; therefore, they will both have the same visible place, and coincide to the eye; and the whole circumference of the great circle continued even until it returns into itself will appear to be a continuation of the same visible straight line.

Hence it follows:

3. That every visible straight line when it is continued *in directum* as far as it can be continued, will be represented by a great circle of a sphere in whose centre the eye is placed. It follows,

4. That the visible angle made by two intersecting visible straight lines is equal to the spherical angle made by the intersection of the two great circles that are the representatives of these visible lines. For since the visible lines appear to coincide with the great circles, the visible angle made by the former must be equal to the visible angle made by the latter. But the visible angle made by the two great circles when seen from the centre is the same size as the spherical angle that they really make, as mathematicians know; therefore the visible angle made by any two visible lines is equal to the spherical angle made by the two great circles of the sphere that are their representatives.

5. It follows obviously that every visible straight-lined triangle will coincide in all its parts with some spherical triangle. The sides of either will appear equal to the sides of the other, and the angles of either to the angles of the other; and therefore the whole of one triangle will appear equal to the whole of the other. In short: to the eye they will be one and the same, and have the same mathematical properties. Thus, the properties of visible straight-lined triangles *are not* the same as the properties of plane triangles, but *are* the same as those of spherical triangles.

6. Every lesser circle of the sphere will appear a circle to the eye (which we are still supposing to be at the centre of the sphere). And conversely every visible circle will appear to coincide with some lesser circle of the sphere.

7. Moreover, the whole surface of the sphere will represent the whole of visible space: every visible point coincides with—and has the same visible place as—some point on the surface of the sphere, so the totality of the parts of the spherical surface will represent the totality of possible visible places, i.e. the whole of visible space. And from this it follows, in the last place,

8. That every visible figure will be represented by that part of the surface of the sphere on which it could be projected, the eye being in the centre. And every such visible figure will bear the same ratio to the whole of visible space as the part of the spherical surface that represents it bears to the whole spherical surface.

The mathematical reader, I hope, will find it quite easy to take in these principles and will just as easily perceive that the following propositions about visible figure and space—which I offer only as a specimen—can be mathematically derived from them, and are as true and obvious as Euclid's propositions concerning tangible shapes.

1. Every straight line when continued long enough eventually returns into itself.
2. A straight line returning into itself is the longest possible straight line; and all other straight lines bear a finite ratio to it.
3. A straight line returning into itself, divides the whole of visible space into two equal parts, each of which will be surrounded by this straight line.
4. The whole of visible space bears a finite ratio to any part of it.
5. Any two straight lines when they are continued for long enough will meet at two points, and mutually bisect each other.
6. If two lines are parallel—i.e. everywhere equally distant from each other—they can't both be straight.
7. Given any straight line, a point can be found that is at the same distance from all the points on it.
8. A circle can be parallel to a straight line, i.e. can be equally distant from it in all its parts.
9. Straight-lined triangles whose angles match also match in the lengths of their sides.
10. Of every straight-lined triangle, the three angles taken together are greater than two right angles.
11. The angles of a straight-lined triangle may all be right angles, or all obtuse angles.
12. The difference in the areas of two unequal circles is not proportional to the difference between the squares of their diameters, and the difference in their circumferences is not proportional to the difference between their diameters.

This small specimen of the geometry of visibles is intended to lead you to a clear and distinct conception of the shape and extension that is presented to the mind by vision; and to demonstrate the truth of my earlier statement •that the shapes and the extension that are the immediate objects of sight are *not* the shapes and the extension that common geometry deals with; •that when the geometrician looks at his diagram while demonstrating a proposition, he has a shape presented to his eye that is only a sign and representative of a tangible shape; •that he entirely neglects the visible shape and attends only to the tangible one; and •that these two shapes have different properties, so that what he demonstrates of the one is not true of the other.

Still, it should be noted •that a small part of a spherical surface doesn't perceptibly differ from a plane surface, so that a small part of visible extension differs very little from the extension in length and breadth that is the object of touch. And •that the human eye is so formed that an object that is seen distinctly and at one view can occupy only a small part of visible space. That is because we never see clearly anything that is at a considerable distance from the axis of the eye, so that if we want to see a large object at one view we must place our eye so far away from it that it occupies only a small part of visible space. From these two observations it follows that plane shapes seen at one view, when their planes are not oblique but direct to the eye, differ little from the visible shapes that they present to the eye. The various lines in the tangible shape have very nearly the same proportions to each other as ·do the corresponding lines· in the visible shape; and the angles of one are very nearly (though not strictly and mathematically) equal to those of the other. So, although we have found many instances of

natural signs that don't in the least resemble the things signified, this isn't the case with regard to visible shape. It always resembles the thing signified by it in the way a plan or profile has to what it represents; and in some cases the sign and thing signified—·i.e. the visible figure and the tangible figure·— have the same shape and the same proportions, so far as our senses can detect.

If we could find a being who was equipped with sight but with no other external senses, and who was capable of reflecting and reasoning on what he saw, *his* notions and philosophical speculations might help us in the difficult task of distinguishing •the perceptions we have purely by sight from •the ones that come from other senses. Let us suppose such a being, and get the best understanding we can of what notion he would have of visible objects, and what conclusions he would deduce from them. We mustn't think of him as disposed by his constitution, as we are, to regard the visible appearance as a sign of something else; to him it isn't a sign because ·for him· there is nothing signified by it; so we must suppose him as much disposed to *attend to* the visible shape and extension of bodies as we are disposed to attend to their tangible shape and extension.

If various shapes were presented to his sense, then as they became familiar he could of course compare them with one another and perceive their likenesses and unlikenesses. He could perceive visible objects to have length and breadth, but he couldn't have any notion of a third dimension, any more than we can have a notion of a fourth. All visible objects would appear to be terminated by lines, straight or curved; and objects terminated by the same visible lines would occupy the same place and fill the same part of visible space. He couldn't have the thought of one object's being *behind* another, or nearer or more distant than another.

To us, with our notion of three dimensions, a line can be conceived as straight, or as curved in one dimension and straight in another; or as curved in two dimensions. Suppose a line to be drawn upward and downward, its length makes one dimension which I shall call 'upward and downward'. That leaves two other dimensions, in which it may be straight or curved. It may be bent to the right or to the left; and if it doesn't bend either way, it is straight in this dimension. If so, there still remains one other dimension, in which it may be curved, for it may be bent backward or forward. When we conceive a tangible straight line, we exclude curvature in each of these two dimensions; what is *conceived to be excluded* must be *conceived*, just as what is conceived to be *included* must be conceived; so it follows that all the three dimensions enter into our conception of a straight line. Its length is one dimension; and the conception of it *also* •includes its straightness in two other dimensions, which is to say that it •excludes the line's being curved in these two dimensions.

The being we have supposed, having no conception of more than two dimensions of which the length of a line is one, can't possibly conceive it either straight or curved in more than one dimension; so that in his conception of a straight line, curvature to the right or left is excluded but curvature backward or forward can't be excluded because he doesn't and can't have any conception of such curvature. This shows us why a line that is straight to the eye can return into itself: its being straight to the eye only implies straightness in one dimension, and a line that is straight in one dimension can be curved in another dimension, and so can return into itself. To us, who conceive three dimensions, a surface is what has length and breadth, excluding thickness; and a surface can be either plane or curved in this third dimension; so that the notion of a third dimension enters into *our* conception

of a surface, for it is only by means of this third dimension, that we can distinguish surfaces into plane and curved, *neither* of which can be conceived without conceiving a third dimension.

The being whom we have supposed has no conception of a third dimension, so his visible figures have length and breadth but his thought of them neither includes nor excludes thickness, because he has no conception of thickness. It follows that visible figures, though they have length and breadth as surfaces have, are neither plane surfaces nor curved surfaces. For 'curved surface' implies curvature in a third dimension, and 'plane surface' implies lack of curvature in a third dimension; and our supposed being can't conceive either of these because he has no conception of a third dimension. Moreover, although he has a distinct conception of two lines intersecting to make *an angle*, he can't have the thought of a *plane angle* or of a *spherical angle*. Even his notion of a *point* is somewhat less determined [here = 'less complex'] than ours. *Our* notion of a point excludes length, breadth and thickness; *his* excludes length and breadth, but it can't either exclude or include thickness because he has no conception of that.

Having thus settled the notions that such a being as we have supposed might form of mathematical points, lines, angles and shapes, it is easy to see that by comparing these with one another and reasoning about them he could discover their relations and arrive at geometrical conclusions about them, built on self-evident principles. No doubt he could also have the same notion of *numbers* as we have, and construct a system of arithmetic. It doesn't matter what order he might follow in such discoveries, or how much time and trouble they might take; what matters is just to know what such a being *could* discover, using reason and ingenuity, with no sensory input except from sight.

It is harder to attend to an account of *possibilities* than to a *factual* account—even one the truth of which is not authenticated. So let me present an extract from the travels of Johannes Rudolphus Anepigraphus, a Rosicrucian philosopher who made a deep study of the occult sciences from which he learned how to transport himself to various parts of the earth and to converse with various orders of intelligences ·that he found there·. In the course of his adventures he became acquainted with an order of beings who are exactly such as I have supposed—·i.e. they have eyesight but no other external senses·.

How they communicate their views to one another, and how he came to know their language and become initiated into their philosophy—as well as of many other details that might have gratified the curiosity of his readers and perhaps made him easier to believe—he hasn't thought fit to inform us, because these are things that only insiders should know. His account of their philosophy is as follows.

'Many of the Idomenians are very intelligent and much given to contemplation. They have most elaborate theories of arithmetic, geometry, metaphysics and physics. In the two latter, indeed, they have had many disputes that have been carried on with great subtlety, and they are divided into different sects; yet in arithmetic and geometry there has been as much unanimity as there is among the human species. Their principles relating to numbers and arithmetic is exactly the same as ours except for differences of notation, but their geometry differs very considerably from ours.'

As our author's account of the geometry of the Idomenians agrees in everything with the geometry of visibles of which I have given a specimen above, I shall pass over it. He goes on thus:

'Colour, extension, and shape are conceived to be the essential properties of body. A very considerable sect maintains

that colour is the essence of body. They say:

> If there had been no colour there would have been no perception or sensation. Colour is all that we do or can perceive that is exclusive to body, because extension and shape are possessed by empty space as well as by body. Consider what is involved in supposing a body to be annihilated: *colour* is the only thing in it that can be annihilated, for the *place* that it occupies—and thus the shape and extension of that place—must stay in existence, and can't be imagined not to exist.

These philosophers hold that space is

> the place of all bodies,
> immovable and indestructible,
> without shape,
> exactly alike in all its parts,
> incapable of growing or shrinking,
> measurable; because each tiny part of space bears a finite ratio to the whole.

So that with them *the whole extent of space* is the common and natural *measure* for everything that has length and breadth: the size of every body and of every figure is stated in terms of what fraction it is of the whole universe. Similarly, the common and natural measure of *length* is an infinite straight line, which (as I noted above) returns into itself, has no limits, yet bears a finite ratio to every other line.

'Their natural philosophy [here = 'philosophy and natural science'], as the wisest of them admit, has been for many ages in a very low state. The philosophers, having observed that one body can differ from another only in •colour, •shape or •size, took it for granted that all the particular qualities of bodies must arise from the various combinations of •these their essential attributes. So it was thought that the aim of natural philosophy should be to show how the various combinations of these three qualities in different bodies produced all the phenomena of nature. It would take for ever to enumerate the various systems that were invented for this purpose, and the disputes that continued for ages, with the followers of each system using great skill to expose the weak points in other systems and to disguise the weak points in their own.

'Eventually some free-thinkers with a sense of humour, tired of eternal disputation and of the labour of patching and propping weak theories, began to complain about •nature's fine-grained complexity, •the infinite changes that bodies undergo in shape, colour and size, and •the difficulty of accounting for these appearances. They made this their excuse for giving up, as empty and useless, all inquiries into the causes of things.

'These wits had plenty of raw materials for mirth and ridicule in the systems of ·natural· philosophers, and, finding it an easier task to pull down than to build up and support, their view began to spread mightily, and went on with great success. They were helped in this by the fact that each sect provided them with weapons and soldiers with which to destroy some other sect. Thus philosophy gave way to scepticism and irony, and systems that had been the work of ages and the admiration of the learned became jokes for the vulgar; for even the vulgar were glad to join in the triumph over a kind of learning of which they had long been suspicious because all it produced was wrangling and quarrelling. The wits having now acquired a great reputation, and flushed with success, began to think that to complete their triumph they needed to overturn *every* claim to knowledge; so they began their attacks on arithmetic, geometry, and even on the common notions of uneducated Idomenians. Conquerors have always found it hard to know where to stop!

'In the meantime [this is still Anepigraphus speaking], natural philosophy began to rise from its ashes under the direction of

a person of high intelligence who is regarded as having had something in him above Idomenian nature. He remarked that the Idomenian faculties were certainly intended to be used for contemplation, and that •the works of nature were a nobler subject to exercise them on than •the follies of systems or •the errors of the learned; and, being aware of the difficulty of finding out the causes of natural things, he proposed to make accurate observations of the phenomena of nature in order to find out the *rules* according to which they happen, without inquiring into the *causes* of those rules.

'In this he made considerable progress himself, and planned out much work for his followers, who call themselves 'inductive philosophers'. The sceptics look with envy at this rising sect, which they see as eclipsing their reputation and threatening to limit their range of influence; but they can't decide what direction to attack it from. The vulgar begin to reverence it, as producing useful discoveries.

'Every Idomenian firmly believes that two or more bodies can exist in the same place ·at the same time·. For their sense—·their eyesight·—tells them this, and they can't doubt it any more than they can doubt whether they have any perception at all. They often see two bodies meet and coincide in the same place, and then separate again, without undergoing any perceptible change as a result of this penetration ·of each by the other·. When two bodies meet and occupy a single place, usually only one of them *appears* in that place, while the other disappears. The one that continues to appear is said to "overcome", the other to "be overcome".'

To this quality of bodies they gave a name which our author tells us has no translation in any human language. . . . He calls it the 'overcoming quality' of bodies. He assures us that:

> The theorizing that went on concerning this one quality of bodies, and the hypotheses devised to explain it, were sufficient to fill many volumes. And just as many hypotheses have been invented by the Idomenian philosophers to explain the changes of size and shape—qualities that they perceive to be in continual flux in most bodies that move. The founder of the inductive sect, believing that Idomenian faculties weren't capable of discovering the real *causes* of these phenomena, worked on finding from observation what *laws* they are connected by; and he discovered many mathematical ratios and relations concerning the motions, sizes, shapes, and the 'overcoming quality' of bodies—relations confirmed by constant experience. But the opponents of this sect prefer to content themselves with •fictional causes of these phenomena, rather than accepting the •real laws that govern them—laws that humble their pride by being admittedly not explainable in their turn.

Thus far Johannes Rudolphus Anepigraphus. . . . I shan't undertake to judge the narrative of this learned traveller by the 'external' marks of his credibility; I shall confine myself to the marks that textual scholars call 'internal'. . . . The important question is whether the account given above is a true report on their geometry and philosophy. We have all the faculties they have along with others that they lack; so we can form some judgment concerning their philosophy and geometry by putting aside all our senses but one, and reasoning purely on the basis of the perceptions we have by sight. As far as I can judge in this way, after a careful examination, their geometry must be such as Anepigraphus has described. Nor does his account of their philosophy ·and science· appear to contain any obvious marks of fakery, though here, no doubt, we should allow for liberties that travellers take ·with the truth·, as well as for involuntary mistakes that they are apt to make.

10. The parallel motion of the eyes

Having explained *visible shape* as clearly as I can, and shown how it connects with the thing signified by it, I should next consider certain phenomena of the eyes and of vision. They are ones that have commonly been attributed to •custom, to •anatomical causes, or to •mechanical causes; but I think they come down to •basic powers and forces of the human mind, which is why they belong properly to the subject of this inquiry. ·They will be my topic until the end of section 19·.

The first of these phenomena is the parallel motion of the eyes: when one eye is turned to the right or left, upward or downward, or straight ahead, the other always goes along with it in the same direction. It is obvious to us when both eyes are open that they are always turned the same way, as if the two were acted on by a single moving force; and if one eye is shut and a hand placed over it while the other turns in various ways, we feel ·in the palm of the hand· the closed eye turn at the same time—and it does this whether or not we want it to. This phenomenon is surprising because all the anatomists agree that the muscles that move the two eyes and the nerves that serve these muscles are entirely distinct and unconnected. If we saw a man who throughout his life never moved one arm without moving the other precisely in the same way, so that they were always parallel, we would find this very surprising and inexplicable. But it would be no harder to find the physical cause of such motion of the arms than it is to find the cause of the parallel motion of the eyes, which is perfectly similar.

The only cause that anyone has proposed for this parallel motion of the eyes is *custom*. The explanation goes like this:

> We find by experience, when we begin to look at objects, that to get a clear view of something we need to turn both eyes towards it; so we soon get the habit of doing this every time and gradually lose the power of doing otherwise.

This account of the matter seems inadequate, because habits aren't acquired at once; it takes time to acquire and to confirm them; and if this motion of the eyes came from habit we would see newborn children turn their eyes different ways, and move one without the other, as they do their hands or legs. I know that some say that they *are* apt to do this; but I have never found it true from my own observation, although I have taken trouble to make observations relating to this and have had good opportunities ·to do so·. [Reid was the father of nine children.] I have also consulted experienced midwives, mothers and nurses, and found them to agree that they had never observed distortions of this kind in the eyes of children except when they had reason to suspect that the child was ill.

So it seems to be extremely probable that there is something in the ·human· constitution, some natural instinct lying deeper than custom, which directs us to move both eyes always the same way.

We don't know *how* the mind acts on the body, nor by what power the muscles are contracted and relaxed; but we see that in some of our voluntary motions as well as in some of the involuntary ones this power is directed in such a way that many muscles that have no material tie or connection act in concert, each being taught to play its part with correct timing and rhythm. Think about how a company of expert actors in a theatrical performance (or excellent musicians in an orchestra or good dancers in a country dance) work together so that their separate contributions produce one uniform effect; well, they don't do this in a more regular and orderly way than a number of muscles do in many of the animal functions and in many voluntary actions. Yet

we see such actions being performed just as skillfully and regularly by children, and by people who don't know that they *have* such muscles, as by the most skillful anatomist or physiologist.

Who taught all the muscles involved in sucking, swallowing, breathing, excreting and so on to play their part in such regular order and with the timing just right? It wasn't custom, surely. It was ·God·, the powerful and wise being who made the human body and fixed the laws by which the mind operates on every part of it so that the parts can do what they were intended to do. And when we see so many such examples of a system of unconnected muscles working together so wonderfully in their separate functions, with no help from habit, it shouldn't be thought strange that the muscles of the eye should, also with no help from habit, work together to give the eyes the direction they need if they are to do what they are intended to do.

We see a similar working together in the muscles that contract the pupils of the two eyes, and in the muscles, whatever they are, by which the shape of the eyes is varied according to the distance of the objects ·being looked at·.

But it should be noted that although it appears to be by natural instinct that both eyes are always turned the same way, there is still some latitude left for custom. ·I now explain this·. What I have said about the parallel motion of the eyes isn't to be understood too strictly—nature doesn't direct us to keep the axes of the eyes always precisely and mathematically parallel to each other. Indeed, although they are always nearly parallel they are seldom exactly so. When we look at an object, the axes of the eyes meet at that object; so they make an angle, always a small one but larger or smaller depending on how close the object is. Nature has very wisely left us the power of varying the parallelism of our eyes a little, so that we can direct them both to the same point, whether far or near. No doubt this is learned by custom, which is why we see that it is a long time before children do this perfectly.

This *natural* power of varying the parallelism of the eyes goes only as far as is needed for the purpose intended by it, but it can be increased through much practice and straining. And so we see that some people have become able to distort their eyes into unnatural directions, just as others have become able to distort their bodies into unnatural postures.

Those who have lost the sight of one eye commonly lose what they had acquired by custom, in the direction of their eyes, but retain what they had by nature. That is, although their eyes always turn and move together; when they look at an object the blind eye often deviates from it a little. A casual observer wouldn't notice this, but it can be spotted by someone who is used to making exact observations in these matters.

11. Seeing objects the right way up by images that are upside down

Another phenomenon that has puzzled philosophers is our seeing objects the right way up when it is well known that their images or pictures on the retina of the eye are inverted. The sagacious Kepler first made the grand discovery that clear but inverted pictures of visible objects are formed on the retina by the rays of light coming from the object. The same great philosopher showed through the principles of optics how these pictures are formed:

> The rays coming from any one point on the object and falling on the various parts of the pupil are refracted by the cornea and crystalline lens in such a way that they meet again at one point on the retina, and there they paint the colour of the point on the object from

> which they come. As the rays from different points on the object cross each other before they come to the retina, the picture they form must be upside down; the upper part of the object being painted on the lower part of the retina, the right side of the object on the left of the retina, and similarly with the other parts.

Kepler thought that we see objects the right way up by means of these inverted pictures for this reason:

> As the rays from different points of the object cross each other before they fall on the retina, ·when they get there· we conclude that the impulse we feel on the lower part of the retina comes from above, and that the impulse that we feel on the higher part comes from below.

Descartes later gave the same explanation for this phenomenon, and illustrates it by what we think about the positions of objects that we feel with our arms crossed or with two sticks that cross each other.

But I can't go along with this explanation. First, because it takes our seeing things the right way up to be something we *infer* from certain premises, whereas it seems in fact to be an immediate perception. And, secondly, because the premises from which all mankind are supposed to draw this conclusion never entered into the minds of the great majority of people, and are absolutely unknown to them. We have no feeling or perception of the pictures on the retina. . . . In order to see objects the right way up, according to the principles of Kepler or Descartes, we must already know

- that the rays of light come from the object to the eye in straight lines;
- that the rays from different points of the object cross one another before they form the picture on the retina; and lastly
- that these pictures are really upside down.

All these things are true, and are known to philosophers, but they are absolutely *un*known to the great majority of mankind; and people who are absolutely ignorant of them can't possibly reason from them and build conclusions on them. . . . I have had occasion to note many instances of conclusions drawn. . . .from premises that pass through the mind *very quickly* and are never made the objects of reflection; but surely no-one will think it possible to draw conclusions from premises that never entered into the mind *at all*!

Bishop Berkeley having rightly rejected this explanation, gives one based on his own principles. (He is followed in this by the judicious Dr. Smith in his *Optics*.) I shall now explain and examine the explanation given by that ingenious writer. Here it is ·in my words·:

> The ideas of sight are altogether *unlike* those of touch. . . . So we can learn only *by experience* how one sense will be affected something that affects the other sense in such-and-such a way. Shape, position, and even number (i.e. number of tangible objects) are ideas of touch; and although there is no resemblance between these and the ideas of sight, we learn by experience that a ·tangible· triangle affects the sight in manner M_t and that a ·tangible· square affects it in manner M_s; and from this we judge that whatever affects our sight in manner M_t is a triangle, and whatever affects it in manner M_s is a square. In the same way, finding from experience, that an object the right way up affects the eye in one way and the same object upside down affects it in another, we learn to judge from how the eye is affected whether the object is the right way up or upside down. In short, visible ideas are signs of the tangible; and what takes the mind from the sign to the thing signified is not

> •any resemblance between them or •any natural force, but rather •its having found them constantly conjoined in experience, as the sounds of a language are ·conjoined· with the things they signify. Thus, if the images on the retina had always been the right way up they would have shown the objects the right way up, just as they now do with the images upside down. . . . Similarly, if the visible appearance of two shillings had been found connected from the beginning with the tangible idea of one shilling, that appearance would as naturally and readily have signified *one* shilling as it now signifies *two*.

This opinion is undoubtedly very ingenious; and if it is sound it will solve to explain not only our present phenomenon but also the one I shall consider next [section 13], namely our seeing objects *single* with *two* eyes.

It is clear that in Berkeley's explanation it is supposed that initially—before we have any habits—we don't see things either as the right way up or as upside down, as having this shape or that, as single or double; and that *we learn from experience* to use visible signs to tell us objects' tangible position, shape, and number.

There is no denying that it's extremely difficult to distinguish the immediate and natural objects of sight from the conclusions that we have been accustomed from infancy to draw from them. Berkeley was the first to try to distinguish between them and to trace out the boundary that divides them. If in doing so he has gone a little off-track on one side or the other, this might be expected in a subject that is so intricate and altogether new. The nature of vision has received great light from this distinction; and many phenomena in optics which had previously appeared altogether inexplicable have been clearly and sharply explained by it. When someone has made an important discovery in philosophy it is natural—almost unavoidable—that he should take it a little beyond its sphere and to use it to 'explain' phenomena that don't fall within its province. Even the great Newton, when he had discovered the universal law of gravitation and seen how many of the phenomena of nature depend on this and other laws of attraction and repulsion, couldn't help expressing his conjecture that *all* the phenomena of the material world depend on attracting and repelling forces in the particles of matter. And I suspect that the ingenious Berkeley, having found so many phenomena of vision that are instances of the constant association of the ideas of sight and of touch, carried this principle a little beyond its just limits.

In order to judge as well as we can whether this is so, consider the situation of a man •who is like Dr. Saunderson in being blind and having all the knowledge and abilities that a blind man can have, and •who is suddenly made to see perfectly. Let us suppose him to be kept from all opportunities of associating his ideas of sight with those of touch until ·the following experiment is performed·. After the ideas of sight become a little familiar to him, and his first surprise at the objects of vision has died down, give him time to check them out and compare them in his mind with the notions that he formerly had by touch; and in particular to compare in his mind the •visible extension that his eyes present to him with the •extension in length and breadth with which he was previously acquainted ·by touch·.

I have tried ·in section 7· to prove that a blind man can form a notion of the visible extension and shape of bodies from how it relates to their tangible extension and shape. It will be even easier for him, when this visible extension and shape are presented to compare them with tangible extension and shape and to perceive that one has length and breadth as well as the other; that one can be bounded

by straight or curved lines as well as the other. So he will perceive that there can be visible as well as tangible circles, triangles, and quadrilateral and multilateral figures. The visible shape is coloured and the tangible one isn't, but that doesn't present them from having the same shape, any more than two objects of touch are prevented from having the same shape by the fact that one is hot and the other cold.

I have demonstrated that the properties of visible shapes differ from those of the ·tangible· plane shapes that they represent; but I noted at the same time that when the object is small enough to be taken in clearly all at once, and is placed directly before the eye, the difference between the visible and tangible shape is too small to be perceived by the senses. Thus, it is true that in every visible triangle the three angles are greater than two right angles, whereas in a ·tangible· plane triangle the three angles are equal to two right angles; but when the visible triangle is small its three angles will be so nearly equal to two right angles that the senses can't pick up the difference. . . . So we find that small visible shapes—ones that can be seen clearly at one view—don't just *resemble* the plane tangible shapes that have the same name, but are *the same* so far as the senses are concerned. So that if Dr. Saunderson had been made to see, and had attentively viewed the figures of the first book of Euclid, he might—just by thinking and without touching them—have discovered that they were the very figures he had previously been so well acquainted with by touch.

When ·tangible· plane figures are seen obliquely, their visible shape differs more from the tangible shape; and the representation of solid [here = 'three-dimensional'] shapes that is made to the eye is still more imperfect, because visible extension has only two dimensions, not three. Still, just as it can't be said that an exact picture of a man has *no* resemblance to the man, or that a perspectival view of a house has *no* resemblance to the house; so it can't be properly said that the visible shape of a man or of a house has *no* resemblance to the objects they represent.

So Berkeley has built on a serious mistake, in supposing that there is no resemblance between the extension, shape, and position that we see and that which we perceive by touch. I would further remark that Berkeley's theory regarding material things must have made him see this question about the right-way-up appearance of objects in a very different light from that in which it appears to those who don't accept that theory.

In his *Theory of Vision* Berkeley seems indeed to allow that there is an external material world; but he believed that this external world is only tangible, not visible, and that the visible world—the world accessible only by sight—is not external but in the mind. If this is accepted, then someone who says 'I see things the right way up, and not inverted,' says that there is a top and a bottom, a right and a left, *in his mind*. I'm sorry but I don't know the topography of the mind well enough to be able to give meaning to 'top', 'bottom' etc. when they are applied to it.

So I agree that *if* visible objects *weren't* external, but existed only in the mind, they couldn't have shape or orientation or extension; and it would be absurd to say that they are seen either the right way up or upside down or that there is *any* resemblance between them and the objects of touch. But when I ask 'Why are objects the right way up and not upside down?' I am taking it for granted that we are not in Berkeley's ideal world, but in the world that men who submit to the dictates of common sense believe themselves to inhabit. I am taking it for granted that the objects both of sight and of touch are external, and have a certain shape and a certain orientation in relation to one another and in relation to our bodies, whether we perceive this or not.

When I hold my walking-cane upright in my hand and look at it, I take it for granted that I see and handle the same individual object. When I say that I *feel* it as the right way up I mean that I *feel* the head directed away from the ground and the point directed towards it; and when I say that I *see* it as the right way up I mean that I *see* it with the head directed away from the ground and the point toward it. I take the ground to be a fixed object both of sight and of touch, in relation to which an object can be said to be high or low, the right way up or upside down; and to ask 'Why do I see the object the right way up, and not upside down?' is like asking 'Why do I see the object with the orientation that it really has?' or 'Why does the eye show the real orientation of objects, rather than showing them upside down as they are seen by a common astronomical telescope or as their pictures are seen on the retina of an eye when it is dissected?'

12. More on this topic

The only way to give a satisfactory answer to this question is to point out the laws of nature that apply in vision, for they are what the phenomena of vision must be regulated by. So I answer **(1)** that by a law of nature the rays of light go from every point on the object to the pupil of the eye in straight lines. And **(2)** that by the laws of nature the rays coming from any one point on the object to the various parts of the pupil are refracted in such a way that they meet again at one point on the retina; and the rays from many different points on the object, first crossing each other and then proceeding to that many different points on the retina, form an upside-down picture of the object.

The principles of optics tell us—and experience confirms—that if there is no such picture on the retina there is no vision; and that how the object appears in respect of colour, shape, clarity or fuzziness, and brightness or faintness, depends on what the picture on the retina is like.

So it is obvious that the pictures on the retina are, by the laws of nature, a means of vision; but we know nothing at all about *how* they accomplish their end. Philosophers think that the impression made on the retina by the rays of light is passed along to the optic nerve, and passed by the optic nerve to some part of the brain that they call the 'sensorium'; and that the impression thus conveyed to the sensorium is immediately perceived by the mind, which is supposed to reside there. But we know nothing about where the soul is; and we don't perceive immediately what is goes on in the brain—indeed we know less about the brain than about any other part of the human body. It is indeed very probable that the optic nerve is just as essential an instrument of vision as the retina is, and that the pictures on the retina have some effect on it. But we know nothing about what kind of effect this is.

There isn't the least probability that either the optic nerve or the brain contains any *picture* or *likeness* of the object. The pictures on the retina are formed by the rays of light; and whether we side with those who hold that when the rays bang into the retina they cause some •vibration of the fibres of the optic nerve, or with those who hold that the impact of the rays on the retina sets in •motion some subtle fluid contained in the nerve, neither the •vibration nor the •motion can *resemble* the visible object that is presented to the mind. Nor is there any probability that the mind perceives the pictures on the retina. These pictures are no more objects of our perception than the brain is, or the optic nerve. No man ever saw the pictures in his own eye, nor indeed the pictures in the eye of someone else until the eye was taken out of the head and duly prepared ·for microscopic examination·.

It is very strange that philosophers ·and scientists· of all ages should have agreed that

> the images of external objects are conveyed by the organs of sense to the brain, and are there perceived by the mind.

Nothing could be more unphilosophical, for two reasons. (1) This thesis has no foundation in fact and observation. The eye is the only sense-organ, as far as we can discover, that forms any kind of image of its object; and the images formed by the eye are not in the brain but at the back of the eye, and they are not at all perceived or felt by the mind. (2) It is no easier to conceive how the mind perceives images •in the brain than to conceive how it perceives things •more distant. If you show me how the mind can perceive images in the brain, I will undertake to show you how it can perceive the most distant objects; for if we give the mind eyes to perceive what is transacted at home in its dark chamber, why can't we make these eyes a little longer sighted? And if we do *that* we shall have no need for the unphilosophical fiction of images in the brain! In short, the manner and mechanism of the mind's perception is quite beyond our understanding; and *this* way of explaining it, by images in the brain, seems to be based on very gross notions of the mind and its operations—implying that the supposed likenesses in the brain, by a kind of contract, formed similar ones in the mind, of which the mind is supposed to be conscious.

I have tried to show throughout this inquiry that the effects made on the mind by means of the five senses haven't the least resemblance to the objects of sense; and therefore, as I see no shadow of evidence that there are any such likenesses in the brain, I see no scientific purpose that can be met by supposing them. Since the picture on the retina, therefore, •isn't itself seen by the mind, •doesn't have on the brain or sensorium any effect that is seen by the mind, and •doesn't have any effect on the mind that resembles the object, the question still stands: How does this picture on the retina cause vision?

Before answering this question, I should point out that in the operations of the mind, as well in those of bodies, we must often be satisfied with knowing that certain things are connected and invariably follow one another, without being able to discover the chain that goes between them. Such connections are what we call 'laws of nature'; and when we say that one thing produces another 'by a law of nature', all we mean is that one thing (in everyday language called the 'cause') is constantly and invariably followed by another that we call the 'effect', and that we don't know how they are connected. Thus, we see that it is a fact that bodies gravitate toward bodies, and that this gravitation is regulated by certain mathematical proportions depending upon how far apart the bodies are and the quantity of matter that each has. Being unable to discover the cause of this gravitation, and presuming that it is the immediate operation either of ·God·, the author of nature, or of some subordinate cause that we haven't yet discovered, we call it a 'law of nature'. If any philosopher some day has the pleasure of discovering the cause of gravitation, this will have to be by discovering some more general law of nature from which the gravitation of bodies necessarily follows. In every chain of natural causes the highest link is a primary law of nature, and the highest link that we can find by sound induction is either this primary law of nature or a necessary consequence of it. Tracing out the laws of nature by induction from the phenomena of nature is all that true philosophy aims at, and all it can ever reach. [Remember that 'philosophy' also covers *science*].

There are laws of nature by which the operations of the mind are regulated; there are also laws of nature that govern the material system; and just as the latter are the ultimate conclusions that the human faculties can reach in the philosophy of bodies, so the former are the ultimate conclusions we can reach in the philosophy of minds.

Now, I put the question of *how* the picture on the retina causes vision in the way that it does. From what I have just been saying, we can see that the question amounts to this:

> By what law of nature is a picture on the retina the means or occasion of my seeing an external object of the same shape and colour, with the opposite up-down orientation, and in a certain direction from the eye?

I am sure it will be agreed that I see the whole object in the same manner and by the same law by which I see any one point on it. Now I know it to be a fact that in direct vision I see every point on the object in the direction of the straight line that passes from the centre of the eye to that point on the object; and I also know from optics that the ray of light that comes to the centre of my eye passes on to the retina in the same direction. So it seems to be a *fact* that

> every point on the object is seen in the direction of a straight line passing from the picture of that point on the retina through the centre of the eye.

As this is a fact that holds universally and invariably, it must be either a law of nature or the necessary consequence of some more general law of nature. And according to sound rules of philosophizing we can regard it as being itself a law of nature until we discover some more general law from which it follows (which I suspect can never be done). [Throughout this discussion Reid mostly uses 'law of nature' to mean '*basic* law of nature'.] Thus we see that •the phenomena of vision lead us by the hand to •a law of nature, or a law of our constitution; and a necessary consequence of this is that we see objects the right way up through upside-down images. . . . My chief aim in dealing with this question was to point out this law of nature—a law which is a part of the constitution of the human mind, and therefore belongs properly to the subject of this inquiry. So I shall make some further remarks about it, after doing justice to the ingenious Dr. Porterfield who, long ago in his *Medical Essays* or more recently in his *Treatise of the Eye*, pointed out, as a primary law of our nature something which. . . .very nearly coincides with the law that I have mentioned.

In order, therefore, that we may have a more distinct notion of this law of our constitution, I shall offer three observations.

1. We can give no reason why the retina is the only part of the body on which pictures made by the rays of light cause vision; so we must set this down to being simply a law of our constitution. We can use optical glasses to form such pictures on the hand or on any other part of the body, but we don't feel them and they don't produce anything like vision. A picture on the retina is no more *felt* than is a picture on the hand; but it produces vision—and the only reason for this, as far as we know, is that the wisdom of nature intended it for this purpose. The vibrations of the air strike on the eye, the palate and the olfactory membrane with the same force as on the ear-drum; their effect on the ear-drum produces the sensation of sound, while their effects on any of the other sense-organs produce no sensations at all. This re-applies to all the senses, each of which has its own special laws according to which the effects on the organ of that sense produce sensations or perceptions in the mind that can't be produced by effects made on any other organ.

2. The laws governing perception by the different senses are very different, not only in respect of the nature of the objects perceived by them but also in respect of how they

inform us about the distance and situation of the object. In all of them the object is thought of as external and as having real existence independently of our perception; but by one sense (·touch·) the mind is presented with the distance, shape and situation of the object, by another (·sight·) the shape and situation but not the distance; and by another (·hearing·) neither shape, situation or distance. It is no use invoking the principles of anatomy or natural philosophy to explain these differences in the manner of perception by the different senses. Eventually we have to bring it back to the will of ·God·, our maker, who intended that our powers of perception should have certain limits, and adapted to his wise purposes the organs of perception and the laws of nature by which they operate.

When we hear an unusual sound, the sensation indeed is in the mind, but we know that something external produced the sound. At the same time, our hearing doesn't tell us whether the sounding body is near or far, in this direction or that; so we look around to discover it. If any new phenomenon appears in the heavens, we see exactly its colour, its apparent place, size, and shape, but we don't see its distance. For all the eye can tell, it may be in the atmosphere, among the planets, or in the sphere of the fixed stars.

The testimony of the sense of touch reaches only to objects that are contiguous to the organ, but with regard to them it is more precise and detailed. When we feel a body with our hand, we know its shape, distance and position, as well as whether it is rough or smooth, hard or soft, hot or cold. The sensations of touch, seeing and hearing are all in the mind, and can't exist except when they are perceived. How do they all constantly and invariably suggest the conception of and belief in external objects that exist whether or not they are perceived? No philosopher can give any answer except that *that is the way we are constituted*.

How do we know that the object of touch is at the finger's end and nowhere else? That the object of sight is in such-and-such a direction from the eye, and in no other direction, but can be at any distance? and that the object of hearing can be at any distance, and in any direction? Not by custom, surely, or by reasoning or comparing ideas, but by the constitution of our nature. How do we perceive visible objects in the direction of straight lines perpendicular to that part of the retina on which the rays strike, while we don't perceive the objects of hearing in lines perpendicular to the ear-drum on which the vibrations of the air strike? Because such are the laws of our nature. How do we know which parts of our bodies are affected by particular pains? Not by experience or by reasoning, but by the constitution of nature. The sensation of pain is of course in the mind, and can't be said to have any relation, from its own nature, to any part of the body; but because of the way we are built this sensation gives us a perception of some particular part of the body whose disorder causes the unpleasant sensation. If it weren't so, a man who never before felt either the gout or toothache might when he first had gout in his toe mistake it for toothache. Every sense, therefore, has its special laws and limits by the constitution of our nature; and one of the laws of sight is that we always see an object in the direction of a straight line passing from its image on the retina through the centre of the eye.

3. You may want to say: 'It would be easier and just as satisfactory to conceive a law of nature by which *we always see objects in the place where they are, and with their true orientation*, without bringing in images on the retina or the optical centre of the eye.' To this I answer that nothing can be a law of nature that is contrary to fact. The laws of nature are the most general facts we can discover in the operations

of nature. Like other facts, they are not to be found by lucky guesses but to be soundly derived from observations; like other general facts, they are to be inferred not from a few particulars but from a patient and cautious induction from a large number of particulars. That we see things always in their true place and orientation *is not fact*, so it can't be a law of nature. In a plane mirror I see myself and other things in quite different places from those they really occupy; and this is the case whenever the rays coming from the object are either reflected or refracted before striking the eye. Those who know anything of optics know that in all these cases the object is seen in the direction of a line passing from the centre of the eye to the point where the rays were last reflected or refracted, and that all the powers of the telescope and microscope depend on this.

Shall we say, then, that it is a law of nature that *the object is seen in the direction. . . .contrary to that of the rays when they meet the eye*? No. This is not true, so it isn't a law of nature. For the rays from any one point on the object come to all parts of the pupil; so they must have different directions; but we see the object only in one of these directions, namely that of the rays that come to the centre of the eye. And this holds true even when the rays that are heading for the centre are blocked and the object is seen ·only· by rays that pass at a distance from the centre.

You may think that although we aren't made so as to see objects always in their true place, or as precisely in the direction of the rays when they strike cornea, perhaps we are made so as to *see the object in the direction that the rays have when they reach the retina after undergoing all their refractions in the eye*—i.e. the direction in which the rays pass from the crystalline lens to the retina. But this isn't true either, and consequently it isn't a law of our constitution. To see that it isn't true, we must conceive all the rays that pass from the lens to one point on the retina as forming a small cone whose base is on the back of the lens, and whose vertex is a point on the retina. Obviously the rays that form the picture at this point have different directions, even after they pass the lens; yet the object is seen only in one of these directions. . . .

From this induction I conclude that our seeing an object in that particular direction in which we *do* see it is not a result of •any law of nature by which we are made to see it in the direction of the rays, whether before or after their refractions in the eye, but of •a law of our nature by which we see the object in the direction of the straight line that passes from the picture of the object on the retina to the centre of the eye.

The facts on which I base this induction come taken from four fascinating experiments by Scheiner and reported by Dr. Porterfield, and confirmed by his experience. I have repeated these experiments myself, and found them to agree with the report. As they are easy to perform and tend to illustrate and confirm the law of nature I have mentioned, I shall present them here as briefly and clearly as I can. [In this version, Reid's account will be made somewhat briefer still. The omissions will not be signalled by . . . . ellipses.]

Experiment 1. Place a well-lit pinhead about eighteen inches from your eye; keep your eye still, looking at the pinhead steadily. We know that the rays from anyone point on this object, whether they pass through the centre of the eye or away from the centre, come together again at one point on the retina; and that these rays have different directions, both before they strike the eye and after they pass through the crystalline lens.

Now make a small pinhole in a card and look at the pinhead through this hole, moving the card so that different parts of your eye are in play. When you do this you will be

seeing the pinhead sometimes by rays that are central and sometimes by rays that are not, with different directions and different angles to one another (both when they strike the cornea and when they strike the retina), but always by rays that come to the same point on the retina. And what is the upshot? It is that the object is seen in exactly same direction, whether seen by all these rays together or by any one subset of them.

Experiment 2. Place the pinhead about four or five inches in front of your eye. We know that in this case the rays coming from one point on the object don't meet at one point on the retina, but spread over a small circular spot of it; the central rays occupying the centre of this spot, the rays that pass above the centre occupying the upper part of the spot, and similarly with all the rest. And we know that in this case the object is seen confused, every point on it being seen not in one direction but in several. To remedy this confusion, look at the object through the pinhole, and while you move the pinhole over the various parts of the pupil the object won't keep its ·apparent· place but will seem to move in the opposite direction!

Take note of this: when the pinhole is moved upward over the pupil of the eye, the picture of the object is moved upward on the retina while the object seems to move downward, so as to be always in the straight line passing from the picture through the centre of the eye. Bear in mind also that the rays forming the upper and the lower pictures on the retina don't cross each other as in ordinary vision; yet *still* the higher picture shows the object lower, and the lower picture shows the object higher, just as when the rays do cross each other. One consequence of this, by the way, is that the phenomenon of our seeing objects with the opposite orientation to that of their pictures on the retina does *not* depend on the crossing of the rays, as Kepler and Descartes thought.

Experiment 3. As in the second experiment, but this time make *three* pinholes in a straight line, close enough together for rays coming from the object through all them to enter the pupil at the same time. The upshot of this is very remarkable: the object is seen triple with one eye! And if you make more holes within the breadth of the pupil, you will see as many objects as there are holes. But I shall take the case of *three* holes—one right, one middle, one left—so that you see three objects standing in a line from right to left.

Notice that of the three pictures on the retina, the one on the left is formed by the rays that pass on the left of the eye's centre, the middle picture by the central rays, and the right-hand picture by the rays that pass on the right of the eye's centre. It is also important that the object appearing on the right is not the one seen through the hole on the right, but the one seen through the hole on the left; and similarly the object appearing on the left is the one seen through the hole on the right; this being easily proved by covering first one hole and then the other. Thus, whatever the direction may be of the rays that form the right-hand and left-hand pictures, still the right hand picture shows a left-hand object, and the left-hand picture shows a right-hand object.

Experiment 4. It is easy to see how to vary the second and third experiments by placing the object too far away to see clearly. For this purpose I looked at a candle ten feet away, *and put the eye of my spectacles behind the card, that the rays from the same point of the object might meet, and cross each other, before they reached the retina*. [The *asterisked* portion is in Reid's exact words.] In this case as in experiment 3, the candle was seen triple through the three pinholes; but the candle on the right was seen through the hole on the right, and the left-hand candle through the hole on the left. The principles of optics make it clear that in this experiment the rays forming the several pictures on the retina cross

each other a little before they reach the retina; so that the left-hand picture is formed by the rays that pass through the hole on the right; so that the position of the pictures is opposite to that of the holes through which they are formed, and therefore also opposite to that of their objects, as we have found it to be in the former experiments.

These experiments exhibit several unusual phenomena relating to the apparent place of visible objects and their apparent direction from the eye—phenomena that seem to go flatly against the common rules of vision. ·I shall mention five ways in which they do so·. (i) When we look at the same time through three holes that are in a straight line and at certain distances from each other, we expect that the objects seen through them should really be and should appear to be at a distance from each other; yet by experiment 1 we can through three such holes see a single object and a single point on that object; and through each of the three it appears in the same place and direction.

(ii) When the rays of light come from the object in straight lines to the eye, without any reflection, bending or refraction, we expect the object to appear in its real and proper direction from the eye, and so it usually does. But in experiments 2, 3 and 4 we see the object in a direction that isn't its true and real direction from the eye, although the rays come from the object to the eye without any bending, reflection or refraction.

(iii) When both the object and the eye are kept perfectly still, and the medium ·through which the light rays pass· is unchanged, we expect the object to appear to be at rest, staying in the same place. But in experiments 2 and 4, when both the eye and the object are at rest and the medium unchanged, we make the object appear to move upward or downward or in any direction we please.

(iv) When we look at the same time and with the same eye through holes that stand in line from right to left, we expect the object seen through the left-hand hole to appear on the left, and the object seen through the right-hand hole to appear on the right. But in experiment 3 we find the exact opposite.

(v) Although there are many situations where we see a single object as double, using two eyes, we always expect it to appear single when seen through by one eye. But in experiments 2 and 4 we have cases where a single object can appear double, triple or quadruple *to one eye*, with no help from a polyhedron or multiplying glass.

All these extraordinary phenomena relating to the direction of visible objects from the eye, as well as those that are common and ordinary, take us back to the law of nature that I have mentioned, of which they are necessary consequences. There is no probability that we'll ever be able to give a reason why pictures on the retina make us see external objects while pictures on the hand or on the cheek do not, or why we see the object in the direction of a line passing from its picture through the centre of the eye rather than in any other direction. So I am inclined to look on this law as a *primary* ·or basic· law of our constitution.

Don't misunderstand me. I am *not* saying that •the picture on the retina will make us see •an object—in the direction mentioned or in any other!—independently of whether •the optic nerve and the other more immediate instruments of vision are in good working order. We don't have a good grasp of what the task of the optic nerve is, or of how it performs that task; but it seems to be certain that it has *some* part in the faculty of seeing, because in an amaurosis—·blindness with no apparent change in the eye·—which is believed to be a disorder of the optic nerve, the pictures on the retina are clear and distinct, and yet there is no vision.

We know still less of the use and function of the choroid membrane; but it seems also to be necessary for vision; for it is well known that pictures on that part of the retina where it isn't covered by the choroid. . . .produce no vision. . . . So I acknowledge that the retina is not the last and most immediate instrument of the mind in vision. There are other physical organs whose operation is necessary for seeing, even after pictures have been formed on the retina. If we ever come to know the structure and use of the choroid membrane, the optic nerve and the brain, and what effects are had on them by means of pictures on the retina, we may come to •see some more links of the chain and to •discover a more general law of vision. But when we know so little of the nature and function of these more immediate instruments of vision, it seems impossible to trace vision's laws beyond the pictures on the retina. Nor would I deny that there may be diseases of the eye, or accidents, which can lead to our seeing objects in a direction somewhat different from the one mentioned above. [Reid then describes some evidently permanent defects in his own vision, caused by inadvertently glimpsing the sun through a telescope.]

13. Seeing objects single with two eyes

Another phenomenon of vision that deserves attention is our seeing objects single with two eyes. There are two pictures of the object, one on each retina, and each picture by itself makes us see an object in a certain direction from the eye; yet both together usually make us see only one object. All the accounts or explanations of this that anatomists and philosophers have given seem to be unsatisfactory. I shall pass over the opinions of Galen, of Gassendi, of Baptista Porta, and of Rohault. The reader can see these examined and refuted by Dr. Porterfield. ·In sections 18-19· I shall examine Dr. Porterfield's own opinion, Bishop Berkeley's, and some others. But first we must be sure of the *facts* about single and double vision, for if we don't get the phenomena right, it's ten to one that we'll be led astray regarding the causes. ·The process of *describing* the phenomena can shade into the process of *explaining* them·. The next paragraph explains why. It presents something that we ought carefully to attend to; it is accepted *in theory* by everyone who has any true judgment or sound instincts in inquiries of this kind, but it is very often overlooked *in practice*.

In explaining natural phenomena, the furthest that our faculties can take us is this: from •particular phenomena we can by induction trace out •general phenomena of which all the particular ones are necessary consequences. When we have arrived at the most general phenomena we *can* reach, there we must stop. 'Why did •that leaf gravitate toward the earth?'—we can only answer 'Because •all bodies gravitate toward the earth'. This explains a particular phenomenon through a general one. 'Why do all bodies gravitate toward •the earth?'—the only explanation we can give is 'Because all bodies gravitate toward •each other'. This explains a general phenomenon through a *more* general one. 'Why do all bodies gravitate to one another?'—we have no answer; but if we did, it could only be by bringing this universal gravitation of bodies under some other still more general phenomenon of which the gravitation of all bodies is a special case. The *most general phenomena we can reach* are what we call 'laws of nature'. So that the laws of nature are nothing but the most general facts relating to the operations of nature, which include a great many particular facts under them. If we sometimes label as a law of nature something that we later discover comes under something still more general, there is no great harm done. . . .Now let us consider the phenomena of single and double vision, in order to discover some general

principle to which they all lead and from which they all follow. If we can discover any such general principle, it must be either •a law of nature or •the necessary consequence of some law of nature; and its authority will be equal either way. ·The material to be presented in this section will be in nine episodes·.

1. We find that when the eyes are sound and perfect, and the axes of both are directed to one point, *an object placed at that point is seen single*; and I would point out here that in this case the two pictures that show the object single are in the centres of the retinas. As an aid to keeping things clear, ·I shall introduce a couple of mildly technical terms·. When two pictures of a small object are formed at points on the retina, if they show the object single I shall call those points 'corresponding points' on the retina. If they show the object as double, I shall say that the points on the retina at which the pictures are formed 'do not correspond'. Now, in this first phenomenon it is evident that the two centres of the retina are corresponding points.

2. When the eyes are sound and perfect, and the axes of both are directed to one object, *other objects appear single if they are at the same distance from the eyes as the object to which their axes are directed.* I direct my eyes to a candle ten feet away while another candle stands at the same distance from me and within my field of vision. While I am looking at the first candle, I can attend to how the second appears to my eyes, and I find that in this case it too always appears single. An important point here is that the pictures of the second candle don't fall on the centres of the retinas; either they fall on the right, or both to the left, and both are at the same distance from the centres. This is easy to show from the principles of optics. In this second phenomenon of single vision, therefore, it seems that the corresponding points are points of the two retinas that are similarly placed in relation to the two centres, being both on the same side of the centre and at the same distance from it. It also appears from this phenomenon that every point on one retina *corresponds* with the similarly placed point on the other.

3. When the eyes are sound and perfect, and the axes of both are directed to one object, *other objects appear double if they much nearer to the eyes or much further from them than the object to which the two eyes are directed.* Thus, if a candle is placed ten feet away and I hold my finger at arm's length between my eyes and the candle: when I look at the candle I see my finger double, and when I look at my finger I see the candle double; and the same thing happens with all other objects at such distances that fall within the sphere of vision. Those who understand the principles of optics will realise that the pictures of the objects that are seen double don't fall on points on the retinas that are similarly placed, whereas the pictures of the objects seen single *do* fall on points that are similarly placed. From this I infer that while the points on the two retinas that are similarly placed in relation regard to the centres do correspond, those that are not similarly placed do not correspond.

4. Notice this: in cases such as I have just described we have been accustomed from infancy to see objects double that we know to be single, custom and experience of the singleness of the object never take away its appearance of doubleness.

5. I would point out, though, that if you make a regular practice of attending to visible appearances, this will have a considerable effect, making a difference to how much of the phenomenon of double vision you notice and remember. Someone may honestly say that he never saw things double all his life; but when he is put into the position described in 3 above, he will immediately see the candle double when he looks at his finger; and his finger double when he looks

at the candle. Does he now *see* differently from how he saw before? No, surely; it's just that he *attends* to what he never attended to before. The same double appearance of an object has been presented to his eye a thousand times before now; but he didn't attend to it; and so it is as little an object of his reflection and memory as if it had never happened. ·This general phenomenon of as-it-were-not-*seeing* what one doesn't *attend to* deserves a couple of paragraphs to itself·.

When we look at an object, surrounding objects can be seen at the same time, although more obscurely and indistinctly; for the eye has a considerable field of vision, which it takes in all at once. But we *attend* only to the object we look at. The other objects that lie within the field of vision are not attended to; and therefore it's as though they weren't seen. If any of them draws our •attention it naturally draws the •eyes at the same time, because in the ordinary course of things the eyes always follow the attention; and when they are separated, as in a day-dream, we hardly see what is directly in front of us. So we can see why the man I have been talking about thinks that he never before saw an object double. When he looks at any object, he sees it single and doesn't notice other visible objects at that time, whether they appear single or double. If any of them draws his attention, it draws his eyes at the same time; and as soon as the eyes are turned toward the object it appears single. But in order to see things double—or at least to have any reflection or memory of doing so—he has to •look at one object while •attending to the faint appearance of other objects that are within his field of vision. He may never have done this, or even tried to, so he doesn't recollect that ever he saw an object double. But when he is set to work to give this attention, he immediately sees objects double in the way and with the same details as those who have given this attention through most of their lives.

There are many phenomena like this, showing that the mind can •not attend to, and thereby in a way •not perceive, objects that strike the senses. I mentioned several examples in chapter 2; and I have been assured by people who are highly skilled in music that when they are hearing a tune on the harpsichord, while they attend to the treble they don't hear the bass, and while they attend to the base they don't perceive the tune in the treble. . . .

6. It is observable that whenever we see an object double the two appearances have a certain position in relation to one another, and a certain apparent. . . .distance. This apparent distance is greater or less in different circumstances; but in the same circumstances it is always the same, even to different persons.

Thus in the experiment mentioned above, if twenty different people who see perfectly with both eyes place their finger and the candle at the stated distances and hold their heads upright, in looking at •the finger they will see two candles, one on the right and the other on the left. The one seen on the right is seen by the right eye, the one seen on the left by the left eye; and they—·the twenty people·—will see them at the same apparent distance from each other. And if they look at •the candle they will see two fingers, one on the right and the other on the left; and they will all see them at the same apparent distance; the finger toward the left being seen by the right eye and the other by the left eye. If the twenty people all tilt their heads 90º to one side, with the other circumstances remaining the same, one appearance of the object that is seen double will be directly above the other. In a word, however you choose to vary the circumstances, the appearances will be varied in one and the same manner to all the spectators.

7. Having made many experiments to study the apparent distance between the two appearances of an object that is

seen double, I have found this [what follows expands Reid's text a little, in ways that ·small dots· can't easily indicate]:- When a single object is seen double,

- •let x be the point on the retina of the left eye where the picture of the object is made,
- •let y be the point on the retina of the right eye where the picture is made, and
- •let z be the point on the retina of right eye that is situated similarly to x.

Then what I have found is that *the apparent distance between the two appearances is proportional to the distance between y and z.* Thus, just as the apparent distance between •two objects seen with one eye is proportional to the arc of the retina that lies between their pictures, so also when an object is seen double with two eyes, the apparent distance between the two appearances is proportional to the arc of either retina which lies between •the picture in that retina and •the point in that retina corresponding to the point that has the picture in the other retina.

8. Just as in certain circumstances we invariably see one object appear double, so in others we equally invariably see two objects unite into one and in appearance lose their doubleness. This is evident in the appearance of the binocular telescope. And the same thing happens when one looks through two similar tubes in a parallel direction: we see only one tube; and if two similar coins are placed at the ends of the two tubes, one exactly in the axis of one eye and the other in the axis of the other eye, we see only one coin. If two coins (or other bodies) with different colour and shapes are properly placed in the two axes of the eyes and at the ends of the tubes, we see *both the bodies in one and the same place*, each as it were spread over the other, without hiding it; and the colour will be what you get from putting those two colours together.

9. From these phenomena, and from all the experiments I have been able to conduct, it seems clear that in perfect human eyes the centres of the two retinas correspond and harmonize with one another; and that every other point in one retina corresponds and harmonizes with the point that is similarly situated on the other retina, in such a way that

- •pictures on the corresponding points of the two retinas show only one object even when there are really two objects, and •pictures on points of the retinas that don't correspond show us two visible appearances even when there is really only one object.

So that pictures on corresponding points of the *two* retinas present the same appearance to the mind as if they had both been on the same point on *one* retina; and pictures on non-corresponding points of the two retinas present to the mind the same apparent distance and position of two objects as if one of those pictures were on the point corresponding to it on the other retina. I offer this. . . .not as an hypothesis but as a general fact or phenomenon of vision. All the phenomena of single or double vision that I have described lead to it and are necessary consequences of it. It holds true invariably in all perfect human eyes, as far as I can discover from countless experiments made on my own eyes and many made by others at my request. Most of the hypotheses that have been contrived to explain single and double vision presuppose this general fact without their authors' being aware of it. [Reid adds a few details to that, in relation to work by Isaac Newton and Robert Smith, author of *A System of Optics*.] So this general phenomenon appears to be based on a very full induction, which is all the evidence we can have for a fact of this kind. Before I finish with this subject I ought to ask ·and answer· some questions:

- •Do animals whose eyes are on opposite sides of their heads and point in opposite directions have such

corresponding points in their retinas? (·section 14·)

- •What is the position of the corresponding points in imperfect human eyes, I mean in those who squint? [sections 15-16, not included in this version]
- •Is this harmony between the corresponding points in the retinas natural and original or rather the effect of custom?
- •If it is original, can it be explained by any of the laws of nature already discovered, or should it itself be regarded as a law of nature and a part of the human constitution?

·The last two questions will be the topic of section 17. After that, in sections 18-19, I shall discuss the views of some other writers concerning single and double vision·.

14. The laws of vision in brute animals

In giving eyes to animals, nature intends that the animals should be able to perceive the situation of visible objects, or the direction in which they are placed. So it is probable that in ordinary cases every animal, however many eyes it has and of whatever structure, sees objects •single and •in their true and proper direction. And since there is an enormous variety among the structures, motions and number of eyes in different animals and insects, it is probable that the laws governing vision are not the same in all, but are variously adapted to the eyes that nature has given the animals in question.

Mankind naturally turn their eyes always the same way, so that the axes of the two eyes meet at one point. They naturally attend to or look at only the object that is placed at the point where the axes meet. And whether the object is more or less distant, the shape of the eye is adapted to the distance of the object so as to form a clear picture of it.

When we use our eyes in this natural way, the two pictures of the object we look at are formed at the centres of the two retinas; and the two pictures of any contiguous object are formed at points of the retinas that are similarly situated in relation to the centres. So if we are to see objects single and in their proper direction, with two eyes, all we need is to be so constituted that objects whose pictures are formed on the centres of the two retinas, or on points similarly situated in relation to these centres, shall be seen in the same visible place. And this is the constitution that nature has actually given to human eyes.

There are two, and only two, states of affairs in which we **(1)** see one object double, or **(2)** see two objects run together into one. Each involves conduct on our part that is unnatural, but that can be learned by practice: **(1)** We distort our eyes so that their axes aren't parallel; **(2)** We direct the axes of the two eyes to one point while directing our attention to some visible object that is much nearer or much more distant than that point. In these cases, **(1)** the two pictures of the same object are formed at points on the retinas that are not similarly situated, and so the object is seen double; or **(2)** the two pictures of different objects are formed at points on the retinas that are similarly situated, and so the two objects are seen run together in one place.

So it seems that the laws of vision in the human constitution are wisely adapted to the natural use of human eyes, but not to unnatural uses of them. We see objects truly when we use our eyes in the natural way, but have false appearances presented to us when we use them in an unnatural way. We may reasonably think that the case is the same with other animals. But isn't it *un*reasonable to think that animals which •naturally turn one eye toward one object and another eye toward another object must thereby have presented to them false appearances such as we have

when we •unnaturally do the same thing?

Many animals have their eyes so placed by nature that the axes of the two eyes are always in opposite directions. Do objects painted on the centres of the two retinas appear to such animals as they do to human eyes, in one and the same visible place? I think it is highly probable that they don't, and that they appear as they really are, in different places.

Judging by analogy with the human case, we will think that there is a certain correspondence between points of the two retinas in such animals, but that it is a different correspondence relation from the one we have found in human eyes. The centre of one retina will correspond with the centre of the other in such a way that the objects whose pictures are formed on these corresponding points will appear not to be in the same place (as in human eyes) but in different places. Similarly, the upper part of one retina will correspond with the lower part of the other, and the front part of one will correspond with the back part of the other.

Some animals are naturally able easily to turn their eyes in the same direction or different directions, as we turn our hands and arms. Do *these* animals have corresponding points on their retinas, and points that don't correspond, as we have? I think that probably they don't, because in them such a constitution would only serve to present them with false appearances. If we judge from analogy, that will lead us to think •that because such animals move their eyes in a manner like the way we move our arms, they have an immediate and natural perception of the direction they are pointing their eyes in, as we have of the direction we give to our arms; and •that they perceive the situation of visible objects by their eyes in a manner like that in which we perceive the situation of tangible objects with our hands.

We can't teach brute animals to use their eyes in any way other than in that which nature has taught them, nor can we teach them to tell us the appearances that visible objects make to them, either in ordinary or in extraordinary cases. So we don't have the same means of discovering the laws of vision in them as we have for mankind, and must rest content probable conjectures. What I've said about this is chiefly intended to show that animals to which nature has given eyes that differ in their number, their position and their natural motions may well be subject to different laws of vision, adapted to the special features of their organs of vision.

15. Squinting considered hypothetically

This section is omitted.

16. Facts relating to squinting

This section is also omitted.