Table of Contents

2. Sense Perception as Individual Experience

Pursuing George Berkeley's Thoughts on Vision

Georg Maier

Berkeley's Approach to Vision

My interest in developing optics on the basis of sense perception was kindled when I read George Berkeley's "Essay towards a New Theory of Vision" of 1709. The essay was a firm and emphatic plea for an *experiential understanding of vision.* And Berkeley's views were just as controversial as those voiced by the wrong-minded student of the last chapter. He claimed, rather dramatically, that the "things of sight" are incommensurable with the "things of touch"; therefore, as perceiving beings, we inhabit two different worlds: a world of images appearing as we open our eyes and a world of tangible objects that our body's surface may detect when feeling direct contact to them. In moving our body to distant objects we find further "things of touch." Berkeley argued that, in contrast, the images we see are not perceived at any such distance from our body.

It is worthwhile to look into examples that seem to support his argument and also examples that seem not to uphold it. But in doing so we must be aware of Berkeley's philosophical aims. He was leading his readers toward a stance he would defend later: disbelief in the existence of a material world. Of course, we cannot adopt his views wholesale three hundred years later, nor need you fear that the following will be an excursion into the history of philosophy. I will not advocate Berkeley's notorious "immaterialist" doctrine. But it turns out worthwhile to take seriously his claims about the difference between seen objects and those given to the sense of touch.

Berkeley's assertions still come as a bit of a shock—as they are meant to. We are all quite sure we live in a world basically made up of touchable objects which the eye simply experiences in a different, non-touching sort of way. But Berkeley helps us to see a visual world that cannot be taken as the mere replica or re-presentation of a tactile one. Since this book is intended to spark interest in experience as such, attempting to come to terms with his claims may prove useful. At the very least it will enable us to become more familiar with the circumstances of visual perception. Further, it will lead us to various non-tactile features of our optical interactions.

A reminder: *it is essential* to gain for yourself the experiences described in this chapter. Otherwise the text can have little meaning, since it is about your experience and not about a set of ideas. There are few printed illustrations here, since they would be inadequate to support the full-bodied experience we are after.

Optical Appearances Need Not Be Representations of Material Bodies

Objects, or as Berkeley says, things or ideas, of sight need not be tangible. At sunrise, when the dazzling sun appears above the horizon, the world around me brightens. Turning away from the sun, I discover my shadow, which extends far out from my feet. I recognize it as the distorted image of my body. At the far end of my shadow I discover its head, which, incidentally, looks rather small. Under some conditions a bright halo radiates around the shadow's head.

If I close my eyes, all this vanishes. The "ideas of sight" are absent and I become all the more conscious of what I experience as "things of touch." Walking around, I feel the ground. Maybe it is a soft lawn. Stooping down, I touch the grass and, if conditions are right, I may feel the cool wetness of the morning's dew. Dew as a "thing of touch" turns out to be associated with the appearance of the halo as an "idea of sight."

If others are next to me, I will be able to compare their shadows with my own. Like mine, their shadows will be associated with their bodies. But it now becomes apparent that their shadow heads lack the splendor of my own halo. But if I dare tell them this, they are not impressed, since in their view *I* am the one missing a halo. Everyone will find the halo only around his or her own "head."

As we move around, our shadows accompany us. This, of course, is a truism. But it may seem a bit odd once we notice certain things about the seen landscape extending from our feet to the horizon. As we walk, we pass quickly by the seen foreground, while the far background, seen at a distance to our right and left, seems to be accompanying us. For the moment, it is enough to point out that, according to this foreground/background criterion, *our own* shadows, as "things of sight," act as if they belong to the distant background.

At this point, recall that your own shadow always remains opposite to the sun, regardless of your movements. And the halo stays fixed around the shadow of your head as you look at it. The shadows of our own heads, it appears, are rather special: in comparing them to, say, the shadows of our legs, we can remind ourselves that our heads are the locus from where we look. And, as seen from there, my *own* shadow's head is directly opposite the sun! So at last we come to the conclusion that the "ever-so-bright halo" encircles the direction opposite the sun—the sun being a "thing of sight" at great distance and therefore belonging to the appearances that accompany us as we move through the landscape. Needless to say, other people's shadows do not satisfy this special criterion of being opposite the sun *as seen from my eyes.*

Critique of the Concept of Rays

In Berkeley's time, illumination, shadows, and sight were already being treated in the framework of three-dimensional body space. One became accustomed to imagining light issuing from sources in the form of rays, as Newton had proposed. Rays were taken to be like straight lines. And such straight lines—of appropriate length—were taken to connect the seen objects with the eye. Then, as a matter of course, seen objects were taken to be at the corresponding distance from the eye.

We may arrive at the idea of straight-line rays by considering our experience in setting fence posts. One way to ensure that the posts are in a straight line is to set each new post by looking down the "line" of existing posts. In doing this we take a vantage point from which all the other posts almost vanish behind the one nearest us. Slight deviations from a straight line then become very noticeable. It will be the same if we look along a stretched string: closing one eye, we move our head as close as possible to the position from which the string's appearance will shrink almost to a point. Thus we should bear in mind that the straight line of sight will *not* appear to the eye as an extended line. Rather, the line reduces, for the person looking along it, to a *single point*. It is something like the vanishing point of perspective art.

The idea of straight-line rays provided the explanation for shadows in Berkeley's time. Shadows resulted where opaque objects stopped rays from hitting an illuminated surface, while neighboring rays could pass along an entirely transparent path. Similarly, vision was thought to result when rays from illuminated objects concentrated on the human eye. Given an opposite direction, these rays could be taken as rays of sight. Berkeley criticized this whole approach because it *strays from the original perspective of the observer*. *Rays seen from the side as straight lines are not given in sense experience.* Above all, we cannot see the lines of sight imagined to be the explanation of vision. Moreover, such lines would degenerate to a point when seen by the eye to which they are supposed to lead. Berkeley's argument now was that the length of the supposed lines of sight is not a visible quantity. Therefore *distance* of the seen world from the eye is not part of what we perceive *directly* in vision.

We See Images, Not Solid Objects

Berkeley's admittedly radical view is perhaps best understood if we provisionally assign what is *seen* to a realm of its own. Instead of putting vision into a three-dimensional, or spatial, framework, he reminds us that the seen world as sensed by our eyes is given in the form of fundamentally *two-dimensional* images. As we turn our head, say, to the right, new visible content wanders into our field of vision from the right, while we lose sight of appearances we had seen on our left. If we continue to turn in the same direction, not only turning our neck, but swiveling our whole body, we may scan the entire panorama of our surroundings. After a full turn we will have covered an angle of 360°. In this way we may understand our field of vision to be of *angular extension* between left and right and also between up and down. Inside that frame we perceive *images*—Berkeley called them *ideas*—composed of different colors in different levels of light or dark. We will see that these basically given properties of vision may be modified in diverse ways. But if we are prepared to travel with him this far, we can well understand his ploy of contrasting the "ideas of sight" (or "immediate objects of sight") with the "objects of touch" that give us our paradigm of solid spatial nature. For example, he notes that pure "ideas of sight" are not perceived as being a certain distance from the eye; they lack the dimension of depth. This lack may prove less perplexing if we keep in mind that we cannot perceive the length of the "rays" usually drawn from the seen object to the eye. (In more modern usage, one would say that such lines are not observables for the sense of sight.)

Since we are so deeply accustomed to locating percepts in the outside world—the world we explore by moving our limbs—we will at first be surprised by Berkeley's contention that seen images themselves are not located "out there." He writes that they lack *outness* (§126). Using the appearance of the moon to explain properties of a typical "object of sight," Berkeley wrote (§44):

> Suppose, for example, that looking at the moon I should say it were fifty or sixty semidiameters of the earth distant from me [sixty is accurate]. Let us see what moon this is spoken of: it is plain it cannot be the visible moon, or anything like the visible moon, or that which I see, which is only a round, luminous plane of about 30 visible points [half a degree] in diameter. For in case I am carried from the place where I stand

> directly toward the moon, it is manifest the object varies, still as I go on; and by the time that I am advanced fifty or sixty semidiameters of the earth, I shall be so far from being near a small, round, luminous flat [surface] that I shall perceive nothing like it; this object having long since disappeared, and if I would recover it, it must be by going back to the earth from whence I set out.

The visible moon as we normally experience it is an image seen while standing on the earth. And although on other grounds we may reasonably assign a body we call "the moon" to the realm of tangible, three-dimensional space, we cannot do this based on the visual image alone. Realizing this, we may take an interest in the more subtly differentiated understanding of vision proper that Berkeley is offering us.

How We Normally Associate Vision with Physical Depth

Of course, the seen world is normally taken to be "out there"—out there in the three-dimensional realm of touch space. In everyday life we successfully walk through complex spatial settings, for example through rooms with a lot of furniture, finding our way, say, to a chair. And we usually sit down on it without first touching it in order to be sure of its position. So vision guides us in a three-dimensional world in our daily life. In actual fact, however, little-noticed, non-visual sense percepts accompany the "ideas of sight" and relate them to touch space. In order to judge distance, we are supported by a number of effects that we will now explore.

a. When *moving*, we notice that things change in our field of vision. When walking on a paved sidewalk, watching our step, we are bound to see our feet stepping onto ever new paving stones. What we had seen in front of us comes nearer, only to pass by and vanish behind us. When watching the changing scene to our right or left, we find that things move past us at different speeds, the most fleeting ones being those nearest our path. We get the most solid impression of their form as we pass them. It is as if we were touching them from different sides in succession—as if what happens all at once in stereoscopic vision (see below) were now taking place in time. Looking out a side window of a moving vehicle while driving through a hilly area, we often get a vivid impression of the spatial structure of the landscape. All the while the things on the far horizon seem to accompany us, as if they were our true companions. As we change our direction, new escorts take over.

The truest—and the only escorts at sea—are, of course, the stars. While these do move in the course of time, perhaps we can consider the starry heaven to be one of the best examples of a

Berkeleyan “object of sight,” the moon being the most variable and most characteristic image in this context.

b. *Perspective* gives intimations of distance, since visible size decreases with distance. Looking down a straight avenue flanked by trees of uniform height, we will see their converging rows vanish into a point. At our end of the avenue, the limits of our field of vision will no longer allow us to survey a whole tree’s height, but instead details in a trunk’s bark or even the veins of leaves become apparent. It’s hard to describe this span in manners of appearance without alluding to distance. Berkeley argued that the immediate visual image is one thing, and what we infer as a result of perspective effects is quite another; the difference between the two should be respected. What the image of the landscape is said to imply (that is, distance) is an *interpretation* of the given (two-dimensional) visual percept, not an integral part of it.

c. Due to *atmospheric perspective*—the influence of a denser or hazier atmosphere—the colors of objects in the landscape change at a distance. Vegetation loses the quality of fresh green, and darker parts appear more bluish. Such effects again *imply* distance. But to judge distances correctly on this basis one must be aware of the effect of the sunlight illuminating the landscape: under a sky overcast by clouds, the effect of a slight haze will be similar in all directions, but this will be very different if the sun is shining directly, and all the more if it is not too high overhead. Then, when we look toward the sun, we will be looking directly at the shaded, darker side of any trees or buildings. These render a background in front of which we will readily see the haze that lights up most brightly in that direction. Grays will appear to dominate the scene. Conversely, when the sun is behind us the atmosphere will seem much more transparent; everything is directly illuminated and all object colors possess a striking clarity. Now it will seem that things are much nearer to us and it is hard to estimate their distance. It is as if a gauge for distance has been lost.

d. *Stereoscopic vision*, the effect of seeing things with two eyes that are set apart, gives us a feeling for the *spatial form* of nearby objects. We achieve stereoscopic vision by bringing the different images from our two eyes into at least partial coincidence. This also gives us a hint about the relative *distance* of nearby objects. This “sense” works in a rather hidden way; nevertheless, it is of great practical value in everyday life. You will immediately experience this when you close one eye, keep your head still, and try to pour coffee into a cup that someone has set a horizontal arm’s length away on the table. Under these circumstances, you will hardly dare to attempt this feat.

When looking at a scene of some depth with both eyes open, the difficulty arises that at any particular moment we can only make the two images we form coincide at a single distance. So when holding up one finger, but looking past it at a person farther away, the finger will be seen doubled, and both views of the finger will seem partially transparent. But when choosing to look at the finger, we may notice that the person seen behind it now has doubled outlines. As soon as we close one of our eyes, all this breaks down and with it our ability to sense distance stereoscopically.

Stereoscopic vision not only signals distance; it also can convey the quality of full bodily solidity. Looking at my thumb with both eyes at close range, I will get just that impression. Two images are united, but they can be investigated separately by closing one eye at a time. And in comparing them I find that they differ; each is formed from a special vantage point, because the eyes are located at different positions.

As we have seen when changing our focus between finger and background, we can fix our gaze into space at will. While reading, you will be moving your attention along the lines of print, keeping your focus at the appropriate distance. But at any moment you can, at will, gaze through the page —now the lines of the text become chaotic; at the ends of the lines you can still see the words singly, while in the middle the text is definitely seen to be double. When looking *through* the text, you are focusing your stereoscopic organ at a distance at which there is nothing to focus on!

Now you are prepared to make a nice, but difficult, experiment: Your two eyes are offered two squares lying next to each other. Looking at them directly, you will first see two images. But then try to stare through the page as you did with the printing. As you already know, this will turn each square into a pair. And the farther away you direct your stare, the more the members of each pair come apart, until at last the left member of the right pair is superimposed on the right member of the left pair:

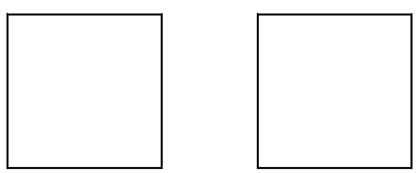

Fig. 1

There seems to be a very strong tendency to let the inside squares merge to form a single square in the middle. Having succeeded in *seeing the three squares*, now try the same thing when both squares contain a vertical line:

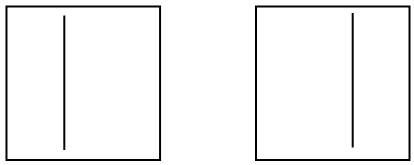

Fig. 2

The added line in the middle (third) square does not seem to lie in the same plane as the square! Perhaps you have noticed that the line appears to be *behind* the frame. When trying the next pair, pay attention to a change in the line's seeming location:

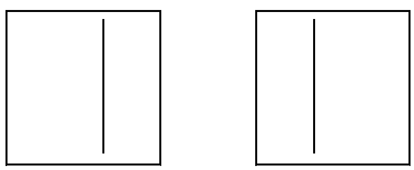

Fig 3

Here is a hint on how to understand what is going on in Figure 2. Suppose you are standing in front of a small window with your nose opposite its center. You are looking through the window at a pole some distance behind the window. Then the left square of Figure 2 represents how you would see the pole and window with your left eye alone when your right eye is closed. Similarly, the right square shows the view with your left eye closed. In merging the two views given to the left eye and the right eye, you have simulated this stereoscopic effect of depth. In Figure 3 the simulated situation implies a pole *in front* of the frame.

In Figures 2 and 3 stereoscopic vision produces from totally flat patterns the effect of *spatial depth*. For those who find this experience intriguing, I recommend Bela Julez's *Foundations of Cylopean Perception* (1971). He doesn't make you struggle to look past them as I have, since his patterns are in blue and red. All you have to do is look at them through a red filter with one eye and through a blue one with the other.

In the examples, the two respective squares are set apart horizontally. When you begin to look through the page into the far distance, the images split up into pairs, which are again set apart horizontally. At the extreme, the two inner images come together and coincide as one. But this is no longer true when you either tilt your head to the left or right, or keep your head upright and tilt the page. In other words, stereoscopic vision usually results from combining what our two eyes see from horizontally separate vantage points of equal height.

Stereoscopic Vision Can Direct Our Movements in Body Space

By now you will have become more familiar with stereoscopic sensing. You will have experienced that it depends on *merging* the two separate images our eyes produce. And in order to effect this merging you must allow your eyeballs to turn within the eye sockets. The nearer an object is, the more the eyeballs must swivel toward the nose. However the object needs to have a structure that lets you notice when the two images merge. As we will see, not all objects offer such a structure. As long as we hold our head upright, our stereoscopic sense seems to work on vertical elements that can be made to coincide when each eye moves appropriately to the left or the right.

A lovely experiment will let you experience this. Take an even, uniform wire or fishing line. (It must not have any kinks or marks on it.) In our experiment we will test how well you can fix a clothespin on that special clothesline. First, the line is held vertically by two assistants, one deep down, near the floor, and one standing on a chair with hand held high. Hold the clothespin in one hand and move it toward the line from one side. Usually this first task is easy to fulfill, and is completed in no time. You can sense the location of the line vividly.

Next the assistants hold the line horizontally at eye-level while standing far to your right and left. You must now move the clothespin toward the line from below. But you will find that the situation has changed radically. As the line is now devoid of visible structure along its horizontal extension; there are no elements for your eyes to concentrate on. The onlookers will only notice that the hand holding the clothespin hesitates, while it is the poor person doing the task who experiences the difference. The line remains at an uncertain distance. Most people will just have a try, hoping to be lucky (and some are). Others will "cheat" in an intelligent way: by moving their heads up and down, they try to get an impression of the line's location—this trick depends on sensing distance from movement, as we described earlier.

After all the people involved have had their go, it will be worthwhile to think about the role of stereoscopic sensing of location. It does seem that in using it, we introduce a further "sense" to augment the sense of vision. And standing in front of the taut horizontal line one feels that this additional sense has suddenly *gone blind*. One might even concede to Berkeley that this new sense is one of those that give appearances the character of “outness.” It gives the vertically held line the property of an “idea of touch,” which the line is deprived of when held horizontally.

Combining Perspective and Stereoscopic Vision in Movement

With both eyes open, look at a bunch of keys you are holding in the palm of your hand. Now move your hand farther away, to full arm’s length, and watch the keys. Still keeping your eyes on them, bring them back to normal reading distance and even a little nearer. In order to become accustomed to the effect, you can continue observing the keys as you move them back and forth.

Now close one eye and repeat the process a few times. In order to become more aware of what is going on, try to pay attention to how your hand appears as seen inside the frame of your field of vision. This time it will be striking how the keys grow in visual size, when brought nearer, diminishing in visual size while being moved away. This variation is an effect of perspective; the keys look smaller at a distance, just as we observed trees appearing smaller at a distance. But now we are seeing a difference in this effect, depending on whether we employ one or two eyes. The effect of changing distance is less striking when we watch our hand and keys with both eyes open. At shorter distances perspective seems to apply only when we close one eye. This may come as a surprise. It seems that in keeping both eyes open—that is, in using stereoscopic vision at close range—we lose the visual quality of perspective. At the same time, we gain a new quality, as if we were “seeing” the keys as “things of touch.” It is as if we could directly *see* body sizes.

In our experiment, we could experience that stereoscopic vision tends to conserve object size, regardless of perspective. As a matter of fact, many craftsmen are very good at estimating the size of relatively near objects, regardless of the exact distance. Consistent with Berkeley, we might say that there are certain spatial clues associated with vision, and these enable us to *interpret* the purely visual image as an in-depth “object of touch.” Stereoscopic vision, in combination with perspective, may provide such vivid spatial clues for nearby objects that the interpretation more or less becomes the direct perception. That is, objects appear to be the “right” size (an unvarying size) regardless of distance. We can emphasize the touch aspect, with its conservation of size, by focusing narrowly on the group of keys as an isolated object. And we can emphasize the purely visual aspect, with variation of apparent size, by attending to the frame of our vision as we move the keys back and forth.

Pure Objects of Sight as a Limiting Case

Summing up, Berkeley's "objects of sight" are best understood as a limiting case or particular aspect of what we experience in the seen world. We may experience "objects of sight" best at the moment when one of the indications of depth loses its effect—when, for example, walking through a hilly landscape, we stop abruptly. As our view of the landscape suddenly freezes, the effect of changing perspective is lost and for an instant what we had just been experiencing as so obviously implying spatial depth just fades away. For a moment the scene seems to lose the *quality* of being at any particular distance. Then, of course, other clues to outer distance become effective and our desire to find ourselves as bodies in a world of spatial nature is again satisfied. We also experienced a loss of depth when we could not bring the clothespin to the horizontal line

When a scene does not forcefully suggest its spatial aspect, we tend to be irritated. Think of walking through the woods, almost in the dark, with the stars above your path. You may then appreciate what it means to lose awareness of the spatial structure of your surroundings. As for the starry sky itself, it is a purely visual scene; lacking all depth clues, we cannot participate in it other than visually.

A World of Light and Color

I have the impression that Berkeley had a premonition of modern painting. Painters eventually discovered that by giving up naturalism they could liberate a purely visual content from any fuller representation of the natural world. Abandoning the attributes of spatial extension instead of emphasizing the likeness to familiar bodies in space, they defamiliarized the content of their composition, giving it the scope of an expression in its own right. And so they discovered ways and means of concentrating on a visual content. *Berkeley's "objects of sight" result from such a special, "purist" way of looking.*

We can deconstruct the usual result of perception in steps:

- In giving up movement, we allow our surroundings more of a chance to appear in a non-spatial manner.

- In giving up stereoscopic sensing of distance, we sacrifice a clue that lets us assign spatial size to a visual image.
- If we also refrain from interpreting what we see in terms of spatial objects, we have removed every condition that supports three-dimensional representation. Yet visual content remains. This is the content of Berkeley's "seen world."

Once we recognize that vision need not be confined to representing bodies in three-dimensional space, we may attend to other traits of the seen world. We may, that is, attend to the qualities uniquely sensed in vision: to *color* and the level of *illumination*. Such qualities will pervade an entire landscape. Thus, as the sun rises, slopes inclined toward the east are illumined, while shadows cover areas slanting west. A sunrise is by no means localized. As the day progresses—even into the night—the scene continues to be transformed qualitatively in ways we can describe with reference to direction, but without reference to distance.

What is true for the course of the day is true also for the development of plant life through the seasons. In the panorama that the sense of sight presents to us, we may participate in processes apparent in the whole of the scene. As the days grow longer and the sun rises higher in the sky and the air becomes warmer, new color permeates the scene. The tender, translucent green of newly sprouting leaves of the beeches accentuates the silver gray of the trunks that had been unobtrusive before. The seasons appear most characteristically in the changing coloration of the landscape, with gaudy autumn finally yielding to the blanket of snow that seems to turn the trees black.

Objects of Sight as Straightforward Physical Quantities

Most people would be surprised to learn that Berkeley's objects of sight are a valid starting point for a modern science of optics. We will show one aspect of this different approach, touching on the field of illumination.

While the "starry heavens" appear at night without needing any external light, the moon and the planets turn out to be illuminated by the sun, as we can conclude from their changing appearance in the course of time. The moon never shows its back side to the earth, and it shows us its whole front side in full illumination only at full moon. In astronomical terms, the moon is then in opposition to the sun, the two bodies being opposite to each other from a terrestrial viewpoint. At this time the moon appears as a circular disk bathed in sunlight. We could produce the same "full-moon effect" on a tennis ball by holding it opposite to the sun and just outside the shadow of our own head. The other phases of the moon can be simulated by holding the ball at appropriate angles to the sun. If the daytime moon is present in the sky when we are trying this out, we can duplicate the moon's phase on the tennis ball by holding it in the direction of the moon.

Now, although the moon is brightly illuminated by the sunshine, the sun's "light" that supposedly flows through space to be reflected by the moon is not itself a visible phenomenon! This means our Berkeleyan visual standpoint does not allow us to invoke such flowing light in our explanations. What we definitely do know is that sources of illumination are especially bright "things of sight," as Berkeley would say. And these must be visible from any surface they are illuminating. Putting this in other words, we may formulate the following principle: objects light up according to their visible surroundings. On these terms alone—and without reference to flowing light—we will be able to explain the diminishing brightness of illumination at increasing distance from a lamp.

Illumination is usually explained as follows. Imagine light to be steadily issuing from a lamp in all directions. We assume the surrounding space to be perfectly clear, so no light is lost as it spreads into space. But the light must *expand*, so that its power to illuminate is distributed over surfaces of greater extent at greater distances. Take the lamp to be located at the center of a sphere, with the flow of light distributing itself evenly over the surface of the sphere. The area of this surface grows in proportion to the square of the sphere's radius. Thus, as distance from the lamp *increases,* the illuminating effect of the lamp *diminishes*, corresponding to the reciprocal of the square of the distance.

This argument depends on our imagining ourselves to be observing light as it crosses space in front of us, as if its movement could be seen from the side. We are all used to imagining this. But if we remind ourselves of the appearance of the moon at night—where we do not see sunlight streaming toward it—we will have to admit that this habit is not supported by experience. Berkeley did not like it. But it has hardly been noticed that his approach—which is meant to rest on sense experience—leads to an alternative train of thought that is just as useful in its result. Doing without the imagined viewer observing a stream of light from the side, we can deal with the problem of illumination this way:

We take lamps to be "objects of sight." That is, they gain in visible size as we move toward them and diminish in visible size as we move away from them. This is the effect of perspective. And as we will see, this change in visible size is sufficient to give us the law we are seeking. Let us again assume that the atmosphere is perfectly clear. Then we can convince ourselves that the seen brightness of a lamp does not change with distance. That is, if we view two identical frosted lamps with the second one at a greater distance than the first, and if we allow the first one to overlap our view of the second, then we will readily observe that they appear *equally* bright. The two bright disks will *merge.*

What changes with distance isn't the brightness, but the visible area of the lamp exhibiting this brightness. The *visible area* alone determines the illuminating effect at a given distance from the lamp. (Of course, in science one does not say "visible area"; one speaks of the "solid angle" subtended by a luminous surface.) According to the laws of perspective, the visible area of a lamp will diminish in proportion to the inverse square of its distance from the observer. So we have obtained the same result we did above—but by speaking of the visible area of the light source rather than invisible rays moving through space. Outside the immediate vicinity of the lamp we get exactly the same simple law as above. And since we have given up the usual idealization which treats the lamp as a point source, our formulation of the law now can also deal with the problem of illumination in the immediate vicinity of the lamp—a problem that the point-source idealization cannot handle, namely, the fact that the illumination remains proportional to visible size.*

Note that by relating the apparent size of the lamp*, its visual quantity,* to its effect as an illuminant, we no longer need to assume that light transports itself through space, at least in the context of problems of illumination. But even in a much wider context modern physics tends to give up the notion of light traveling through space in the way bodies do. For example, we learn from principles of optical imaging that the precision of the image deteriorates as the line of sight (that is, the presumed path of "flowing" light) from object to image is defined more exactly. This can easily be demonstrated. Reduce the aperture of the eye's lens by looking through a tiny hole pricked into a piece of paper. In this way you define the sight path (the imagined "path of light") with greater precision. But the result is a blurring of your sight. The image deteriorates, while your knowledge of the path between it and your eye becomes more accurate. On the other hand, the big telescopes used in astronomy, with their huge openings pointed toward the sky, "see" an ever so finely structured scene. This reciprocal relation between precision of the line of sight and quality of the resulting image suggests that the supposedly *intrinsic* ray-like character of light is really an *artifact* of the mind, an artifact that has been handed down from generation to generation.

---

* The hypothetical "point source" from which the light is supposed to stream out into space is not given in reality—it would be physically impossible and, moreover, the calculated illuminating effect of such a point at close range would not be what we actually observe. On the other hand, the lamp that is more realistically taken to be of the nature of "things of sight" just grows in solid angle the nearer you approach it, consistent with the observed law of illumination**.**

Outness Proper: Extension into Which We Move Our Bodies

Independently of the arguments above, let us compare the reports of the sense of touch with those of the sense of sight. We become much more conscious of the world of touch in the absence of visible percepts. If you close your eyes now, you will be near the usual situation of darkness. Suddenly you will become aware of the sum of tactile contacts your body presently has: the floor under your feet, the seat that is supporting you, the rest under your elbow. From this “home base” you can reach out, seeking to touch the things you remember being around you before you closed your eyes. In reaching out you are prepared for a coming sensation, but even within a visually familiar setting, when contact occurs, it always comes as a bit of a surprise. You can thus become aware of the unfamiliar nature of the external tactile world. This nature is that of “outness,” of being outside our physical body, in contrast to the seen world that renders itself immediately present. Of course, the “things of touch” that we may really experience as such are “near at hand,” in contrast to the visually attainable “things of sight” which, in terms of tactile distance, may be far away. The difference between the two worlds lies in the fact that vision does not have to *overcome* distance in the way our body does.

We have an additional sort of awareness of our immediate spatial surroundings even when we are not in touch with them. For example, we have a deep bodily familiarity with flights of stairs we often ascend and descend. Our feet need little guidance. Similarly, we know when we have made the steps necessary to reach the end of a familiar corridor, without counting them. Small everyday tasks like tying our shoelaces may become more difficult when watched, and certainly so when seen in a mirror. When shaving, I tend to close my eyes. In the same vein, be careful not to watch the tip of your pen too closely when repeating your signature at the counter of a bank. If I want to twist open a screw that is directed upward, I just ask my hand to suggest the appropriate direction of rotation. We begin to understand that there is a need to “translate” our seen surroundings into the tactile context at the disposal of our limbs. The two worlds have a different character. The concept of distance, of spatial extension, is the very real measure of the effort required to bridge space by moving your limbs.

Percepts of touch arise when a part of our body’s surface is felt to be indented. The feeling changes as pressure is changed. You first touch the table with your fingertip, but when you press the finger down you feel a greater tension in finger, hand, and arm. Also, they sense any movement accompanying the strain, and, in this rather complex situation, you feel that the table is hard, and is not being moved or deformed by the pressure. By moving your fingertip around, you get an impression of the table's surface roughness and its flat form, and you may notice there is a sticky spot on it, after which the fingertip itself may feel sticky, resulting in stronger friction against further movement across the surface. It turns out that the simple reports of touch we rely on in daily life stem from many clues ensuing from different parts of our bodies. The original sensations are perceived inside our bodies and then are translated into characteristic qualities of an external object.

Touch gives only *localized* perceptions characteristically associated with regions on the contours of the physical body. The percepts arise through pressure in a perpendicular direction. In contrast, vision provides us with an *extensive panorama.* Within this panorama we may concentrate on a center of directed interest (recalling the fingertip on the table) wherein more details are forthcoming. But the eye cannot bear to be touched. In a way, it is the opposite of the fingertip that only senses in direct contact; even the near-sighted cannot see things too near the organ of sight. Given that celestial phenomena belong to the world of vision, it is obvious that bodily exertion can hardly give us access to everything we experience visually.

A Set of Exercises in Perceptual Activity, in Attending, in Encountering

Having read this chapter, you are begged to forget all the arguments about Berkeley's assertions. The true aim here was to point out a multitude of phenomena that usually remain unnoticed: your own halo in the dew; the landscape unfolding as you move through it (revealing "distant" views as your true escorts); various experiments with stereoscopic vision where you feel distance without knowing how you judge it; comparison of high-resolution sight with sight through tiny, pin-pricked holes; and so on. The aim was to let you gain experience through exercises—exercises in observing the process of perception itself rather than merely observing unusual perceptual content.

Let us remind ourselves of the questions that came up in the preceding chapter, which gradually made us aware that we do not perceive passively. The kind of attention we offer to the situation at hand turns out to be the foundation of the experience we gain. And that is what the exercises of this chapter are about. The fishing line stretched horizontally in front of me will hardly inform me that its location is not visually perceivable if I don't try to attach the clothespin to it. Nor will the momentary loss of the landscape's spatial character reveal itself to me if I do not suddenly stop my walking to inquire about it. As our minds contribute *questions* to an encounter, the encountered situation expresses itself more richly. What I really owe to George Berkeley is his questioning of the visual world and its special nature. And that questioning has the potential to generate more questions, more observations. It is fruitful.

Having worked through this chapter about the tactile (spatial) and visual (non-spatial) worlds, you will be ready for the observations to come. The following chapter is about reflection in a pond. Whereas the tactile approach to optics "sees" light bouncing off the water, we will leave the reflected images where we find them: *in* the water. *Images are where we see them.* But what may surprise you is their three-dimensional character.