From Inference to Affordance:  
The Problem of Visual Depth-Perception  
In the Optical Writings of Descartes, Berkeley and Gibson

Michael J. Braund, B.A.

Department of Philosophy

Submitted in partial fulfillment  
of the requirements of the degree of

Master of Arts

Faculty of Humanities, Brock University  
St. Catharines, Ontario

© January, 2008
This work is dedicated to the memory of Arthur B. Hennessey, my grandfather, Who died on the day the first draft of this thesis was completed.
<table>
<thead>
<tr>
<th>Table of Contents</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>p. 4</td>
</tr>
<tr>
<td>Abbreviations</td>
<td>p. 5</td>
</tr>
<tr>
<td>Introduction</td>
<td>p. 6</td>
</tr>
<tr>
<td>Chapter 1</td>
<td>p. 12</td>
</tr>
<tr>
<td>Chapter 2</td>
<td>p. 32</td>
</tr>
<tr>
<td>Chapter 3</td>
<td>p. 59</td>
</tr>
<tr>
<td>Conclusion</td>
<td>p. 104</td>
</tr>
<tr>
<td>Bibliography</td>
<td>p. 115</td>
</tr>
</tbody>
</table>
Abstract

This thesis explores the debate and issues regarding the status of visual inferences in the optical writings of Rene Descartes, George Berkeley and James J. Gibson. It gathers arguments from across their works and synthesizes an account of visual depth-perception that accurately reflects the larger, metaphysical implications of their philosophical theories. Chapters 1 and 2 address the Cartesian and Berkelean theories of depth-perception, respectively. For Descartes and Berkeley the debate can be put in the following way: How is it possible that we experience objects as appearing outside of us, at various distances, if objects appear inside of us, in the representations of the individual’s mind? Thus, the Descartes-Berkeley component of the debate takes place exclusively within a representationalist setting. Representational theories of depth-perception are rooted in the scientific discovery that objects project a merely two-dimensional patchwork of forms on the retina. I call this the “flat image” problem. This poses the problem of depth in terms of a difference between two- and three-dimensional orders (i.e., a gap to be bridged by one inferential procedure or another). Chapter 3 addresses Gibson’s ecological response to the debate. Gibson argues that the perceiver cannot be flattened out into a passive, two-dimensional sensory surface. Perception is possible precisely because the body and the environment already have depth. Accordingly, the problem cannot be reduced to a gap between two- and three-dimensional givens, a gap crossed with a projective geometry. The crucial difference is not one of a dimensional degree. Chapter 3 explores this theme and attempts to excavate the empirical and philosophical suppositions that lead Descartes and Berkeley to their respective theories of indirect perception. Gibson argues that the notion of visual inference, which is necessary to substantiate representational theories of indirect perception, is highly problematic. To elucidate this point, the thesis steps into the representationalist tradition, in order to show that problems that arise within it demand a turn toward Gibson’s information-based doctrine of ecological specificity (which is to say, the theory of direct perception). Chapter 3 concludes with a careful examination of Gibsonian affordances as the sole objects of direct perceptual experience. The final section provides an account of affordances that locates the moving, perceiving body at the heart of the experience of depth; an experience which emerges in the dynamical structures that cross the body and the world.
### Abbreviations

<table>
<thead>
<tr>
<th>Title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>An Essay Towards a New Theory of Vision</td>
<td>NTV</td>
</tr>
<tr>
<td>The Theory of Vision Vindicated</td>
<td>TVV</td>
</tr>
</tbody>
</table>
Introduction

The accepted view of perception is still that ... perception goes beyond the stimuli and is superimposed on sensations. The sensations are basic and, being parts of our organic equipment, tend to be the same for all. Perceptions, however, are secondary and, depending on the peculiarities and past experience of the individual, may vary from one observer to another.¹

In this quotation from his first ground-breaking book, *The Perception of the Visual World*, James J. Gibson singles out what he considers as the most entrenched presupposition in the traditional visual theory of Descartes and Berkeley. The doctrine states that perception is a subjective interpretation of the external world, performed on the basis of elementary sensations. Sensations arise when the body is stimulated by an external event of some kind. In an effort to explain sensory stimulation, Descartes described the body as a machine, and the sense-organs as mechanisms for receiving and transmitting movements in the external world to local brain centers. Descartes drew the analogy between perceivers and (then popular) automatons, "which moved when an external stimulus actuated a device that released the moving mechanism."² According to Descartes, sensations are the body's intrinsic response to stimuli in the world. Perception, on the other hand, was thought to be an intellectual procedure, whereby the mind makes judgments about the events that caused the sensations to arise in the first place. Since the performance of these judgments was thought to depend "on the peculiarities and past experience of the individual," Descartes and Berkeley stipulated that the percept is "essentially subjective in that it depends on some contribution made by

the observer himself." In what follows, I will investigate this claim both *generally* and in the *specific* context of depth perception.

In Chapter One, I will introduce the basic terminology of my thesis. Thereafter, I will provide a reading of Descartes's two treatises, the *Dioptrics* and *The World*, interpreting them in the framework of this terminology. Descartes proposes a model of how we come to have visual experiences of the spatial world on the basis of unconscious, geometrical calculations performed by the mind. I will maintain that this model of space perception is a corollary of Descartes's attempt to present a geometrically conceived theory of the natural world. In this system, only matter and motion exist. Hence, only matter-in-motion can come into contact with our bodies and cause them to have sensations. As Margaret Atherton points out, "Vision ... is ... a particularly important branch of science to choose, since it is the supposition that the qualities we see are like those of the natural world which might lead someone to reject Descartes's attempt to reduce the qualities of the natural world to extended matter in motion." Thus, if Descartes can successfully provide a geometrical theory of space perception, he would be able to "use the success of such a science as a partial conformation of the geometric picture of nature."

According to Descartes, the visual percept is *not* a cognitive replica of mind-independent things, since bodies in space do not produce likenesses in us by way of *resemblance*. Rather, Descartes's theory of perception is an attempt to show that the visual percept is a natural, causal result of the way the optic system is constructed for responding to movements in the material layout of the world. Visual percepts arise when

---

5 Ibid., p. 22.
matter-in-motion reaches the sensitive eyes, subsequently producing movements in the optic nerves. These movements enable the mind to perceive diverse qualities in external bodies on the basis of the "varieties of movements they cause in the brain."\(^6\) Hence, visual qualities are represented in the mind by a co-variance with the physiological changes in the body. These changes, in turn, can be traced to an external, geometrically described object. When the points in the brain are activated by movements in the material world, a sequence of sensory events occurs from which the mind can infer the "spatial" properties of objects as easily as "color" properties. In the Chapter One, I will describe geometrical inferences as the basis of Descartes's theory of the indirect perception of space.

In Chapter Two, I will examine Berkeley's rebuttal of the geometrical theory of space perception, as put forward in his *NTV* and critically evaluate his conclusions therein. Like Descartes, Berkeley conceded that distance, from the eye to the object, cannot be directly perceived by sight. In the introductory lines from the *NTV*, he writes, "It is ... agreed by all that distance, of itself and immediately, cannot be seen."\(^7\) This philosophical contention, which Berkeley inherits from Descartes, is part and parcel of the scientific discovery that objects in space project a merely two-dimensional collection of data on to the retina. The question is, "How do we perceive a three-dimensional world on the basis of a two-dimensional retinal manifold?" Whereas Descartes attempts to solve the "flat image" problem by integrating perspective geometry into the operations of

---


the visual system (which measures distances by the angle of the two eyes "concurring" on the object in space), Berkeley detected a fallacy underlying this approach. If the angles are to be used as "cues" for depth, then perceivers would need to see the angles directly. However, it is impossible to perceive lines and angles running out from the eyes to the object, unless one has already had a direct perception of depth. Thus, the geometrical approach is circular; it presupposes knowledge of depth in order to prove it.

In an attempt to bypass the absurdities in the Cartesian theory of perception, Berkeley put forward a set of sensation-based, visual cues for depth perception that did not presuppose an immediate perception of depth. According to D.M. Armstrong, these cues would have to possess a merely contingent connection with the distance of objects in space; a connection that is learned a posteriori "in the same way we discover that smoke is a sign of fire." This is why Berkeley is hesitant to describe the procedure in which the mind derives distance perceptions from sensations as inferential. Cartesian "inferences" are based on deductive principles, which enable the visual system to calculate a percept from the immediate sensory data. Berkelean "associations" involve a mental synthesis of past and present experiences, by which perceivers learn to associate different orders of sensory information. Since Berkeley thought that visual experience lacked inherent spatiality, and that the three-dimensions of space were registered only by the sense of touch, he hypothesized that optical information acted as a cue for tangible consequences in the environment. These considerations led Berkeley to some interesting conclusions about the nature of perception and the perceived world.

---

As Armstrong points out, a conclusion is only as good as its first premise. Thus, even if Berkeley's argument for depth-perception is a more cogent piece of reasoning than Descartes's, it is only valid if distance cannot be immediately perceived. As I will argue, this claim is tethered to the presupposition that retinal information is the basis of vision. In Chapter Three, I consider the astonishingly far-reaching implications of Gibson's claim that the retinal image is not the basis of sight; this is a claim that contradicts centuries of scientific dogma. According to Gibson, vision cannot be explained by the retinal image because optical information is not "in the eye," but rather, it is in the environment. While it is true that the inspection of optical information is performed by the visual system, of which the retina is a part, the information is an environmental fact. "Information is available to be detected, it is not a picture at the back of the eye," as visual theorists have supposed since the Renaissance. In place of these traditional, sensation-based theories of indirect perception, Gibson offers an alternative model of direct perception. For Gibson, the ordering of perceptual experience is not based on having sensations first, and then inferentially constituting a mental map of the environment. Rather, perception involves the detection of invariants in the flow of optical information that is generated when the perceiver moves through the environment. These so-called invariants specify permanent aspects of the perceived environment, and can do so without the mediation of sensations. For Gibson, perception is unmediated, non-inferential, and directly attuned to the information that pervades the environment.

Gibson does not suppose that "depth perception" is a mental procedure, performed on the basis of sense-data. By denying that visual properties of the world are

---

derived from retinal information, Gibson avoids the difficulty of reconstructing a 
continuous three-dimensional world from a fleeting, two-dimensional collection of 
sensory "points" on the retina. This aspect of Gibson's theory makes it truly seductive 
and I will adopt a version of it. In what follows, then, I intend to advocate a form of 
Gibsonian direct perception in place of the traditional theories of indirect perception, 
proposed by Descartes and Berkeley.
Chapter 1: Cartesian Optics

Section 1: Theories of Direct and Indirect Perception
(An Overview)

We directly and intuitively see objects ... This is a simple perception of which no analysis can be given ... the fact itself cannot be disputed ... Metaphysical investigation and physiological inquiry ... confirm the universal belief that mankind has in the direct visual perception of the three dimensions of space.\(^{11}\)

In this passage from his 1842 *Review of Berkeley's Theory of Vision*, Samuel Bailey signals the decisive problem of vision to which Descartes and Berkeley address themselves. It begins with certain “popular assumptions,”\(^{12}\) the most striking of which is that our experience of depth is manifest in a direct and intuitive encounter with public three-dimensional objects. This chapter pursues the implications of this claim, in light of Descartes’ revolutionary denial (found in the *Dioptrics*). I shall characterize this denial as a theory of indirect perception.

Before we examine Descartes’s theory of spatial perception it will be necessary to explain some key terms. Two such terms are the notions of *direct* and *indirect* perception, respectively. If we understand where and how Descartes’ theory of vision fits into these categories, we can become clear about the meaning of these categories themselves. Therefore, I will devote Section One of this chapter to a preliminary explanation of direct and indirect perception.

In general terms, theories of direct and indirect perception have to do with perceptual experience and its relation to the world. In the language of Descartes and Berkeley, this problem is formulated as the question of “What are the *immediate* objects


of awareness in sensory experience?" Similarly, we can ask about the giveness of such objects.

Most theorists who have attempted to answer this question have denied that we have an immediate or direct experience of physical objects. Instead, many theorists contend that sensations (not physical objects) are immediately given in perceptual experience. Sensations are private entities that contain the experienced qualities, or qualia, of the physical object if there is one. On the basis of these directly apprehended sensations, the perceiver is said to infer the existence of physical states-of-affairs obtaining in the external world. This chapter demonstrates how inferential awareness is central to Descartes's theory of indirect perception, as it is put forward in the optical writings.

The notion of inference, which enjoys a long and distinguished history of dispute in philosophy, is the basic criterion that separates direct from indirect theories of perception. Something is immediately or directly experienced if the apprehension of it is not arrived at through an inferential process. For Descartes, an "inference" is an unconscious, intellectual operation that deduces "perceptual" information from "sensory" information, using a priori principles. In the visual perception of objects in space, for instance, the relevant information is inferred mathematically. Consider Kepler's problem of the "flat image." According to Kepler, the images projected on to the retina specify a two-dimensional collection of data, and yet, the perceived world is unabashedly three-dimensional. How does perception move from one order of information to the other? To

---

13 In 1627, Kepler's discovery and account of the retinal image as the eidolon of visual perception was the established paradigm against which Descartes's argued in his Dioptries. This is why I have chosen to treat spatial perception as a problem of "dimensionality" (i.e., of bridging two and three dimensional information). In Chapter Three, I will examine Gibson's rejection of retinal-based accounts of vision.
solve this problem, Descartes integrates perspective geometry into the visual processes. He urges that, given a direct sensory awareness of the distance between the two eyes, the mind can infer the distance of objects in space as if by a natural geometry. Of course, we are unaware of any such mathematical inference. This is taken to be problematic by other theorists. Berkeley writes, “In vain shall any man tell me that I perceive certain lines and angles which introduce into my mind the various ideas of distance, so long as I myself am conscious of no such thing.” That there are numerous problems with inferential accounts, and particularly unconscious ones, is a claim that will have to wait for subsequent chapters. In Chapter Two, I offer a detailed consideration of Berkeley’s famous rebuttal to the geometrical theory of perception and its reliance on deductive inferences.

According to Lawrence Bonjour, if we accept the theory of indirect perception, the two main answers to the problem of “What is immediately given in experience?” are representationalism and phenomenalism. For now I will give an overview of both, but will defer questions pertaining to their validity.

Representationalism is the view that the “immediate objects of experience represent … physical objects in a way that allows one to infer justifiably from such experience to the existence of the corresponding external objects.” This is Descartes’s starting point. For example, in The World, Descartes articulates his theory of indirect perception by demonstrating how the physical body acquires sensory information about the world through a causal “sign system.” Descartes explains how this sign system works

---

14 For the details, see Section Three of this chapter.
by showing how a law-governed system of motions, in the physical world, can cause
sensations in us that correspond to everything we sense in that world. Ultimately,
Descartes describes a “new world” that lies behind our ideas, acting as the cause of our
sensory information about it. On the basis of this sensory information the mind can infer
relevant facts about the external world. We will return to Descartes’s representationalism
shortly.

Phenomenalism, by contrast, is the view that “physical objects are reducible to or
definable in terms of the occurrence and obtainability of such experience.”

Phenomenalism is primarily concerned with features and relations of the immediate
objects of perceptual experience (i.e. sensations). On this account, to say that there is an
object experienced is to say that sensations of various sorts have been experienced in the
past, are being experienced in the present, and will continue to be experienced if the
“appropriate conditions” hold in the future. According to Ayer and Bonjour, to
perceive an object x amounts to believing that there are 1) sensations which reflect the
presence of an object x occupying a certain space, and 2) that such sensations could be
experienced at any time (i.e. that it is always logically possible to experience these
sensations) under the appropriate conditions. Thus, the phenomenalist speaks of “actual
and obtainable” sensations. John Stewart Mill made this point by arguing that material
objects are none other than the permanent possibilities of sensations.

Therefore, for the phenomenalist to believe that a material object exists involves nothing more than the

---

17 Bonjour, Lawrence, *Epistemological Problems of Perception*,
19 Bonjour, Lawrence, *Epistemological Problems of Perception*,
belief that sensations of the appropriate sort are either actual or possible. To this, Bonjour adds that “It is not just that it is logically possible for them to be experienced (which would apparently always be so as long as the description of them is not contradictory), but that they would in fact be experienced under certain specified circumstances (themselves specified in sensory terms).”

Although there have been many objections launched against the phenomenalist view, they are quite irrelevant to our purposes here. What is important is that we have a sense of the kind of argumentative positions that a theory of indirect perception may confine us to. Of the two camps, representationalism and phenomenalism, the former is a stronger candidate for the theory of indirect perception. While phenomenalism seems to bypass the epistemological problem of explaining how subjective beliefs conform to objective states-of-affairs (a problem of reference), it begs the question as to why the pattern of actual and obtainable sensory experience has the order that it does. As Bonjour points out, the only possible phenomenalist response to this question is to say that the fact “That sensory experience reflects this sort of order is simply the most fundamental fact about reality … not further explainable in terms of anything else.” The reason being, he explains, that any attempt at further explanation would have to appeal to a criterion outside experience. Given the phenomenologists’ initial position such a criterion is impossible. Therefore, phenomenalism begs the question of explanation.

A third alternative to representationalism and phenomenalism is sometimes called a theory of direct perception. The central idea here is that theories of indirect perception are false, and that perceptions are not mental composites of discrete sensations. Instead

---

22 Ibid., sec. 2.1.
of immediately experiencing sensations, then, we experience environmental objects without the mediation of these other sorts of entities.

In general terms, the theory of direct perception holds that perception is a non-inferential awareness of things in the surrounding environment. This theory, most notably and contemporarily expounded by James J. Gibson, rejects the idea that in perception we are aware only of mental intermediaries (i.e., sensations, impressions, ideas, and so forth). Rather, perception is a form of direct access to the external world and does not require an inference or intermediary to bridge the gap between perceiver and perceived world. For Gibson, we misconstrue visual perception if we think of it as a process whereby the brain constructs (i.e., represents to itself) an internal model of the environment on the basis of sensory information. Vision does not take place in the brain of the perceiver, as Descartes famously conceded in the *Dioptrics*. The perceiver is not the brain, but rather the whole organism as embedded in the environment. The information available to us in vision is not the global pattern of light stimuli incident on the retinal plane. Rather, the environment is itself the repository of information. Vision is the process whereby a perceiver acquires information about the environment by coming into direct contact with it via active explorations. I will devote Chapter Three to a detailed analysis of this direct approach to visual perception.

Now that I have provided a brief overview of three alternative views of perception, the reader will be in a better position to understand Descartes's representational theory of indirect perception (Section Two), and the indirect perception of three-dimensional space (Section Three).

---

23 This is because the visual perception of distance is no longer considered as a means whereby the perceiver translates two- into three-dimensional information. For Gibson, there is no such translation.
Section 2: Descartes’s Representational Theory of Indirect Perception

In this section, I will consider Descartes’s representational theory of perception. As I have suggested, this model commences by accepting the view that perception is indirect. For Descartes, this means that perception is always the result of having sensations. If the physical body were not a receptacle to determinate stimuli in the external world, perceptual experiences would never arise. A good account of Descartes’s theory of vision requires an equally good analysis of sensory acquisition, that is, the process whereby we first acquire our sensations. Thereafter, it must be explained how this sensory basis in the body becomes the seat of visual perception in the mind (i.e., how having sensations can give rise to perceptual experiences in the first place). Descartes’s answer appeals to a kind of representationalism. Given direct access to sensory information, the mind is able to reconstruct an internal model of the external world through a series of inferential processes. These processes are, in turn, responsible for the representation of the three-dimensional, visual world in thought. Descartes posits a separation between (what David Morris calls) thought-space and world-space, wherein thought comes to represent world-space to itself.¹⁴ I will argue that this is precisely why his theory of spatial perception is indirect. Section Three of this chapter addresses that claim in detail.

Representational theories of visual perception are not original to Descartes. Nearly a generation before, Kepler had already established a representational basis for vision. Kepler’s discovery of the retinal image is considered to be the end of the medieval optical tradition and the beginning of the modern era in physiological optics. According to Edward Reed, “Since the Renaissance, western thinkers had treated seeing

as a matter of having images. Kepler’s discovery of how lenses form visible images was hailed as meaning that the eyeball is like a camera with a lens in it, focusing images on the retina and thus producing sight.”

Kepler theorized that the image on the back of the eye was the *eidolon* upon which sight was based. The retinal image was thus a copy of objects that came into direct contact with observers. This is the impression made by light on the eye that creates simulacra of things inside the eye. It was precisely this version of representationalism that Descartes sought to replace with his own *mechanical* brand.

What distinguishes Descartes from Kepler is his treatment of this “image” at the back of the eye. Descartes writes, “It is necessary to beware assuming that in order to sense, the mind needs to perceive certain images transmitted by objects to the brain.”

This commonly held opinion, he continued, is based on the mistake that in order to know something, our minds need a copy of it. But, he continues, “We should consider that there are many other things besides pictures which can stimulate our thought, such as, for example, signs and words, which do not in any way resemble in every respect the objects they represent … for otherwise there would be no distinction between the object and the image.”

Descartes used his knowledge of perspective geometry to demonstrate how optically formed images need not even partially resemble the objects that cause them. I will elaborate on this notion, when I discuss Gibson’s theory of *stimulus information* in Chapter Three, Section One.

Here, “Descartes made an extraordinary leap from the theory and practice of representing objects to the eye by means of *perspective*, to a theory of the way in which

---


27 Ibid., pg.89.
the mind is stimulated and becomes aware of objects in the first place." This served as a conceptual basis for Descartes's new mechanistic physiology. Resemblance is irrelevant; the issue is to understand how "images can enable the mind to perceive all the diverse qualities" in external bodies, on the basis of "the varieties in the movements they cause in the brain." Descartes conceived of Kepler's retinal image as a pattern of movements in the optic nerve and brain stimulated by light rays. For Descartes, these brain movements explain seeing, not the image at the back of the eye. The sensory points cause and determine the perceptible images. Thus, "an object composed of ten thousand parts capable of sending rays toward the back of the eye... in ten-thousand different ways, and consequently of making ten thousand different colors visible at once, nonetheless will enable the mind to distinguish no more than a thousand if we suppose that there are but a thousand fibers of the optic nerve" and their connections to the stimulated region of the brain. Our visual awareness is, therefore, not of some image at the back of the eye. Our visual awareness is possible only on the basis of motions conducted through the optic nerve into the brain.

To remain with the language of direct and indirect perception, Descartes's mechanistic account of vision rises and falls with his sensation-based theory of perception. In visual perception, the movements caused by light trajectories in the optic nerve and brain produce sensations, of which perceivers are immediately aware. For every sensation in the eye, the mind infers a determinate property of some aspect of the external world. Therefore, an explanation of the mind's awareness of visual properties

30 Ibid., pp. 103-104.
via sensations requires a parallel account of the world itself. How, according to
Descartes, does the world produce these sensations in us? I will answer this question by
examining Descartes's conception of light as motion in his treatise entitled *The World.*

In the beginning of *The World,* Descartes is careful to establish a representational
basis for his theory of perception. In chapter one, entitled "On the Difference Between
our Sensations and the Things That Produce Them,"31 Descartes posits an important
separation between our ideas of things and the things themselves. Essentially, Descartes
deals with the problem of the visual perception of the world by *idealizing* the connection
between our ideas and things. As David Morris points out, he argues for this idealization
in the case of light, by comparing light to language.32 Just as words "bare no
resemblance to the things they signify," nature could also have established "some sign
which would make us have the sensation of light."33 Thus, it is conceivable that nature
contains nothing like light (as we experience it sensorily). However, things in nature can
be constituted so as to produce signs in us that cause us to have ideas of light. Descartes
devotes the rest of *The World* to an explanation of how this sign system works, by
showing how a law governed system of motions in the material world can cause ideas in
us that correspond to everything we sense in that world. Essentially, this "new world"
that lies behind our ideas is nothing other than "continuous uniform matter, differentiated
into things and properties by its motion."34 By modeling this connection on what Morris
calls "a naturalized version of the relation between words and things," he reconnects
ideas and things "through a causal system... In this causal system light itself is moving

matter, so the light that we experience is encoded in motion."^ Just as a linguistic system becomes transparent and unnoticed to its speakers, so Descartes’s causal system is transparent to our ideas of vision. It is for precisely this reason that we identify our visual ideas of the experienced world with the things in the world. We fail to see that the world in itself is the "new world" of matter-in-motion.

As Morris points out, this conception of light as motion is essential to Descartes’s later work in the *Dioptics*. In the first discourse, Descartes gives an overview of the sense in which (his conception of) light is a stimulus for vision. Therein, he postulates several "comparisons" that are supposed to facilitate the reader’s comprehension of light as a stimulus. Since these models conceive light as motion, "it is evident that the philosophical program articulated in *The World* pervades his account of vision in the *Optics." Following Morris, I will treat them collectively.

This connection is most evident in Descartes’s first comparison, in which he compares light to a blind person’s stick. Since this is the more instructive comparison, I will devote my attention to it. A sighted person, wandering through a dark, unfamiliar setting with only a stick to guide them, may be able to discern some of the qualities of objects, using the stick as a medium. Through a series of impulses, transmitted instantaneously from one end of the stick to their hand, the perceiver would perhaps be able to tell whether the objects were trees, stones, water, mud and so on. While it is true that tactile data of this sort are often confused, consider the precision with which a person, born blind, can wield the same stick. In their hands, the stick becomes an effective perceptual apparatus, an organ of some “sixth” sense. Yet, "no determinations

---


^ Ibid., p. 365.
of things as such travel through the stick, the stick just moves as a whole within a larger framework."\textsuperscript{37} To the blind person, detecting the difference between objects can be "nothing other than the various ways of moving the stick or resisting its movements ... The resistance or movement of the bodies ... (is) the sole cause of the sensations he has of them."\textsuperscript{38} The blind person can detect these differences quite accurately, but detects them through resistances that do not resemble the ideas they form of them. Descartes writes,

In order to draw a comparison from this, I would have you consider light as nothing else, in bodies that we call luminous, than a certain movement or action, very rapid and very lively, which passes toward our eyes through the medium of the air and other transparent bodies, in the same manner that the movement or resistance of the bodies that this blind man encounters is transmitted to his hand through the medium of his stick.\textsuperscript{39}

Just as the impulses and resistances traveling along the stick do not "resemble" their corresponding percepts in the mind of the perceiver, so light is a motion whose determinations are nothing like our ideas of color or light (the proper objects of vision). The purpose of this comparison is to show that, just like blind people, sighted people can perceive objects using nothing but motion as well. Moreover, if vision is caused by motions in the external, material world that are unlike the visible world we see, then the ideas that we derive from motion need not resemble the visible properties that are in things themselves.

Besides demonstrating that motion is sufficient to convey ideas of luminous bodies, Descartes's idealization of the connection between ideas and things allowed him to reject the medieval doctrine of intentional species. This doctrine held that the lens of

\textsuperscript{39} Ibid., p. 67.
the eye acts as a selector of visual information and transforms the physical stimuli of light and color into visual impressions. These, in turn, give rise to perceptual images that are passed back along the stream of visual spirits (traveling mediators) to local brain centers. These images serve as representations of their generating objects, enabling both perception and cognition. For Descartes, however, there is no internal structure in light itself that carries semblances of visible qualities of the object to the eye of the perceiver. Since signs need not "resemble the things they signify," as is shown by the case of letters, words, and sentences, such an internal structure in light is not necessary. Images and sensations are not "out there" in the world, flittering about and being transmitted externally. In Descartes's philosophy, there are no ideas outside of the mind. Thus, "by conceiving light as motion [Descartes] eliminates the Scholastic's intentional species 'flitting through the air' from thing to mind and...any other theory that claims...the visible is a phenomenon that constitutes itself outside of us."40 For Descartes, vision is representational; it is an operation internal to the mind. Images do not pass from objects along a "spiritual current" to our eyes to make us see light, colors, shapes, forms, and so forth. Outside of the mind there are just independent motions. Therefore, there is no sense in talking about resemblances between images on the back of the eye and things in themselves, as Kepler suggested; for such "images" have no internal structure that would make them into resemblances. "It is only though the constitutive work of the soul that...independent motions are put together to become ideas of the visible and of the visible's qualities."41 For Descartes, it is the soul that sees and not the eye.

41 Ibid., p. 367.
Section 3: The Indirect Perception of Space

As Morris points out, Descartes’s analysis of vision is representational (and therefore indirect), because he ideationalizes the connection between “mind and things, turning vision into a thought that is caused by a multiplicity of motions.” These motions are not in themselves visible. Rather, they are the preconditions for the possibility of vision. For just this reason, “Descartes’s analysis must presuppose an intelligible world of motion that has determinate structures that mediate optical motion to the eyes, nerves, and brain.” If Descartes’s conception of light is to explain vision, the perceiver and perceived objects must already be embedded in a space that conforms to the axioms of Cartesian geometry. Otherwise, Descartes cannot explain how motions in the eye provide the mind with determinate “signs” of objects. There must be what Morris calls a “natural geometry of nerve fibers” in place, in order to connect motion to the eye and brain of the perceiver.

Thus, Descartes begins by presuming a determinate geometrical space, reconstituted ideationally by inferential processes in the mind. All of the structures of the new world – its space, its motion, and so forth – are represented in human thought. This model is then used to facilitate Descartes’s account of distance perception.

In the **Dioptics**, Descartes proposes three distinct accounts of distance perception. While all three are relevant, only the first theory explicitly posits a geometrical inference in perception. Since Berkeley’s and Gibson’s criticisms are aimed primarily at this sort of theory, I will devote my attention to it (to ensure that the latter are not addressing a strawman).

---

43 Ibid., p. 367.
44 Ibid., p. 367.
Descartes's triangulation account of distance perception utilizes a point made in his account of the visual perception of position. Therein, Descartes stipulates that the disposition of the parts of the perceive[r’s body is registered by motions in the brain. Given a direct and intuitive apprehension of the disposition of the two eyes (via ocular sensations), the mind can infer the position of an object in space by “locating it on strait lines that we can image to be drawn”\(^{45}\) by that inferential process. This process amounts to following the path of light rays from the eye to the object. Distance perception is a triangulation based on the same operation. Given a direct perception of the distance along the baseline of the two eyes and the vergence angle, the mind can infer, “as if by a natural geometry,”\(^{46}\) the distance between the object and the baseline. To illustrate this point, Descartes reintroduces the example of the blind person, this time holding two sticks, one crossed over the other. Through a direct perception of the distance and angle between the two hands, the blind person can infer the distance of one stick’s intersection with the other. Margaret Atherton comments, that “Although, for this analogy to work, it is necessary for Descartes to assume we perceive the same sort of distance in the same ... way by sight and touch, the motivation for the analogy was the refutation of the theory of intentional species [as discussed above], the theory that what we perceive resembles the object represented.”\(^{47}\) Berkeley will spend much time, in the *New Theory of Vision* (*NTV*), discrediting this very analogy.

In anticipation of Berkeley’s critique, it is worth highlighting several aspects of the inferential operations used in Descartes’s theory of distance perception. The central

---

46 Ibid., p. 105.
feature of the geometrical inference of distance is its deductive nature, which closely resembles the logical operation used in deductive argumentation. For instance, the conclusion that an object \( x \) is situated at such-and-such a distance from the perceiver, is guaranteed by the truth of the premises that precede it. So if the perceiver intuitively knows (1) the distance between the two eyes in determinate, calculable units and (2) the angle of the two eyes converging upon the object \( x \) in geometrical space, then (3) the perceiver can also be said to know the distance of the object \( x \) by means of a deductive inference. This model has a strategic advantage over earlier theories; namely, that the deductive character of geometrical reasoning guarantees that its conclusions follow from the premises with absolute necessity. The conclusion that object \( x \) is at such-and-such a distance follows (necessarily) from the perceiver’s knowledge of (1) and (2). In this way, it is supposed to be a definitive proof of the truth of the conclusion, ensuring that it is impossible for the premises to be true but the conclusion to be false. Berkeley himself comments, “There appears a very necessary connection between an obtuse angle and near distance, and an acute angle and farther distance ... [which] may evidently be known by anyone before he had experienced it.” Unlike inductive inferences, which assess the probable relationship between empirical premises and conclusions, the logic of deductive inferences ensures that the conclusion follows from the premises, a priori. Hence, seeing distance is more like deducing theorems from axioms, than making rough-and-ready approximations on the basis of experience.

48 According to Descartes, the perceiver knows the truth of (1) and (2) on the basis of directly apprehended, kinesthetic sensations.
Much remains to be said about the nature of deductive and inductive inferences. Since this topic informs much of Berkeley's critique, I will postpone a detailed discussion until Chapter Two, Section Three. For now, I will discuss several internal problems with Descartes's theory of the indirect perception of space.

In his illuminating study on depth-perception, Morris points to two distinguishable circularities in the Cartesian doctrine. The first circularity involves an epistemological skepticism, as suggested at the beginning of this section. Descartes's account of distance perception presupposes knowledge of a mind independent world-space in order to prove it. For instance, if seeing objects in world-space depends on seeing distance, and distance perception requires an inference that must be carried out in a space that is only thought (thought-space), then we must already have a guarantee that the operations of thought-space produce results that are true to world-space. But in order to know that thought-space yields results true to world-space, we must presuppose knowledge that world-space has characteristics that match up with thought-space.

World-space must conform to the axioms of Cartesian geometry. Hence, "in order to [come to] know world-space one already has to know world-space."\(^{50}\)

The second circularity is similar to the first. In order to triangulate the distance of an object from one's position in space, one must already know other distances in the world required to perform the act of triangulation. For instance, we must know the distance between the two eyes (the baseline), as well as the vergence angle of the optic axes. Morris calls these "grounding distances," since they ground the triangulation process. He writes, "If thought infers the determinacy of depth from signs given it, yet the given signs only have their determinacy in relation to grounding distances, then

thought's inference must be grounded on direct and immediate signs of grounding distance." Hence, Descartes has stumbled into a vicious regress. If distance can only be inferred, then the ground of this inference cannot. Any attempt to infer the ground would already require it. Thus, there must be some already established framework in place that grounds and is prior to the inference of distance. Descartes assumes that we just know these grounding distances, because our body and nervous system are configured so as to provide us with this information. Beyond that, he remains silent.

As Morris points out, Descartes cannot rid himself of these circularities by saying that another sense besides vision provides thought with grounding distances. The reason for this is that any other sense besides vision would measure distance by an inference, which itself depends upon other grounding distances, and so on, ad infinitum. This consequence follows from Descartes's notion of the body as a mechanism for receiving and decoding movements in the material world. Each one of the senses is simply a receptacle to these movements, and depends upon them for their modal information. Hence, we run into the same problem with all five senses.

In a later work entitled *The Sense of Space*, Morris points to a Berkelean critique of the inferential approach to visual space perception. In line with Berkeley's arguments in the *NIV*, Morris claims that Descartes's inferential approach is a classic example of what psychologists call the experience error. He writes, "It is true that a human being with proper tools can ... infer distance by means of geometrical triangulation." This is what the surveyor does. However, it does not follow from this that "triangulation is the sole means for gaining a sense of depth." Many animals have eyes on opposite sides of

---

their heads. Their visual fields do not overlap, and so they cannot infer depth from binocular disparity or the so-called geometrical cues. And yet, horses, chickens, rabbits and squirrels all possess an extremely proficient sense of depth. They have no trouble getting around and looking at things, situated at various distances from their bodies. These animals are all quite adept at the performance of space perception, each being remarkably attuned to the events occurring around them. Thus, the problem with Descartes's inferential account is not that distances are unable to be triangulated, or that triangulation provides inaccurate information about distance. Rather, the problem is that the triangulation of objects in space cannot be the sole means by which perceivers derive their ideas about distance. Descartes's account is problematic, precisely because it places the cart in front the horse (so to speak). It attempts to reduce perceptual experience to the terms of geometry. However, perspective geometry results from perception, not the other way around. Geometrical space is an abstraction of the lived space of the perceived world. As Gibson points out, confusing the former with latter is "to confuse the Z-axis of a Cartesian coordinate system with the number of paces along the ground to a fixed object."53 I will discuss Gibson's rebuttal of the geometrical theory of space perception in Chapter Three.

Berkeley makes a similar argument in his *N7V*. Since "the lines and angles by means whereof some men pretend to explain the perception of distance are themselves not at all perceived,"54 and because we are not aware of making geometrical inferences

about depth, "the mind does not by them judge of the distance of objects." Thus, because deductive-geometrical inferences are not basic to perceptual experience, they do not provide the appropriate framework by which to analyze the perception of distance. In the next chapter, I will consider Berkeley’s rebuttal to Descartes’s theory of distance perception by sight. Berkeley offers a non-deductive, albeit indirect theory of space perception that challenges some of Descartes’s key assumptions about sensations and their relation to vision. It is toward this critique that we now turn.

Chapter 2: Berkelean Optics

In truth and strictness of speech I neither see distance itself, nor anything that I take to be at a distance. I say, neither distance nor things placed at a distance are themselves, or their ideas, truly perceived by sight.\textsuperscript{56}

The problem of whether perception is direct or if it depends on additional, cognitive contributions made by the perceiving subject, is posed with particular force in the \textit{NTV}. It is evident from the recurrent treatment it receives therein that Berkeley considers it to be one of the central issues concerning perception. Fittingly, the \textit{NTV} devotes the most attention to it. In this chapter, I deal exclusively with Berkeley's treatment of the problem of indirect space perception, as it is presented in that work. This task will consist of three parts.

In Section One, I provide an outline of Berkeley's answer to the question, "What are we immediately aware of in perceptual experience?" Here, I will pay particular attention to Berkeley's use of the term "association" in describing the indirect or mediate procedure whereby vision acquires information about the spatial layout of the external world. Accordingly, it will be shown that while the visual perception of space is a derivative process, "seeing" distance is by no means a matter of performing deductive inferences. Rather, through an ongoing encounter with stimuli in the environment, perceivers develop the habit of associating one order of sensory information with another. Since Berkeley thought that visual experience lacked inherent spatiality, and that "distance" was registered only by the sense of touch, he hypothesized that retinal information acted as a \textit{cue} for tangible consequences in the environment. The result is what Robert Schwartz calls "the pragmatic significance of vision," which is "essentially a

guide to movement and touch." For Berkeley, distance perception is intimately related to movement and to the guidance and adjustment of behavior. Moreover, I will show that this capacity for associating two-dimensional visual information with three-dimensional tactile data is precisely what enables Berkeley to maintain an indirect theory of depth-perception, while rejecting Descartes's geometrical solution. In Section Two of this chapter, I will examine Berkeley's explicit rebuttal of inferential accounts and outline his critique of geometrical optics (sections 3-15 in the NTV). Thereafter, I will consider his conclusions concerning the derivative nature of space perception and the heterogeneity of the ideas of sight and touch. In Section Three, I will draw on the information provided by the previous sections to arrive at a more robust conception of Berkelean "associations." I will characterize the logic underlying "associations" as *inductive* in nature, and then formally contrast them with Descartes's *deductive* "inferences." This discussion will serve as a curtain-puller for Gibson's critique of Descartes and Berkeley in Chapter Three.

Since Berkeley's terms are challenging, and in some cases forbiddingly technical, I will begin by clarifying his key concepts. Unlike most of Berkeley's commentators, however, I will perform this task in the order of their original composition. "Like all of Berkeley's writings, the New Theory of Vision has a clearly defined organization." Its expression is deliberate and methodical, and demands to be read in a particular order. Therefore, I have chosen to begin with Berkeley's own, carefully selected starting place.

59 In the first section of the NTV, Berkeley writes, "My design is to show the manner wherein we perceive by sight the distance, magnitude and situation of objects. Also to consider the difference there is betwixt the ideas of sight and touch, and whether there be an idea common to both senses" (NTV, sec1). Thus, I have organized the sections accordingly.
I will follow along with Berkeley and bring to light those premises from which his seemingly fantastic conclusions are drawn.

Section 1: Mediate and Immediate Perception in the NTV

For such a shrewd theoretician, it is strange that Berkeley begins as uncritically as he does. In section 2 of the NTV, he states, “It is, I think, agreed by all that distance, of itself and immediately, cannot be seen.”\(^6\) The fact that Berkeley did not see the need to explain this phrase, or to provide arguments in support of it, might in all propriety be used as a criticism against him.\(^6\) In any case, this initial statement lays down the terms of a problem about distance perception, a problem he regards as widely recognized. Since the whole argument of the NTV depends upon this contention, it deserves careful scrutiny.

According to Armstrong, the word “distance” presents no problems. It merely refers to the line directed endwise to the eye, at right angles to the retina (sometimes called “outness” by Berkeley). Rather, it is the phrase “immediately seen” that gives us trouble, and so we shall dismiss three false interpretations from the start.

(1) When Berkeley says that the perception of distance by sight is a “mediate” procedure, his claim is not the obvious one that naked vision makes less-than-exact estimates of distance. To cite G.J. Warnock’s example, someone might say, “There is a

---


\(^6\) However, it is my suggestion that this statement can be read to reflect the epistemological climate of Berkeley’s day. As a young man of twenty-four, Berkeley composed the NTV with the looming presence of his fellowship examination in mind. Accordingly, he wrote his work on vision as a formal study of contemporary issues in the philosophy of perception; and by its first publication in 1709, nothing was more contemporary in European intellectual life than the work of Descartes. Descartes, a great champion of indirect perception, was the most influential student of vision since Kepler; his works were published in three languages and accepted as the “received” view on all fronts. Since Berkeley was addressing a committee of Cartesians, he chose to work within a Cartesian context, stressing the derivative nature of spatial perception. The view that perception is indirect was so often conceded in the 18th century, that Berkeley willingly admitted it as the first principle of his NTV.
gap between object A and object B.” To this I might correctly agree. However, if they had said, “The distance between object A and object B is exactly x meters and y centimeters,” then I would be incorrect in saying that this is what I had perceived. While I might claim to have guessed that the distance between the two points was something in that range, I could not claim to see that it was exactly that. After all, nobody sees distance with a surveyor’s accuracy.

In any event, this is not Berkeley’s point. His point, rather, is the more extreme one that (unmediated) vision is altogether incapable of making estimates about distance. This contention is meant to cover even the most rough and ready approximations. For Berkeley, we cannot properly be said to “see” the distance of objects. This is because “distance, being a line directed endwise to the eye ... projects only one point in the fund of the eye, which point remains invariably the same, whether the distance be longer or shorter.” This is called the “one-point argument” and is important, because it forms the basis of his theory indirect perception. Essentially, the argument states that a point at any distance along a line of sight projects only a single point on the retina. The light striking this point could be from an object at any distance at all (i.e., one meter, one hundred meters, two hundred meters, and so on). In each case, the spatial extent between the object and our eye is not represented anywhere on the retina. Retinal information, which is to say, the global pattern of light stimuli incident on the retinal plane, does not specify the tri-dimensionality of the perceptible world. “In a strict sense,” Berkeley

---

63 Which Berkeley regarded as the only information exclusive to vision.
writes, “I see nothing but light and colors with their several shades and variations.” So even though distance appears to be seen immediately along the line of vision, vision as such is without a sense of depth.

(2) This latter claim faces a possible, albeit wrongheaded objection. That things look to be sitting out there, independent of the perceiver, is a characteristic of the visual field. One might, therefore, be inclined to reject Berkeley’s contention on the ground that it seems to deny the obvious fact that things really do look distant. We often say “It looks a very long way off” or “I saw him in the distance.” In these cases, we claim to see things that are at distances from us, and more importantly, that look as if they are. Therefore, if Berkeley’s theory denies this common sensible claim, then he really is trying to paddle up-stream. And while “common sense” is by no means the measure of a philosophical theory, it certainly holds weight when that theory purports to talk about everyday experiences, like seeing things “in the distance.”

This is the most typical misunderstanding of Berkeley’s theory (i.e., that he wants us to accept premises about experience that conflict with it). In response, I need only point to a passage from The Principles of Human Knowledge: Berkeley writes, “That we should in truth see external space, and bodies actually existing in it, some nearer, others farther off … gave birth to my Essay towards a New Theory of Vision, which was published not long since.” The central concern of the NTV is to explain how objects appear in visible space. That they appear in visible space is a fact so obvious, that

65 Berkeley does, however, make “common sense” a necessary condition of philosophical theories in the later writings, such as the Principles (1710) and the Three Dialogues (1713).
Berkeley fails to even mention it. Similarly, the "flat image" problem arises, not because the visual field looks to be two-dimensional, but because it does not look two-dimensional. If it did, if the visual field had the same non-spatial organization as the retinal image, then there wouldn't be a problem in the first place. Accordingly, the main thrust of the NTV is to explain how objects (in the visual field) acquire spatial qualities.\textsuperscript{67}

(3) Another objection to Berkeley's thesis may arise if, by the term "immediacy," one imagines a "temporal immediacy." For instance, no sooner have I opened my eyes, than I am immersed in a world of light, colors and textures. Distances trace themselves out around me and things autonomously jut out in three-dimensions. It would seem, on this objection, that distance must be immediately perceptible by sight. That is, distance is perceived \textit{at the same instant} that light, color, and form are perceived.

However, this reply misses the mark. Berkeley is not employing "immediacy" in any temporal sense of the word. Besides, there is nothing in the NTV to suggest that we cannot make visual estimates of distance at a glance. The process whereby distance is suggested to the eye is as temporally immediate as the perception of light and color is. "I can see that the tree is more distant than the man, just as immediately as I can see that it is to the left of the man, or that its leaves are green."\textsuperscript{68} Thus, to get at Berkeley's claims about distance perception, the term "immediate" will have to be clarified.

What is an immediate perception? According to Berkeley, immediate perceptions are purely sensorial, "non-mental goings-on."\textsuperscript{69} A perception can be called "immediate" if it is not the result of a process that has mental or psychological components. In this sense, "The processes that underlie immediate perceptions are comparable to those that

\textsuperscript{67} I will return to this in Section Two.
underlie the output of our kidneys or ... are responsible for our blinking when air is puffed in our eyes." For Descartes and Berkeley, they are entirely physiological in nature, involving nothing that could be called a mental operation. "Mediate perceptions," on the other hand, are of mental origin; and not only that, "but one or more of the intermediate stages leading to our having the idea ... has ideational or mental content." In the case of distance perception, then, ideas of distance are suggested to vision by means of some other intermediate ideas. For Berkeley, these intermediate ideas are "immediately perceived in the act of vision." For example, light rays, along with certain movements and adjustments of our eyes, cause us to have an array of sensations, which in turn bring it about that we experience an idea of distance. The initial sensory array is immediate. It is the result of purely physiological operations, whereas our idea of distance is non-immediate, depending as it does on the immediate sensory array to bring it about. Therefore, the claim that "we do not see distance immediately" amounts to the claim that the ideas of distance, derived from sight, depend on mental operations. For Berkeley, this means that ideas of distance are brought to mind via intermediate ideas. To clarify this, I will consider three of Berkeley’s more instructive examples from the NTV.

(1) In the first case, Berkeley compares his model of distance perception to his theory of language comprehension. Berkeley’s philosophy of language is remarkably similar to Locke’s. In order to understand someone’s speech, two things must occur. First, we must hear what the person says. It is the experience of hearing the word spoken

71 Ibid., p.10.
that triggers the appearance of the idea that the word represents. For example, the idea, “coach,” that comes to mind is not immediate; rather, it is the result of our having an intermediate idea. In this case, the intermediate idea is the auditory (or visual) experience of hearing (or reading) the word “coach.” In keeping with Descartes’s analogy (outlined in Chapter One), Berkeley theorizes that we do not focus attention on these intermediate ideas and may not be readily aware that we are even having them. It is as if we “read through the experience or sensation of the sign when our attention is directed to its significance.” What concerns us is the ideational content, the “coach” idea, not its sign. Moreover, in most cases of developed space perception, the process of an intermediate idea triggering a mediate idea is automatic; there is an atemporal leap from the one order of perception to the other. Berkeley writes, “No sooner do we hear the words of a familiar language pronounced in our ears but the ideas corresponding thereto present themselves to our minds; in the very same instant the sound and the meaning enter the understanding” (my italics). Thus, it may be impossible to introspectively isolate the qualities of the intermediate sensation for singular investigation.

(2) To better illustrate Berkeley’s meaning, consider a second analogy from the NTV. Berkeley writes, “Sitting in my study I hear a coach drive along in the street; I look through my casement and see it; I walk out and enter into it.” In ordinary discourse, he says, we would be inclined to think that we hear, see and touch the same thing, namely, the coach. However, there is also some important sense in which we cannot hear the coach, but only the sound that it makes.

Ibid., sec.46.
Berkeley is pointing to a real distinction here. He explains that hearing the noise a coach makes, requires only that our auditory sense faculty be in good working order. Conversely, hearing the coach itself requires that a "background of experience" be presupposed. In this case, the background is made up of past associations between auditory stimuli in the environment and other types of stimuli, the combination of which specifies the object "coach" with certain stimuli and does so with regularity. Consequently, the auditory stimulus, which contains all of the information proper to hearing, is insufficient to account for a perception of the coach. The coach can only be heard on the condition that the auditory data is supplemented by additional kinds of sensory information (i.e. visual, tactile, etc.). This process of supplementation is really at the heart of what Berkeley calls "mediate," as opposed to "immediate" perception; and in the "coach" example, he plays on a double sense of the verb "to hear" in order to arrive at this distinction.

Thus, an immediate perception is a perception that depends upon no other. It requires only the vigor of our sense faculties and the presence of stimuli in the environment. Mediate perception, by contrast, draws on a much broader sense of the verb "to hear". It involves, not so much a deductive inference, as an experiential association of the mind. In Section Three, I will return to this distinction and highlight the differences between them.

(3) Another way of making clear this distinction draws on the "argument from illusion." Sensory illusion occurs when the immediate object of perception is either (a) not actually as it appears to us, or (b) is simply unreal. For instance, if a man suffers from jaundice, whatever he perceives will seem to have a yellow tinge about it. Since

---

what he perceives is not actually yellow, but only appears yellow, we say that this man has been subject to a sensory illusion. Similarly, if I believe I have heard a sound, when in fact there is no such sound to be heard, then I have fallen victim to sensory illusion. On the other hand, if I believe that the sound I have heard is a coach, when in fact it was a fire truck or an airplane, I need not have been subject to illusion. This is because it might be that other objects besides coaches make that noise, and, really hearing the noise, I misjudge that there was a coach in the street. Therefore, whereas sensory illusion applies in the case of immediate perception, it does not hold at the mediate level.

This example should clarify the distinction Berkeley has in mind. More to the point, this distinction applies equally in the case of vision. When Berkeley claims that "distance, of itself and immediately, cannot be perceived by sight," what he means to say is that distance is itself not a proper object of sight. Rather, three-dimensional vision is the outcome of mediate procedures. It depends, for its existence, upon a series of habitual associations that link sensory, retinal information (i.e., light and color) together with tactile information about distance. On this account seeing distance is always like hearing coaches, and never like hearing sounds.

Berkeley's solution to the problem of distance depends, in part, upon his refutation of the received view. If his theory succeeds, it does so on the condition that he can give a better account than his predecessors have. Therefore, I will turn toward Berkeley's proposed target: the geometric theory of spatial perception.
Section 2: Berkeley's Refutation of the Geometric Theory of Perception

In section two of the NTV, Berkeley is doing nothing more than pointing to a problem he takes to be well understood. He did not think that this point was original or controversial. In fact, there are passages in Molyneux's *Nova Dioptrica*, which suggest that section two of the NTV is simply paraphrased from this earlier work. Descartes himself entertained this notion in the *Dioptrics*, as the mechanical processing of light stimuli encoded as motion. In this section, I will address the main claims in Descartes's geometrical theory of distance perception, and will discuss Berkeley's critique thereof.

As Warnock points out, "Berkeley saw clearly, as too many writes on the 'theory of vision' did not, that questions of several different kinds can be asked about seeing, and that serious mistakes will be made unless each kind is properly distinguished from the others." For instance, some questions about vision pertain exclusively to the geometry of optics. These include questions about refraction, reflection, magnification, and the focal length of lenses. To this end, the eye does behave like an adjustable lens. However, these questions that can be posed and answered in purely geometrical terms, concern "the mechanism of the eye," and therefore, "appertains to anatomy and experiments." While the doctrines of this study are no doubt valid and theoretically useful, they are of a completely different kind than Berkeley's field of study. Berkeley is interested in the manner by which we perceive, via sight, the distance of objects in space. This latter investigation is, by contrast, of purely psychological value. It studies the experience of distance perception and the equally experienceable conditions that make it possible (I will explain this momentarily). Answering questions about psychology by

---

appeal to geometry is a typical example of a category mistake; that is, of ascribing the features of something to one category, which are only attributable to another. While this is not the only dimension of Berkeley’s critique, it is an important aspect of it. This partition, separating geometrical and psychological optics is among Berkeley’s greatest advancements in the science of vision. Berkeley criticizes Descartes for failing to make the same distinction. However, there is more to be said about Berkeley’s critique of Cartesian optics.

Berkeley has no quarrel with geometric opticians like Molyneux. Molyneux’s theory of vision, to which Berkeley frequently refers throughout the *NTV*, consists solely of demonstrations in applied geometry, for Molyneux’s concern is with the physics of vision. Molyneux writes about the behavior of light rays in the presence of various sorts of lenses and interfaces. Consequently, “Molyneux exempts himself from discussions of the functioning of the sensitive soul, from the problem of how perceivers see.” Since the physics of vision are devoid of psychological consequences, Berkeley allows him to slip past. In the *TVV*, Berkeley writes,

To explain how the mind of man sees is one thing, and belongs to philosophy. To consider particles as moving in certain lines, rays of light as refracted, or reflected, or crossing, or including angles, is quite another thing, and appertains to geometry... The former theory is that which makes us understand the true nature of vision, considered as a faculty of the soul.

In other words, whether the “lines of vision” are refracted or magnified, these considerations have no place in a psychology of vision. It is the purpose of the *TVV* to

---

widen the gap between geometry and perception, relegating the latter to philosophy.\(^1\)

This is precisely the issue that separates Berkeley and Descartes.

A point of commonality between Descartes and Berkeley is their use of the one-point argument. In view of this argument, many writers on optics found it increasingly difficult to explain how perceivers estimate the distance of objects in space. The orthodox view, of which Descartes was a leading proponent, attempted to solve the difficulty by appeal to the fact that most people have two eyes. If both eyes are directed at an object, the two straight lines from the eyes to the object (the 'optic axes') will converge; and if the object is close enough to the eyes to "bear any sensible proportion"\(^2\) to them, the angle of intersection of the optic axes will be fairly large. In these cases, it was supposed that perceivers were able to calculate the distance of an object in space from the angle at which the optic axes converge upon it; the larger the angle the closer the object.

This theory faces an immediate criticism. Even if we suppose that its claims hold true in cases of binocular disparity, what about those who have to or for any reason only wish to use one eye? After all, if I shut my left eye the world doesn’t appear flat – it retains its three-dimensional composure. As mentioned above, horses and chickens have a fine sense of depth, but their eyes are on opposite sides of their heads. Their visual fields do not overlap. Thus, they are unable to triangulate objects in the Cartesian manner.

\(^1\) Although today these issues are more commonly addressed by cognitive and philosophical psychologists, such as James J. Gibson.

The geometrical opticians do make provisions for these cases in which “we see with only one eye at once being exploded.” Their argument here was that the rays of light emitted or reflected from an object very close to us must converge quite sharply upon the eye, and that this angle of convergence decreases as the object is moved farther away. In this way, the distance of the object could be worked out from the angle at which the rays converge on the eye. Of course, this model will only work in cases where the object is close enough to the eye; for as it recedes, the angles of convergence soon become so small that we could not reasonably be supposed to detect any further variations within them. With this one restriction, the problem was widely held to have been solved.

With his usual candor, Berkeley rejects the whole of this account; his reason being that “when the mind perceives any idea not immediately and of itself, it must be by means of some other idea,” of which the mind is immediately aware. In other words, whatever it is that leads me to form a particular judgment on any occasion must be something of which, on that occasion, I am aware; and I am certainly not aware of lines and angles. Consider Berkeley’s example. He writes that while “the passions which are in the mind of another are of themselves to me invisible … I may nevertheless perceive them by sight; though not immediately, yet by means of the colors they produce in the countenance.” So supposing, on meeting with my thesis advisor, I got the impression that he was angry. If I were to inventory the observations that led me to my belief, “Dr. Berman is angry,” I might say that his cheeks appeared flushed, or that he frowned and

---

84 Ibid., sec. 9.
85 Ibid., sec. 9.
furrowed his brow as he spoke. That is why I thought he was angry. Now these qualities of being flushed or frowning, Berkeley says, could never have produced in me the idea, “Dr. Berman is angry,” had I not been aware of them in the first place. Moreover, the possible fact that his adrenal medulla was secreting catecholamine (a stress response in the autonomic division of the sympathetic nervous system) could not have contributed to my belief, if either (1) I did not know that this was the case, or (2) I did not know that hypothalamic reactivity had anything to do with being angry. Therefore, Berkeley concludes, circumstances of which I am unaware have no influence over my ideas.86

In Berkeley’s mind, the geometrical opticians had committed exactly this kind of mistake. Their statements about lines and angles might be correct, and of great theoretical value, but it is obvious that perceivers do not in fact make use of geometry in estimating by sight the distance of objects in space. Berkeley explains, “Those lines and angles by means whereof some men pretend to explain the perception of distance are themselves not at all perceived nor are they in truth ever thought of by those unskillful in optics.”87 In other words, a man who has never heard of the geometrical theory of optics would hardly make use of the “bigness of the angle made by the meeting of the two optic axes” or consider the “greater or lesser divergency of the rays which arrive from a point to his pupil.”88 The fact of the matter is that we do not see lines and angles running out from our eyes and converging upon an object in space (or vice versa). These lines and angles are to be found in the theorists’ diagrams, which are useful in (1) measuring distances, but never in (2) judging them by naked vision alone. Warnock points out that,

86 I have adapted this point from G.J. Warnock’s book on Berkeley, p. 14.
88 Ibid., sec.12.
while the contour lines on a map are useful devices for cartographers, they are useless in helping us to judge the height of hills by vision.\footnote{Warnock, G.J., 
_Berkeley_, Middlesex England, Penguin Books, 1969, p. 28.} Confusing (1) with (2) is an instance of a category mistake; that is, of confusing theory with reality, or the menu with the meal. While the claims of the geometrical opticians may be true, they cannot be the correct answers to the psychological (qua philosophical) problem proposed.

At this juncture, Berkeley offers his account of distance perception. In sections 1-40 of the _NTV_, Berkeley argues that the solution to the problem of distance perception will be in virtue of certain “cues,” which are effectively available to the visual system. Berkeley admits three cues by which we perceive distance by sight. (1) The first concerns the disposition of the eyes, wherein, as the object recedes or approaches us, we alter the disposition of the eyes by increasing or decreasing the interval between the pupils. Each disposition is then attended by a sensation, which, by means of an associative connection performed by the mind, produces ideas of distance in us. (2) The second cue involves the notion of _ocular clarity_. The nearer an object approaches to us, the more confusedly it is seen. Using this cue, Berkeley attempts to argue in the “Barrovian Case” that confusedness in vision is “a more important cue for distance than is the established view based on the angles the eyes make at the object.”\footnote{D.M. Armstrong, 
_Berkeley’s Theory of Vision_, Australia. Melbourne University Press, 1960, p. 19.} (3) Thirdly, Berkeley considers the _ocular strain_ perceivers experience in visual perception. By straining the muscles in the eye, the approaching object can be kept less confused when in the line of sight. This kinesthetic sensation “supplies the place of confused vision in aiding the mind to judge of the distance of the object; it being esteemed so much the
nearer by how much the effort or straining of the eye in order to distinct vision is greater.\textsuperscript{91}

What is perhaps most significant is that, for Berkeley, the passage from a given sign or "cue" to its corresponding distance perception involves a background of experience, the conjunction of visual cues with the object appearing at a distance. Unlike the geometrical cues of Descartes, Berkeley's are non-deductive. There is no necessary connection between the sensation in the muscles of the eye and the distance at which the object purportedly stands from us. "There is only a contingent connection between these phenomena, and the distance of the object seen."\textsuperscript{92} Moreover, the connection between visual cues and the distance of objects is discoverable \textit{a posteriori}. He is insistent on this point, and rightfully so. Berkeley's solution stands, if the geometrical theory falls. Atherton points out that what Berkeley has done, in effect, is to "take cues mentioned by Malebranche, and then point out that they can serve as distance cues without a mathematical or geometrical interpretation."\textsuperscript{93} Therefore, Berkeley concludes his critique of geometrical optics (sections 3-15 in the \textit{NTV}) by undermining the basic premises of Cartesian spatial perception. Berkeley thinks that Descartes and Malebranche wrongly integrate mathematical processes into their account of the visual estimation of distance.

In the final portion of the \textit{NTV} (section 121-159), Berkeley says he is going to look into the difference between the objects of sight and the objects of touch, and see whether there is any idea common to both senses. From the premises put forward, he writes "it is a manifest conclusion" that "a man no more sees and feels the same thing


\textsuperscript{93} Atherton, Margaret, \textit{Berkeley's Revolution in Vision}, New York, Cornell University Press. 1990, p. 84.
than he hears and feels the same thing.”  This is because “we never see and feel one and the same object. That which is seen is one thing and that which is felt is another.” Although shocking, this conclusion is a cogent piece of reasoning and follows quite conclusively from what he has premised.

As Atherton suggests, it is quite common that scholars take Berkeley too literally on this point. She argues that despite Berkeley’s somewhat awkward articulation of his conclusion, there is nothing in the NTV to suggest that we cannot see and feel the same physical object. The coach I see is the coach I touch. Rather, the object that we never see and feel is, to use Berkeley’s expression from the Principles, an “object of sense.” In other words, Berkeley is simply pointing to the fact that the data provided by one sense modality (i.e., sight) is not equivalent to that provided by any other. This was made clear by the distinction between the mediate and immediate modes of perception, outlined in Section One. It is precisely because distance (a mediate idea) cannot be attributed to immediate seeing or hearing, that we are forced to make the distinction in the first place. If we follow Berkeley on this claim, if all our visual sensations specify two-dimensional data, the question becomes “from where do we get our idea of three-dimensions?” As Berkeley states, distance is not immediately apprehended by sight. It must, therefore, be “brought into view by means of some other idea that is itself immediately perceived.” Berkeley concludes that the immediate perception of distance is to be found in tactile experience (using “touch” in a broad enough sense to include kinesthetic experiences).

For Berkeley, we feel distance, but never see it.

---

95 Ibid., sec. 11.
This conclusion has given rise to a multitude of false interpretations and hasty rebuttals. That being the case, the following point is worth repeating. In stressing the derivative nature of distance perception by sight, Berkeley does not claim that we do not see things at a distance from us. As I have argued, Berkeley is not working against common sense \textit{per se}. He is only making a revision to common speech. That his view should appear to conflict with former is an outcome of the latter. The elasticity of ordinary language needs to be stretched to cover Berkeley’s meaning; and so his view often been made the target of a colossal misinterpretation. Berkeley was acutely aware of this risk. He writes, “The difficulty seems not a little increased because the combination of visible ideas has constantly the same name as the combination of tangible ideas wherewith it is connected – which does of necessity arise from the use and end of language.”

As Atherton points out, what Berkeley intends to say is that “distance information is tangible information suggested by what we see.” Given the appropriate cues (a species of vision), ideas of touch, together with the information about distance they embody, are suggested to the mind through habitual associations. What is immediately perceived by sight is simply a reliable sign of what, in all \textit{probability}, we might experience by touch. Distance is traced out by the various motor functions of my body. To say that what we see is at a distance from us means that what we see suggests to our understanding “That after having passed a certain distance, to be measured by the motion of [the] body, which is perceptible by touch, I shall come to perceive such and

---

such tangible ideas which have been usually connected with such and such visual ideas."

Therefore, spatial ideas are concepts of a specific sort, the meanings of which lie in tangible consequences. To know the distance spanning from myself out to the tree, across the yard, is to have ideas about my moving body, and about how many paces it will take to get to the tree. Seeing distance requires only that "environmentally appropriate motor ideas are derived from the flux of visual sensations, whatever these sensations are like qualitatively." Berkeley’s approach to vision is, therefore, a pragmatic one. Vision is a guide to movement and touch. The presence of visual sensations allows perceivers to anticipate a second ordering of ideas which are, although experientially univocal, conceptually unrelated. This view is typically expressed as the heterogeneity of the ideas of sight and touch.

In expressing himself this way, Berkeley’s point is the very simple one that two-dimensional objects of sight and three-dimensional objects of touch are conceptually (although not experientially) distinct. That is, they refer to non-identical spaces. The fact that these fields seem to overlap is insufficient to establish their identity. It is true that they are almost invariably associated with one another, however, their associations remain merely contingent, non-deductive facts. Rather, it is the closeness of this association, Berkeley thinks, that leads us into thinking that distance is immediately perceived by sight. Just as, upon hearing the words of a familiar language spoken, we cannot help but associate the noises heard with the meanings that habitually accompany

100 Drawing, of course, on the notion of temporal immediacy as discussed in Section One.
them, so the close connection between the objects of sight and touch implies that “distance” will be irrevocably suggested to vision, whether we like it or not.

Section 3: Inferences and Associations as Explanatory Concepts

While the introduction of the notion of inference as an “explanatory concept” in the theory of vision is attributable to Descartes, it owes its modern articulation to the work of Herman Von Helmholtz. Following Schwartz, I will briefly consider Helmholtz’s theory of perceptual inferences in order facilitate an explanation of the differences between Cartesian inferences and Berkelean associations. In particular, I will discuss the inductive reasoning that underlies both Helmholtz’s and Berkeley’s approaches, and contrast them with Descartes’s deductive model of perceptual inferences. I have selected Helmholtz because, more than any other thinker, he exerted a direct influence on J.J. Gibson. Helmholtz serves as a conceptual bridge for establishing a link between Descartes, Berkeley and Gibson.

In his Treatise on Physiological Optics, Helmholtz offers an indirect theory of distance perception that is similar to Berkeley’s theory. Like Berkeley, Helmholtz argues that three-dimensionality is not an immediate quality of visual experience (owing to the two-dimensional character of the retinal image). Given this limitation, they argue, three-dimensionality must be added to visual perception beyond what is conveyed by processes involved in detecting sensory stimulation. In this respect, Helmholtz argued that distance perception is a “multistage process” in which the “sensory mechanisms respond to light stimuli by producing ... visual sensations [on the retina] which have no inherent spatiality.”


\[102\] Ibid., p. 87.
intervention of mediating perceptual processes, because distance is not an immediate quality of retinal sensations.

Helmholtz's theory, with its roots in the Berkelean paradigm, is fundamentally an associational theory. In other words, Berkeley and Helmholtz stress the importance of "learning," or more specifically, "habit formation" in the development of an individual's spatial perception. On their account, we perceive distance derivatively. Our immediate visual experiences serve as sensory "cues" for the mediate perception of distance. Habit, formed by past associations, serves to connect our retinal manifold and kinesthetic eye cues (i.e., convergence, accommodation, etc.) with our tangible sensations of space gained from movement and touch. Berkeley and Helmholtz contend that, because the retinal manifold contains no information about tri-dimensionality, the tangible sensations (with which they are associated) give spatial meaning to our immediate visual experiences. Thus, both thinkers provide an explanation of our ability to perceive three-dimensional space by using an associational model.

Like Berkeley, Helmholtz characterizes his associational model as one involving processes of sign interpretation (the "interpretation" being guided by past associations). As outlined in Section One, Berkeley argues that we ought to think of these perceptual processes as similar to the processes involved in understanding language. Immediate visual experiences (i.e., retinal "cues"), like words, are mere signs of their meanings. In order to understand their significance, we must learn what they mean through experience. Just as we are not immediately aware of the spatial properties of objects, but only of a retinal manifold that "serves as a sign to trigger the assignment of [these] properties," so we are not immediately aware of the things that words signify. Helmholtz writes,

“Our ideas of things cannot be anything but symbols, natural signs for things which we learn how to use”\textsuperscript{104} (my italics). Spatial perception, like the acquisition of a language, must be learned over time. However, once this connection becomes habitual, and the associations are established, we pay little attention to the actual sign when it is encountered. Instead, our mind leaps to the interpretation that the sign initiates. Thus, spatial perceptions are the “experiential meanings”\textsuperscript{105} that result from the interpretations we have learned to associate with our immediately experienced sensations.

The critical point of this analogy, for Berkeley and Helmholtz, concerns the logical connection between the sensory or linguistic sign and that which is signified by it. Both contend that the link between the signs and what they stand for is not a necessary connection. Hence, there is no \textit{a priori} way of knowing the spatial significance of our immediate visual experiences, prior to the associations we establish between the tangible ideas of distance and the visual distance cues. Crucially, Berkeley’s and Helmholtz’s distance cues possess a merely \textit{contingent} connection with the distance of objects in space; a connection that is learned \textit{a posteriori} “in the same way we discover that smoke is a sign of fire,”\textsuperscript{106} or that a word is a sign of an object. This is why Berkeley is hesitant to describe the procedure in which the mind derives distance perceptions from sensations as inferential. Cartesian “inferences” are based on deductive principles, which enable the visual system to calculate a percept from the immediate sensory data, “it being a … necessary truth that the nearer the direct rays falling on the eye approach a parallelism, the further off is the point of their intersection, or the visual point from whence they

\textsuperscript{104} Helmholtz, H., Concerning the Perceptions in General, in \textit{Physiological Optics}, vol.3, p. 19.
flow." In contrast, Berkelean "associations" involve a mental synthesis of past and present experiences by which perceivers learn to associate tactile and visual orders of sensory information through experience. For Berkeley, there is no innate or "necessary connection between the sensation we perceive ... and greater or lesser distance." Rather, "because the mind has, by constant experience, found the different sensations corresponding to ... a different degree of distance in the object – there has grown a habitual or customary connection" between immediately perceived retinal sensations and mediately perceived ideas of distance.

Helmholtz expresses the same point in different terms. In the chapter "Concerning the Perceptions in General" Helmholtz stresses the analogy between the associative processes underlying vision and those used in ordinary inductive reasoning. He claims that associative processes, like inductive ones, serve to establish general rules (from experience) that may be applied to any number of particular cases falling under those rules. Thus, we learn from experience that certain kinds of sensations are signs of certain ideas about distance. Subsequently, when we are stimulated and experience such-and-such retinal sensations, our associative processes lead us to form particular representations of the spatial layout of the world. This analogy is supposed to show that, in both inductive reasoning and visual processing, the associative laws governing the application of general rules to particular cases are based on the "habitual disposition of ideas of type-A [i.e., retinal sensations] to trigger ideas of type-B [i.e., tactile

108 Ibid., sec. 17.
109 Ibid., sec. 17.
This habit is the product of experience. Through experience, we develop the habit of anticipating that sensations of type-B will follow from sensations of type-A in a law-like manner.  

In this sense, Berkeley and Helmholtz claim that visual phenomena have a contingent (after), rather than a necessary (prior) connection with distance perceptions. For associationists, there can be no question of deducing the distance of objects from what is immediately given in our visual experience (as Descartes contends), because the relevant cues or signs for depth perception have only a non-deductive connection with the perceived distance of the object in space (i.e., the correlation between ideas of distance and the degree of "ocular strain" felt in our eye-muscles as we bring the object into focus). In other words, we can judge that there will be sensations of type-B when we have sensations of type-A, because in the past we have experienced the conjunction of type-A with type-B. In Berkeley's terminology, tangible perceptions of distance are "suggested" by immediate visual experiences because this connection has been established by constant experience. He writes, "Having of a long time experienced certain ideas, perceivable by touch, as distance, tangible figure, and solidity, to have been connected with certain ideas of sight, I do upon perceiving these ideas of sight forthwith conclude what tangible ideas are, by the wonted ordinary course of Nature, like to

---

111 As the word "analogy" suggests, neither Berkeley nor Helmholtz is seeking to identify inductive reasoning with visual processing. The two are fundamentally distinct. For example, the associative connection between sensations of type-B with sensations of type-A is not explicitly stated in the symbolic representation "If A then B." In visual processing, the laws governing associative dynamics are automatic and "unconscious" (as Helmholtz puts it). Thus, while the associational model of visual processing is analogous to ordinary inductive reasoning, associative visual processes are not identical with the (inductive) reasoning processes used in logic and science. Neither Berkeley nor Helmholtz wishes to conflate the former with the latter.
follow." Therefore, whereas Descartes argues for the deductive model of visual processing, Berkeley and Helmholtz contend that there is a contingent, non-deductive connection between our immediate visual experiences and our mediate perceptions of distance.

Despite this disagreement, there is a striking alliance between Descartes, Berkeley and Helmholtz when it comes to the actual problem they choose to address. They agree that distance perception is a cognitive process, mediated by retinal sensations (i.e., that it is indirect). This agreement can be expressed in three statements: (1) Firstly, there is a difference between sensations and perceptions. (2) Secondly, perceivers have both sensations and perceptions. (3) Thirdly, perceptions are based on or derived from sensations. This much they share in common. For Descartes and Berkeley, distance perceptions follow experientially from the occurrence of retinal sensations. The disagreements come later on, when the issue is a matter of choosing the correct processing model for the job, that is, for specifying those processes involved in going from sensations to perceptions. Nevertheless, Descartes and Berkeley (and Helmholtz) concur on the rules of the game.

In Chapter Three, I consider another answer to the question, "What is immediately perceived?" This answer moves outside the framework of indirect perceptual theories in order to reformulate the terms of the problem. Imaginatively, it is called the theory of direct perception. In what follows, I will discuss Gibson’s theory of the direct perception of space. I will contend that Gibson’s theory is a viable alternative to the Cartesian and Berkelean (and Helmholtzean) approaches. Roughly, this position

---

agrees with the above statements (1) and (2) and disagrees with (3). Thus, while a theory of direct perception maintains that sensations and perceptions are different, and that perceivers have both sensations and perceptions, it disagrees that the latter are based on or derived from the former. In this respect, perception is neither inferential nor associational. It is not based on any kind of computational process mediated by retinal, tactile, etc. sensations. This will require a good deal of explanation, which I provide in the next chapter.
Chapter 3: Gibsonian Optics

The seemingly paradoxical assertion will be made that perception is not based on sensation. That is, it is not based on having sensations ... but it is surely based on detecting information.\textsuperscript{113}

James J. Gibson is one of the best known and perhaps most controversial visual theorists of the twentieth century. Writing in the vein of the American functionalists, and immersed in their profound sense of pragmatism, Gibson sought to establish a more rigorous foundation for the study of vision by reworking its most fundamental concepts.

Over the five decades of his distinguished career, Gibson brought new clarity to the old problems of the tradition. He offered an alternative theory of perception – one that could accommodate the experimental insights of contemporary research programs. He characterized this new theory as a version of \textit{direct} perception, in order to distinguish it from the traditional \textit{indirect} approaches of Descartes and Berkeley.

Gibson’s critique of the Cartesian and Berkelean paradigms is inspired by the conviction that theories of indirect perception radically misconstrue the role of the perceiver. They regard the perceiver as a monocular being, with “one immobilized eye” fixed toward “impoverished ... optical displays.”\textsuperscript{114} However, ordinary perception is nothing like this. Human perceivers are mobile beings, who \textit{actively} engage the world and explore it with a pair of moving eyes. In conducting his experiments, “Gibson ... went out of the laboratory ... to test features that would be native”\textsuperscript{115} to the environment.

In contrast to the Cartesian and Berkelean approaches, Gibson’s theory of direct perception states that the environment contains all of the information needed to specify


\textsuperscript{115} Ibid., p.11.
its properties. Hence, perceiving these properties is a matter of detecting the information available in the environment. This theory avoids the difficulty of explaining how the mind organizes holistic perceptions from atomic sensations.

This difficulty is amplified in the context of depth-perception. If sensations on the retina contain no information about tri-dimensionality, then why do we see objects at a distance? This problem has inspired a whole class of accounts, which attempt to bridge two-dimensional sensory inputs with three-dimensional perceptual outputs by means of an inferential process. In previous chapters, I discussed two competing theories on this issue. However, more than any other thinker, Gibson has shown us that these answers begin in exactly the wrong place from which to develop a consistent theory of space perception. For Gibson, the perception of space is not inferred. This is because perception (in general) is not based on "having sensations." Perception is a process of "detecting information." Since information is intrinsic to the environment of the mobile perceiver, it follows that perceptual activity manifests a direct connection with the environment. The connection is direct because it does not require the mediation of "immediately" perceived sensations, from which the mind infers properties of the world outside of thought. Properly speaking, perception is not a mental activity. Gibson writes, "Perception ... is a keeping-in-touch with the world, an experiencing of things rather than a having of experiences ... It is not a mental act. Neither is it a bodily act. Perceiving is a psychosomatic act, not of the mind or of the body, but of a living observer."116 In what follows, I will attempt to make good this claim.

In section one, I will distinguish Gibson’s concept of the environment from the Cartesian notion of the material world. This step is necessary. The environment must first be described, since what there is to be perceived must be stipulated before one can talk about perceiving it. According to Gibson, the concept of the world can be analyzed at different levels. Gibson does not wish to give an analysis of the world at the level of Cartesian physics, which reduces the world to extended matter and perpetual movement (guaranteed by the circular motions of vortices). Gibson is concerned with the world at the level of ecology, in which animal and environment form an integrated system of mutual constraint. To draw this distinction, Gibson offers a *structural* analysis of the environment. This amounts to an explanatory scheme based on principles of self-organization. This analysis leads Gibson to formulate the concepts of the meaningful environment and the perceiver-environment coupling he calls *reciprocity*. In contrast, Descartes’s *mechanistic* analysis “does not lead naturally to the perceiver-environment concept.”¹¹⁷ This is because mechanistic analyses explain things in terms of general laws established in advance of the particular things being studied. In this sense, Descartes’s mechanistic analysis is consonant with his scientific ideal of objectivity. This ideal leads Descartes to conceive things in terms of a fully constituted, objective world governed by fixed laws that transcend it. In opposition, Gibson’s concept of structure is dynamic through and through. The structure of the environment does not consist of solid parts and a ready-made skeleton of laws that control parts (from the outside). Rather, structure emerges within a web of movement that spins between the perceiver and the environment. This multiplicity of movements forms a moving structure that is the

ongoing result of the very movements that are so structured. In this section, I will demonstrate how Gibson's ecological approach avoids the pitfalls of Cartesian dualism, by rooting perceptual theory in the concept of perceiver-environment reciprocity.

In section two, I provide an in-depth analysis of the structures of the information that is perceived in the environment. For visual perception, the information is light. However, as Gibson points out, the term "light" is ambiguous. "Light" means different things in different sciences, and the textbooks are not at all clear about the distinctions. Thus, I will examine Gibson's claim that light in an environment is structured and (therefore) carries information for perception. The claim is highly controversial. When Descartes published the *Dioptics* in 1637, he laid the foundations for the (now) orthodox view that light as such is internally devoid of perceptual information. Therefore, in order to facilitate a discussion on Gibson's claim that light carries information for perception, I will utilize Descartes's theory of light. In this section, I will delve deeper into Gibson's concepts and prepare the conceptual ground upon which a theory of direct perception can stand.

If Gibson is correct that structured light carries perceptual information about the environment, it should follow that there is information (in light) to specify the "spatial" properties of the environment as well. This is the theme of section three. Therein, I will analyze Gibson's claim that structured light carries information about the spatial properties of the environment, and characterize the manner in which perception "detects" the available information. In keeping with the themes of the previous chapters, I will introduce Gibson's theory of space perception by contrasting it with Berkeley's. In particular, I will offer Gibson's ecological model of *kinetic optical occlusion* as a rebuttal.
to the one-point argument (outlined in Chapter Two). The one-point argument is used by Descartes and Berkeley to establish the indirect perception of space. By undercutting it with the theory of kinetic optical occlusion, I will tip the scale toward direct perception.

In section four, I provide an analysis and interpretation of Gibson’s theory of affordances (the core of the Ecological Approach). Based on the arguments presented in previous sections, I will argue that the theory of affordances shows that perception is more than a means of passively representing the intrinsic physical organization of objects. Perception is inherently active and exploratory. It is seeks out alterations in the vast flow of information enveloping it. These alterations are detected when the perceiver moves through the environment and probes it with a pair of glancing eyes. Locomotion opens up new possibilities for the pick-up of information specific to the perceiver’s environment. This information can then be used to guide subsequent movements, as in a perception-action loop (the two being inseparable). Thus, for Gibson, “we do not ... perceive naked properties of the environment, rather we perceive what the environment affords to our bodies, what we can do with, or in the environment.”

Thus, the theory of affordances demonstrates that the environment is intrinsically meaningful.

In section four, I will also argue that there is information in the environment to specify affordances, thereby linking the “theory of affordances” with the “theory of direct perception.” On my interpretation, the two are inseparable. Affordances are not subjective valuations superimposed on sensations (as theories of perception typically presuppose). Rather, the affordances of the environment are directly perceived as meaningful information in the environment.

Section 1: The Structure of the Environment

Ever since Descartes, psychology has been held back by the doctrine that what we have to perceive is the "physical" world that is described by physics. I am suggesting that what we have to perceive and cope with is the world considered as the environment.\(^{119}\)

As this quote indicates, Gibson is primarily concerned with a description of the world at the level of ecology, that is, a description of the *environment*. The Gibsonian concept of the environment is a radical departure from the traditional Cartesian theory of the material world. Since the time of Descartes, the view that the world is composed of extended, uniform matter in mechanical interaction has been an unchallenged axiom of western science. On this view, material objects are located in a container of space. Their locations are specifiable with reference to the three Cartesian coordinates, and also along an abstract dimension of time. At this *mechanistic* level of analysis, the various properties of the world are described in terms of their intrinsic physical organizations (i.e., texture, size, shape, mass, reflectance, chemical composition, etc.). In turn, these properties are conveyed to the perceiver *via* mechanical interactions among bits of matter.\(^{120}\) The visually perceivable properties of objects are conveyed by light energy (qua matter-in-motion) giving rise to visual experience. Tangible properties, such as solidity and texture, and sounds emitted from objects are conveyed mechanically and then *represented* as tactual and auditory experience.

In this respect, Descartes's mechanical description of the material world is also the basis of his theory of perception. For Descartes, perception is the causal outcome of a

---


\(^{120}\) On the Cartesian account, the perceiver's body (including the senses) is regarded as an extremely complex object of the material world. Gibson writes, "The animal is thought of as a highly organized part of the [material] world but still a part and still an object." (Gibson, 1979, p. 8) Gibson rejects the Cartesian notion of the body as one material object among others. According to Gibson, this way of thinking neglects the importance of the "perceiver-environment reciprocity" concept (Gibson, 1979, p. 8) introduced in this section.
linear chain of events beginning in the material world and (paradoxically) ending in the mind. The first event in the chain of occurrences is a physical stimulus making contact with the photoreceptive retina(s) in the material eye(s). This contact initiates a succession of neural impulses in the sensory receptors, followed by a volley of impulses along receptor tracts to a series of brain sites. For Descartes, the resulting pattern of sensory-neural activity gives rise to meaningful perception indirectly, that is, through the performance of mental inferences. On this account, perceptual meaning is an inferred property. It is imposed on the world by the perceiver’s mental constructions, rather than being a quality discovered in the world. Just as there is no place for colors, sounds, smells and tastes in the domain of matter, there is also no place for the quality of meaning. Cartesian matter is literally meaningless. Given these assumptions, Descartes theorizes that perceptual meaning is part and parcel of inner representations (which are distinct from the domain of the material world). This causal account of how meaningful perceptions are constructed reflects Descartes’s more general application of mechanical models to explain all perceptual processes, bodily functions and natural occurrences.

Expressing himself in this dualistic way leads Descartes into a thicket of problems. The main problem presented by his approach is the problem of mind-world interaction. If world and mind are different in substance, then the interaction between them would be of an “imposed nature.” This is because experience belongs to an unextended mind, but refers to extended matter. Thus, in perceptual experience, the mind’s inferences cross a gap between ideas and things, which are two very different sorts of substances. To account for this phenomenon, Descartes must explain how the

---

physical properties of things in the world are disclosed to the psychical entities (i.e., ideas) in the mind. Descartes offers a mechanical theory of indirect perception, in which “independent physical objects mechanically impart effects from one to another”¹²² in a linear fashion. This mechanical model is sufficient to explain how physical stimuli impart motion to the eye and brain of the perceiver, since stimuli, eyes, nerves and brains are embedded in a common material substance (the spatiality of which conforms to the axioms of Cartesian geometry). However, explaining how “influences are passed between qualitatively different entities, such as a physical energy causing an experiential quality [like] a sensation”¹²³ in the purely psychical mental substance of a mind, is impossible on the basis of Descartes’s standard causal account. The question still remains as to how properties of the world are experienced by the perceiver. Thus, Descartes is faced with the problem of interaction, which he addresses in the *Meditations*.

This is the conceptual morass that Gibson’s ecological program was designed to circumnavigate. To overcome the difficulties inherent in Cartesian dualism, Gibson’s analysis of the environment is concerned with *structures* rather than *mechanisms*. In this section, I will discuss Gibson’s structural analysis of the environment and distinguish it from Descartes’s mechanistic analysis of the material world. Roughly, a structural analysis of the environment centers on the individual’s continuous transactions with meaningful features of the environment. At this level of analysis, individuals engage the environment in order to learn more about its properties and, in many cases, to contribute to the environment’s changing structural character. This analytical stance emphasizes the *reciprocity* of the environment and the perceiver. On this view, the environment (to be

¹²³ Ibid., p. 126.
perceived) does not reside in the representations of an individual’s mind. If it did, then an unbridgeable gap would exist between the “real” environment and its cognitive representation in the mind.

In visual theory, the term *structure* was first introduced by Gestalt psychologists. For the Gestalts, a structure is a form or standard that fits changing content to an already specified framework. For instance, Koffka is primarily with how we see an object in relation to its framework, that is, as a figure on a background. He argues that the figure-background framework constitutes the “intrinsic structure”\(^{124}\) of the visual field. In other words, the figure-background configuration is a template that bundles changing content into pre-specified forms or gestalts. As Morris points out, “it fits the contingent to the necessary, the fluid to the stable, or the *a posteriori* to the *a priori*.\(^{125}\) The Gestalt conception of the figure-background configuration can accurately be described as an *a priori* structure of perception that organizes the fluctuating, *a posteriori* visual contents by fitting them to pre-specified forms.

According to Gibson, this notion of structure is problematic. Difficulties spring up when we ask how changing content calls a new structure into play, since this would require a structure for applying structure. This is problematic because it results in an infinite regress on the task that a structure is meant to achieve. From the Gibsonian standpoint, what is required is a concept of structure that is not detached from what it structures. Thus, the Gibsonian concept of structure is neither *a priori* nor *a posteriori*. Gibson does not interpret the concept of structure within this conceptual division, which

---


overlooks the crucial role played by the reciprocal movements of perceivers and the environment in structural analysis.

Gibson's concept of structure is difficult to articulate because our daily engagement with the environment gears us to put solid things before moving processes, and (consequently) mechanisms before structures. We are, as Henri Bergson points out, inclined to the logic of solids.\textsuperscript{126} For this reason, theories typically decompose structure into solid parts in an \textit{a priori} framework of mechanical laws that control parts. This is the basic thrust of Descartes's mechanistic analysis of the material world. In contradistinction, Gibson resists the temptation of reducing structure to mechanism by conceiving structure as a \textit{process} or \textit{movement} that manifests its own organizing pattern within a perceiver-environment system. If we had to say what the moving structure is made of, or what it is the organization of, we would have to say that it is the self-organization of movement that is animated through perceiver-environment reciprocity. I will return to this point shortly.

To further elucidate the distinction between structural and mechanistic analyses, consider Gibson's example of a traffic jam.\textsuperscript{127} A mechanistic analysis would reduce a traffic jam into independent, vehicular units governed by universal laws of traffic. For Gibson, the mechanistic analysis overlooks the fact that traffic jams would not occur if people drove in a law-like manner at all times. Traffic movement does not follow from mechanistic laws. Commenting on this example, Morris writes, "Different rules of driving emerge in moving contexts that drivers collectively create."\textsuperscript{128} He continues,

\textsuperscript{127} Gibson, James J., \textit{A Theoretical Field-Analysis of Automobile Driving} (From Reasons for Realism: The Selected Essays of James J. Gibson, New Jersey, Lawrence Erlbaum Associates, 1982).
"Experientially, this is quite palpable. There is a different way to drive in smooth highway traffic versus a highway traffic jam. There are subtle differences between traffic jams, which do not result from a priori laws, but from interaction in a given web of moving traffic."¹²⁹ Thus, whereas a mechanistic analysis aims at explaining things in terms of general laws (i.e., laws established in advance of the particular things being studied), structural analysis studies the perceiver-environment system, which actively organizes itself through the reciprocal movements within this system.

Therefore, unlike mechanistic analyses, the ecological approach does not seek universal laws that cover all possibilities of mechanical interaction. Qua ecological, this approach concerns the manner in which the structure of the perceiver-environment system, through the dynamic interrelations of its parts, constrains possibilities.¹³⁰ This is the goal of dynamic systems theory, a recent development in ecological optics, which regards moving structures as rooted in constraint formations. To return to Gibson's example, cars never behave as independent units. In a highway-traffic system, like the QEW, automobile movement is inherently limited by the road and by the moving interrelation of cars, buses and trucks. Not all movements are possible. As Turvey and Carello (1995) point out, this amounts to a collapse of the degrees of freedom of a system.¹³¹ In this respect, highway-traffic systems are not causal outcomes of all-encompassing mechanical laws. They are structured by constraints that are immanent within the actual movement of the highway-traffic system.

¹³⁰ The concept of "constraints" was introduced into visual theory by dynamic systems theorists. In this section, it serves as a conceptual apparatus for facilitating an understanding of the dynamics of perceiver-environment systems.
¹³¹ Turvey, M.T., and Carello, C., Dynamic Touch (From Perception of Space and Motion, California, Academic Press, 1995).
These "immanent constraints"132 are due, not merely to the arrangement of inert bits of matter in mechanical interaction, but to the organization of movement animated within the perceiver-environment system. For Gibson, constraints arise in moving structures that open the perceiver to the environment and the environment to the perceiver reciprocally. The collapse of the degrees of freedom of a perceiver-environment system is itself brought about through the limitations intrinsic to reciprocal movements within this system. This is why dynamic systems theorists, following Gibson, tell us that moving structures can be understood in terms of constraint formations. The dynamic organization of this system is generated by the reciprocal interrelations of its constituents (i.e., perceivers and environments) which, in turn, place constraints on the range of the functioning of these constituents. In other words, the degrees of freedom of the constituents of the perceiver-environment system are constrained by the dynamic organization of the system as a whole. To illustrate this point, consider Carello and Turvey's (2000) example of wielding a hand held object, like a baseball bat.133 Carello and Turvey argue that one's feeling for the length of a wielded object, such as a baseball bat, has to do with one's possibilities for movement, or more specifically, with the way those possibilities are constrained by the joint activity of the body and the bat. As Morris comments, "felt length does not refer to a geometrical length reconstructed by an inferential [or associative] process"134 in the mind; it refers to something directly within the moving interaction of the perceiver and the environment. What we are perceiving when we perceive felt length is a constraint, a limitation on

---

133 Carello, C. and Turvey, M.T., Rotational Invariants and Dynamic Touch (from Touch, Representation and Blindness, Oxford, Oxford University Press, 2000).
movement, that organizes itself within the perceiver-environment system. The joint activity of the body and the bat constrains or limits the degrees of freedom of its wielder. In line with Gibson, Turvey and Carello (2000) conclude that all individual actions are constrained and hence organized within this system as a whole.

Gibson's structural analysis leads him to formulate the concept of the environment, not as a container of entities, but as dynamic structures that manifest in perceiver-environment reciprocity. At first glance, this definition appears to beg the question, "What is the environment, this concept that supposedly overcomes the dualism of Descartes's mechanistic analysis?" If Gibson cannot respond, it seems he is pulling a rabbit out of a hat.

I am suggesting this problem is poorly put. It assumes that Gibson is seeking a fixed entity called "the environment." But such a definition would conflate structure and mechanism and thus return us to Descartes's problems. Against this tendency, Gibson argues that the environment is an open system in which dynamic, self-organizing structures manifest in a moving circuit across purposive actions and shared behavioral settings.135 This is a subtle, but vast shift in perspective. Whereas Descartes conceives the material world as a totality of physical entities that (somehow) interact with psychical entities via pre-established laws, Gibson abandons the interactionist approach and its assumptions. For this reason, Gibson does not pursue an independent conception of the environment isolated from the embodied perceiver. He writes, "The terms animal and environment make an inseparable pair. Each term implies the other. No animal could exist without an environment surrounding it. Equally, although not so obvious, an

135 The purposive action-behavioral setting notion will be addressed in detail in section four, when I discuss Gibson's theory of affordances.
environment implies an animal ... to be surrounded."¹³⁶ Thus, the structures of the environment do not transcend the perceiver-environment system (as mechanical laws transcend the material world they govern). Rather, structures emerge from within the very systems they constrain.

The ecological approach discussed in this chapter has several advantages over the mechanistic approach. First of all, the concept of perceiver-environment reciprocity avoids the dilemma of (private) mind-(public) world interaction by conceiving perceivers and environments as forming a mutually supportive system. Moreover, the ecological approach establishes this conception without reducing the problem to physical-neurobiological terms, as do contemporary mechanistic approaches. In truth, this reductive turn simply dresses the old Cartesian problem in a modern garb. This is the problem of how properties in the material world are actually experienced by perceivers. For this reason, theories that reduce perceptual experience to neurobiological processes do not avoid the problem of interaction. In contrast, Gibson’s ecological program is designed to overcome these difficulties by rooting the perceiver and the environment in a fully integrated system of mutual constraint, instead of treating them as two distinct domains of existence in (inexplicable) mechanical interaction.

These introductory remarks have enormous import for Gibson’s theory of perception (discussed in the proceeding sections). Behind these remarks is a sustained attack on Descartes’s and Berkeley’s sensation-based theory of perception. To recapitulate, this theory states that physical stimuli initiate patterns of excitation in the sensory receptors on the retina, yielding collections of “immediately” experienced

sensations in the material body. On this account, perception is the "mediate" procedure of constructing representations on the basis of these elementary, atomic sensations. In opposition to this view, Gibson argues that perception is wrongly conceived as a private event in the perceiver's mind. Representational theories of perception appeal to frameworks fixed in advance of the perceiver's moving, ecological relation to the environment. For Gibson, models that transcend the perceiver-environment system are both problematic and unnecessary. The structures generated in perceiver-environment systems serve as "stimulus information"\(^{137}\) for the direct perception of the environment. In Gibson's terminology, perception is the detection of *invariants* in the flow of stimulus information, which is sparked when the active perceiver moves through the environment. This is the topic of the next section. In discussing the structures of the information for perception, I will draw on many of the insights in this section.

*Section 2: The Structure(s) of Information in the Environment*

According to Gibson, ecological optics analyzes the information for vision. This analysis consists of two components. The first is a structural analysis of the environment to be perceived and the information available in the environment. The second component is a similar analysis of how perceivers detect and use the information available to them. As I have suggested, these two components are complementary. Environmental information is itself a product of the perceiver's bodily involvement with the environment. This interaction generates a "flow" of information, which underlies and guides all perceptual activity. Hence, the dynamic encounter of the moving perceiver and the environment is the basis of Gibson's theory of direct perception.

The viability of a theory of direct perception depends on demonstrating that there is information in the environment that is capable of specifying its source. For Gibson, to claim that environmental information does not need to be reconstructed or embellished by inferential processes is to claim that stimulation is uniquely and invariably tied to its source. Like all branches of optics, ecological optics claims that light is the stimulus for vision. Only light can meaningfully stimulate the eye of the observer. However, the claim that light in the environment is structured and that these structures serve as information about the environment is controversial. The reason for this, Gibson explains, is that "It has been asserted with some plausibility both that light carries information about the world and that it does not." This debate is as old as the history of visual theory itself. On the one hand, theorists as historically remote as Ptolemy and Kepler have argued that (1) objects constantly send off little images of themselves in all directions and that these images serve as the active information for perception. This was the dominant view until Descartes produced his radical critique of the doctrine of intentional species in The World and the Dioptrics. Thereafter, it became a foregone conclusion that (2) nothing gets into the eye but the rays of light, propagated from "points" in geometrical space. Cartesian light rays are perfectly homogenous "pencils" of moving particles (and therefore lack any internal structure needed to carry semblances of visible qualities of the object to the eye of the perceiver). Upon entering the eye, the light rays converge to a series of points on the retina. Each point in the stimulated region mechanically produces a sensation from which the mind infers determinate properties of the external world. This is the basis of Descartes's theory of indirect perception.

Gibson asks, in rejecting (1) are we forced to accept (2)? That is, if we deny that light carries information for perception insofar as it transmits an exact replica of the object to the eye, must we assume that light is internally devoid of information? If so, then we must also be prepared to accept the claim that the mind builds up a representation of the world from the momentary sensations caused by the stimulation of points on the retina. According to Gibson, this theory is needlessly complex and attributes too much responsibility to the inferential status of the intellect. The difficulties inherent in this view can be overcome by Gibson’s theory of ecological specificity. In this section, I will offer Gibson’s theory as an alternative to Cartesian representationalism by contrasting Descartes’s conception of light as matter-in-motion with Gibson’s notion of ambient light. According to Gibson, the latter implies the existence of a moving perceiver and (therefore) contains structures that serve as information for perception. Since “The essence of ecological optics is the demonstration that there is information in ambient light” for active perceivers, I will begin with the question, “What is ambient light?” My answer will consist of a general description of ambient light and an analysis of the structures of the information it contains for an active perceiver.

In *The Ecological Approach*, Gibson describes ambient light as “light reflected by the environment as a source.” The layout of the environment is primarily composed of a transparent medium and a nested set of textured surfaces. The medium *transmits* light, whereas the surfaces *reflect* it diffusely. These surfaces reflect in multiple fashions,

---

139 Here Gibson is employing the law of parsimony (also known as Occam’s Razor). The law states that, all else being equal, one should prefer simple theories or explanations over complex ones.


142 In a typical environment, surfaces reflect light diffusely, not regularly, since mirrors are rare in nature.
from one surface to another, and to yet another. The outcome of diffuse, multiple reflection is an omni-directional flux of light, which fills the transmitting medium and envelopes the perceiver. If this light has different intensities in different directions, instead of the same intensity in all directions, Gibson proposes to call the flux of light an ambient optic array. It is an array because the variation of intensities produces a differential arrangement within the total field of structured light. It is an optic array because the differential arrangement, constituted by the variations in intensity, provides an active, mobile perceiver with information about the environment. Visual perception is a matter of detecting this information within the ambient optic array. On this account, perceptual information is intrinsic to the environment, instead of being intrinsic to sensations in the perceiver's mind. Consequently, the appeal to inferences is unnecessary. This is because perception is not a matter of inferentially reconstructing or representing the world on the basis of sensory intermediaries (as Descartes and Berkeley assume). No mediation is required. Rather, perception is a form of direct contact with the ambient optic array and the information contained therein.

The issue of whether light contains a perceptible structure signifies a major difference between the Cartesian and Gibsonian approaches to vision. Whereas Descartes's conception of light (as a stimulus) consists of individual rays propagated from "points" in geometrical space to corresponding points on the retinal plane, Gibson's ambient optic array does not consist of individual rays. According to Gibson, a ray is a geometrical fiction. While "such a fiction may be useful for geometrical optics, and convenient for the tracing of rays through refracting media,"\(^\text{143}\) it cannot provide the

A ray of light is unstructured; it is perfectly dense and vanishingly thin. However, if light is to carry information about the environment it must be structured, otherwise nothing can be made visible on the basis of light.\textsuperscript{144} This claim holds in general. Any space filled with unstructured light is as devoid of information as a fog-filled medium. Gibson writes, "[In a fog-filled medium] the air would be translucent but not transparent ... Multiple reflections would occur only between closely packed microsurfaces, yielding a sort of microillumination of things too small to see."\textsuperscript{145} Light without structure is similar to absolute darkness. It would provide no information about the environment. In this respect, Gibson offers a structural analysis of ambient light. The structures of ambient light emerge in the dynamic interaction of the moving perceiver and the environment. These structures constitute information for an active perceiver because of her direct, environmental contact with the ambient optic array.

According to Gibson, the structure of the ambient optic array is comprised of two complementary components. Gibson calls these the invariant and perspective structures, respectively. When the perceiver moves through the environment, the interaction of the moving body against the field of light generates a kind of flow in the ambient optic array. In ecological optics, the flowing character of the array is what makes perception possible. Gibson's central insight is that perception is the detection of invariants that emerge within the flow as the perceiver moves. Invariants refer to higher-order relations in the structure of ambient light that do not change in the context of an otherwise changing

\textsuperscript{144} In this respect, a light ray vanishing to a geometrical line in Cartesian space would offer nothing to be seen.
array. These invariants of the ambient optic array constitute its essential structure, that is, these are what tend to persist despite change. However, what is invariant in the array does not emerge "except within a flux of variation." Gibson continues, "The essentials become evident in the context of the changing non-essentials," meaning that persistence and change are co-dependent terms. Gibson calls the latter the perspective structure of the array, which governs the "perspective transformations...in the ambient optical field." It is a moving structure. The invariant structure, on the other hand, constitutes the optical pattern that persists despite the changes of perspective structure. There are many such invariants in a typical environment, the most important of which is the horizon that separates the ground from the sky. It is the invariant of invariants, so to speak, acting as the limit of all gradients of texture density in the array. The closer something appears to the horizon, the closer it is to reaching its limit of perspective minification. This is what is meant when something is described as "vanishing in the distance."

Of course, invariants of structure can be detected at every level of the persisting environment. In the Ecological Approach, Gibson considers the problem of how a "rectangular surface like a tabletop can be given to sight when presumably all that an eye can see is a large number of forms that are trapezoids." This is a variation on the argument from illusion, as presented by Berkeley. According to Gibson, the argument is a pseudo-dilemma; it is only a problem if we assume that form-perception is an

---

intellectual synthesis of discrete sensory-retinal inputs. This is the approach taken by Descartes and Berkeley. However, for Gibson, the trapezoidal forms on the retina are of no account, since we do not perceive a succession of retinal images. It is their transformation that counts as the perspective structure, and the invariant structure (i.e., the rectangularity of the tabletop) is revealed by these transformations. Gibson writes, “Although the changing angles and proportions of the set of trapezoidal projections are a fact, the unchanging relations among the four angles and the invariant proportions over the set are another fact, equally important, and they uniquely specify the rectangular surface.”

Thus, the invariant structure of the array is only revealed when the observer is permitted to move and the perspective structure flows.

Crucially, the flowing transformations of the perspective structure and the underlying invariant structure are concurrent. Invariants are patterns of change, which emerge when the perceiver moves around. Consider Morris's phenomenological experiment in support of this claim. He writes, “If you immobilize yourself in a room and unfocusedly gaze at a ceiling corner, you might perceive that corner as flattening out into three lines meeting at an angle, but the moment you sweep your eyes back and forth, the angles flow through transformations” (my italics). The invariant pattern of these transformations specifies the persisting features of the environment. Accordingly, Gibson characterizes invariants as patterns of movement in the ambient optic array.

What is invariant is the pattern of variation. To clarify this point, Morris offers the example of a waltz. “The waltzing dancers move around in all sorts of cycles, but the pattern of these cycles (i.e., the basic one-two-three step, the way these steps go in a

---

circle, etc.) remains invariant."  

For Gibson, perception is the detection of invariant patterns that emerge within the reciprocal movement that plays back and forth across the perceiver and the environment. Thus, invariant information specifying the persisting features of the environment is generated through perceiver-environment interaction (as in the case of moving around an object). This is made possible, in part, by bodily locomotion.

Locomotion plays a central role in Gibson’s information-based theory of perception. In this theory, perception and action are invariably coupled, for if perception is to acquire information from the structured array, the perceiver must be capable of movement. Movement generates optical flow and reveals the invariant patterns that underpin it. For Gibson, this information serves to guide embodied action in the environment. It informs us of those aspects of the environment that play a role in the pragmatic organization of our activities. This information can then be used to guide subsequent movements in a perception-action loop. On this view, the function of vision is not the production of mental representations, but rather, the enabling of the perceiver to function appropriately in the environment. Gibson conceives of vision as a way of acquiring information about the environment by coming into direct contact with it via active explorations. After all, “The first responses of a man to an optic array...are to focus, fixate, modulate its intensity, and above all explore it.”

The term “exploration” suggests that perception is more than a means of passively receiving light into the body. Vision is a way of looking, that is, a way of moving

---

influenced by what we see. Gibson shows how vision depends on movement and the way that seeing depends on looking. Gibson writes,

Looking around and getting around do not fit into the standard idea of what visual perception is. But note that if an animal has eyes at all it swivels its head around and it goes from place to place. The single, frozen field of view provides only impoverished information about the world. The visual system did not evolve for this. The evidence suggests that visual awareness is panoramic and does in fact persist during long acts of locomotion.153

Elsewhere, Gibson explains that exploration of the ambient optic array is possible because its structure constitutes "a global stimulus rather than a punctate stimulus."154 According to Gibson, the former is information for perception, whereas the latter is not. The ambient optic array is a global stimulus because it fills the transmitting medium of the environment and surrounds the perceiver. It is extended, enduring, and cannot be given all at once. This goes along with Gibson’s conviction that perception is a temporal act. It unfolds over time as the "active, exploring observer"155 moves about her surroundings and samples the array in successive overlapping sectors. Conversely, a "punctate" stimulus is momentary, like a pinprick. It is given "all at once" and does not permit exploration.156

On Gibson’s view, Cartesian light rays are punctate stimuli that resemble the stimulus prods used in traditional, laboratory psychophysics. When applied to an eye, the individual rays touch off a pattern of "points" on the retina. Since light rays are

156 In section four I will return to this idea of exploration, which signifies the deep coupling of perception and action. On Gibson’s account, “exploration” is just a synonym for the activity of utilizing perceived affordances. This activity has its informational support in the ambient optic array, which I will also discuss in section four.
unstructured and do not carry information about their source, Descartes theorizes that perceptual information is encoded in the array of sensations triggered by the incident rays. This gives the impression that the senses are passive channels for sensations, i.e., mechanisms for passively receiving imposed stimuli and transmitting the attendant sensations to various brain centers vis-à-vis the optic nerves. Upon reaching their cerebral destinations, the sensations are decoded and become the basis of visual inferences about the world. This theory regards the “sensorium as a personal entity ... shut off from the external world but seeking information about it and perceiving the representatives ... of objects that the nerves bring to it.”\footnote{For Descartes, it is these sensory representatives that are directly perceived, not the objects represented. Accordingly, inferential awareness becomes a necessary component of Descartes’s sensation-based theory of indirect perception.}

The concept of the ambient optic array is of monumental significance for Gibson because it explicitly breaks with Cartesian representationalism and the notion that vision is \textit{mediated} by retinal sensations. It allows him to transcend this old way of thinking, both in his theorizing and in his experimentation. Whereas Descartes was searching for some mapping from the world to the mind (and back) in order to find out how retinal sensations represented reality, Gibson abandons this entire project and its assumptions. Such a conception of the nature of vision, Gibson argues, is pitched at the wrong level. The world may “map” onto the ambient optic array, but it need not map into the organism’s mind.\footnote{The environment (i.e., the animal’s habitat) is the sole repository of}

\textbf{Footnotes:}


\footnote{To this effect, Gibson writes, “The structure of the environment at all levels of linear size is mapped into the structure of the array at all levels of angular size.” (Gibson, 1966, p. 192) These perspective projections}
information about it. Vision acquires information directly by exploring the ambient optic array with (a pair of) moving eyes. Therefore, no mediation is necessary.

In this section, I have stressed the importance of bodily motility in perception. A perceiver’s use of the ambient optic array is active, not passive. Accordingly, the eye is not simply a receptacle for discrete light stimuli imposed on the retina, but rather, an organ for exploring an ambient optic array. In this respect, the visual system is responsible for obtaining stimulation over time, not merely for receiving it in momentary prods. Vision can perform this function by paying attention to whatever is invariant in the structured array. Of course, invariants are only revealed when the perceiver is permitted to move and the optical display flows through transformations. For Gibson, the transformations in the ambient optic array provide the information upon which vision is founded. On this account, perception is not based on having sensations (as traditional accounts suppose). Sensations are momentary and discrete, corresponding to nothing in actual experience. In order to account for the unity of perceptual experiences, sensation-based theories have to synthesize the momentariness of sensation with conceptual processes. These processes (i.e. inference, associative memory, visual memory traces, imagination, etc.) would then integrate all the fleeting sensations into representations.159 However, Gibson’s experimental work on the concept of the ambient optic array shows

---

159 In the Critique of Pure Reason, Kant offers a similar (albeit transcendental) theory of the unity of empirical representations. According to Kant, this unification is the result of (1) the production of sensations (i.e., the matter of sensible intuitions) and (2) the application of the categories in experience (i.e., the conceptual form of the understanding, in which all sensations are necessarily cast). Without the latter there would be no unified representations, that is, no synthetic unity of the manifold of intuition, and without the former there would be nothing to be unified in representations. As Kant puts it, "Thoughts without content are empty, intuitions without concepts are blind." (A51/B76)
that the basic elements of visual perception are not punctate sensations aggregating into mental representations, or even a field with figure and ground organization, as in the Gestalt theory of Koffka, Kohler and Wertheimer. Rather, ecological information is directly perceived and constitutes the basis of visual perception.

In the next section, I will bring Gibson’s critique of sensationalism and his new theory of the ecological information contained in structured light to bear on the theory of the indirect perception of space. In particular, I will offer Gibson’s ecological model of kinetic optical occlusion as an alternative to Berkeley’s version of the one-point argument (outlined in Chapter Two)

Section 3: Perceiving Depth in the Ambient Optic Array

In ecological optics, transformations in the ambient optic array directly specify the changing and persisting features of the physical environment for a moving observer. Among these features is included information about the layout of surfaces in depth, and more specifically, the separation of surfaces in depth. For Gibson, surface layout and surface separation presuppose each other. The environment is not composed of a single surface, or even of a single surface in depth. Rather, an environment is a layout of adjoining surfaces, with some in front and some behind others. The question is, “What structure in the ambient optic array might yield the perception of surface layout (i.e., the separation of surfaces in depth)?” This is the central theme of this section. By way of anticipation, my answer will draw on Gibson’s theory of kinetic optical occlusion as put forward in The Senses Considered as Perceptual Systems (1966) and The Ecological Approach to Visual Perception (1979). This theory draws on the information available in
structured light, and is, therefore, the basis of Gibson's theory of the direct perception of space.

I will begin by revisiting the argument for the opposite assertion, namely, the indirect perception of space. In Chapter Two, I characterized it as the one-point argument. The one-point argument is the basis of Descartes's and Berkeley's contention that space perception is non-immediate and depends upon additional mental processing. This argument relies heavily on the Cartesian conception of light and retinal stimulation (discussed above). Therefore, I will integrate my previous arguments into Gibson's refutation of the one-point argument. In short, by utilizing the concept of the ambient optic array and the information contained therein, I will undercut the one-point argument and its assumptions about the sensory/retinal basis of vision.

Despite their differences, Descartes and Berkeley both agree on the ubiquity of the one-point argument and the conclusion that space perception is indirect.\(^1\) Consider Berkeley's formulation at the outset of the *NW*. He states that a point at any distance, along a line of sight, projects the same single point on the retina (call it \(p\)). The light ray striking \(p\) could be from any distance; ten meters, fifty meters, one hundred meters, and so on. In each case, the spatial extent between the object and the eye is not displayed anywhere in the stimulated region of the retina. When the three-dimensional world is mapped from the two-dimensional retina, nothing in the retina directly represents distance. Consequently, depth is not exhibited in visual sensations corresponding to differences in distance along a line of sight. For Descartes and Berkeley, line-of-sight

---

\(^1\) In this respect, their disagreement is primarily over the specific model of non-immediate mental processing. However, Descartes and Berkeley agree that such a model is necessary, because they both thought that distance could not be represented anywhere on the stimulated retina.
distance is not displayed on the stimulated retina or in its accompanying sensation. Hence, they conclude that space perception must be indirect.

According to Gibson, this argument is unsatisfactory. The claim that depth is lost in the two-dimensional retinal image is simply false. It relies on the assumption that perceptions are inferred from retinal inputs, triggered by light rays encoded in motion. Such a conception of light is erroneous. It conceives light stimuli as punctate, unstructured, and above all, as incapable of carrying information about the separation of surfaces in depth. In an earlier work (1950), Gibson considered "the possibility that there is no such thing as a perception of space without the perception of a continuous background surface."\(^{161}\) This ground theory was intended to undercut the air theory of space perception, which Gibson saw as underlying the Cartesian and Berkelean approaches and the one-point argument used to support them. Gibson writes, "The idea was that the world consisted of a basic surface with adjoining surfaces, not of bodies in empty air."\(^{162}\) In contradistinction, the spatiality of the visual world is given to perception by the continuous layout of surfaces. This layout is specified by gradients of texture in the ambient optic array, not by individual light rays propagated from "points" in geometrical space. Hence, for Gibson, the seeing that explores the ambient optic array does not acquaint us with detached objects (in empty space), but rather with a layout of conjoined surfaces in depth. Optical texture intrinsically signifies distance.

According to Gibson, traditional theories of depth perception rely on the "fallacy of the retinal picture"\(^{163}\) and the use of sensory cues to account for depth. Gibson


\(^{163}\) Ibid., p. 148.
replaces these older models of depth perception with the idea that "there is information in ambient light for the perception of the layout of surfaces," thus substituting environmental information for sensory cues. This is the basis of Gibson’s theory for the direct perception of space. The cues for depth are useful, only if visual perception begins with a two-dimensional picture at the back of the eye (which it does not). The rejection of this Cartesian/Berkelean premise signifies Gibson’s turn from traditional optics and the retinal image to ecological optics and the ambient array. Therefore, instead of speaking of a direct perception of the three dimensions of Cartesian space, Gibson will argue for a direct perception of the layout of surfaces in depth.

Perceiving a layout of surfaces already presupposes a perception of the "space" that separates them. In the NTV, Berkeley proposes a model whereby sight can perceive the absenting distance between surfaces in space. It is called “superposition.” This principle states that near objects partially obscure ones that are farther away. On Berkeley’s account, the mind uses the interruption of one object at the boundaries of another as a cue for determining the relative distance between two surfaces. E.G. Boring points out that, although "the circumstances attending the recognition of this principle are lost in antiquity ... it is used in some of the most primitive drawings and early art ... which knew no perspective ... [but] observe this rule." Superposition is an extremely important, albeit obvious artistic technique for conveying the depth and distance of surfaces in pictorial space. This is because it allows painters to avoid the "confusion of

---


drawing parts of different objects in the same place."\textsuperscript{166} However, despite its artistic merits the concept of superposition is insufficient to explain the perception of surface layout. This is because perception does not occur on a motionless picture plane, and to formulate optical laws according to this is to make a serious mistake (i.e. it omits the role played by bodily locomotion). Thus, while the principle of superposition is an adequate cue for determining depth in static images, like photographs and paintings, it is not what happens in real life.

So what does happen? According to Gibson, bodily locomotion is the basic fact of space perception. Information about the separation of surfaces in depth is generated when the perceiver is mobile and the solid angles of the ambient optic array \textit{flow} through transformations. What do these transformations specify? As perceivers move through their surroundings, the visible surfaces of the layout go in and out of sight. This can be observed by walking down a cluttered city street. As the perceiver moves along, the buildings sweep behind one another, as the nearer ones cover the more distant. This dynamic process, whereby surfaces conceal and reveal each other from a moving point of view is called \textit{kinetic optical occlusion}.

Quite simply, kinetic depth is the information picked up from the (kinetic) movement of occluding surfaces. Gibson argues that this information is given to perception by the optical specification of the edges that separate them. Edge information is indicated by a rupture or discontinuity in the optical texture of the array, which he calls "a sort of topological breakage."\textsuperscript{167} Gibson describes the process thusly: "There occurs a \textit{wiping-out} at the leading border, an \textit{unwiping} at the trailing border, and a \textit{shearing} of

\textsuperscript{167} Ibid., p. 203.
texture at the lateral borders of the figure in the array." The descriptive, phenomenological terms *wiping-out, unwiping* and *shearing* refer to the transformations that occur in the texture of the ambient optic array when reflecting surfaces are seen to cover one another from a moving point of observation. Thus, when the wiping and shearing-across of texture in the array occurs, these transformations specify depth at the perceived edges in the environment. In the *Senses Considered*, Gibson concludes, "Depth is specified without ambiguity by wiping and shearing ... [as seen in] the phenomena of kinetic occlusion."

One advantage of Gibson's theory of space perception is that it can account for a variety of phenomena, which traditional theories overlook. For instance, kinetic occlusion also specifies the existence of one surface behind another, which is to say, the continued existence of an occluded surface. Following in the footsteps of Koffka, who asserted that he could see the top of his table extending behind the book that lay on it, Gibson argues that in order to perceive a layout, there must be some sense in which observers can see the temporarily hidden surfaces and not just the unhidden ones. This poses an additional problem for sensation-based theories of perception. If the information for perception were *exclusively* the unhidden objects, as Descartes and Berkeley contend, then observers would be unable to see the many aspects of their environment. They would have to infer it from a succession of circumscribed images, as though perception were a movie projector, stringing together the perceived like a film. As Edward Reed points out, "Not only are the memory requirements of this theory

---

nothing short of staggering, but it completely leaves out of account the fundamentally important information contained in the process through which the hidden becomes visible\textsuperscript{171} and the visible becomes hidden. What does this information imply?

According to Gibson, it implies that optical information about hidden surfaces can be \textit{directly} perceived – or detected – from the wiping of border and texture that occurs in kinetic optical occlusion. Hence, Gibson can make good on Koffka's claim without recourse to a mysterious, intermediate process of the spontaneous neural organization of the visual inputs to the brain.\textsuperscript{172} This is what makes his ecological approach so appealing. The seeing of one thing behind another is not a paradox, precisely because there is information (in the structure of the ambient optic array) to specify the persistence of hidden surfaces.

The first visual theorist to successfully isolate "occlusion information" in light was Albert Michotte. In one of his laboratory experiments (Michotte, Thines \\& Crabbe, 1964), Machotte displayed a series of five picture-images in which a black disk is shown moving down an otherwise empty screen, descending gradually behind an invisible horizon line located at the center of the frame. Gibson observes, "Abruptly, the leading contour stops while the trailing contour continues to move. The circular contour is transformed in this manner"\textsuperscript{173} until it is completely hidden. According to Machotte, all of his observers described seeing a "slit" in the background, behind which the disk descended. Curiously enough, this phenomenal slit is absent from the first and last frames. It is only perceived when a transition in the contour of the disk occurs. Gibson


explains that the appearance of the phenomenal slit is “nothing but the transformation of the contour.” It is this transformation, or rather, the stimulus information intrinsic to it with which Gibson is concerned.

What is especially remarkable is that the disk appears to retain its circular identity while being occluded by the phenomenal slit. The disk is not perceived as going out of existence, or as merely changing shape. It is perceived as “going behind” the invisible horizon, or as being “hidden” by it. Of course, being hidden is not the same thing as vanishing, and the optical information for the one is not the same as for the other. Gibson comments, “A surface that disappears because it is no longer projected to any point of observation ... should not be confused with a surface that disappears because it is no longer projected to a fixed point of observation.” The latter can be seen from another position, whereas the former cannot be seen from any position. Thus, Gibson emphasizes the reversibility of kinetic optical occlusion. Any surface of the layout that is progressively concealed during a displacement is progressively revealed during its reversal. Accordingly, there is a crucial distinction to be made between the phenomenon of “going out of sight” and the phenomenon of “vanishing.” These modes of disappearance are radically different and a theory of perception ought to distinguish between them.

Sensation-based theories of perception have a difficult time accounting for the phenomena of occlusion, precisely because they lack the conceptual tools for making the aforementioned distinction. The occluded disk is not represented anywhere on the retina.

Consequently, no "sensation" can be shown to underlie the perceptions observers reported having of it. Michotte calls this kind of perception *amodal*, for there are no visual sensations upon which to base it. It is entirely lacking in sensory modal accompaniments and is an example of what Gibson calls "sensationless perception."\(^{176}\)

As the quotation at the head of this chapter indicates, the notion of a sensationless perception is thoroughly paradoxical from the standpoint of traditional visual theory. In an attempt to overcome the paradox, proponents of sensationalism often fall back on memory to account for the perceptual completion of a partially occluded surface in the visual field. In the *NTV*, for instance, Berkeley suggests that the mind stores successive sensations, and then associates them in representational vision. This is how past experiences are used to guide present ones. Association enables the perceiver to retain some sort of awareness of the hidden surfaces, even though they are no longer immediately perceived.

This theory faces an obvious difficulty. Consider it in the context of Koffka’s "table under the book" example. Even if the perceiver has never had a sensory experience of the occluded patch of table, she can still *see* it beneath the book; occluded surfaces are still *given* to perception.\(^{177}\) They are simply perceived as being hidden. Thus, what she sees is not a "black patch or a hole," but rather, "the complete table on top of which there is a book."\(^{178}\) In these kinds of situations, the appeal to associative memory is simply inadequate. If there are no sensations (of the occluded surface) to

---


177 From the Gibsonian standpoint, Koffka’s theory of the perception of amodal phenomena is still a form of mediated perception, because it presupposes the intervention of cognitive processes in the organization of the visual information. Therefore, the Gestalt theory of amodal perception is not *direct* in the ecological sense.

begin with, then there can be no memories; hence the problem. Not surprisingly, 
*sensationless* phenomena have occasioned a great deal of neglect in the history of visual 
theory. They create an anomaly for sensation-based theories of perception, and undercut 
the idea that the association of past and present sensations is the basis of perceptual unity. 

The paradoxical nature of amodal perception suffices to show that a simple, one-
to-one correspondence of sensations and percepts, i.e., the constancy hypothesis, rarely 
occurs in living perception.179 However, the puzzle of sensationless perception can be 
resolved if we accept information instead of sensation as the basis of perception. A 
theory of information-based perception can claim that stimulus information is imparted to 
perception by the presence of occluding edges in the ambient optic array and the depth 
specified by them. In these instances of amodal perception, "sensations ... [are] ... 
irrelevant"180 because information is present in the ambient optic array to specify the 
persistence of an occluded surface, even though no sensations of such ever occur. As a 
general rule, then, one might say that the perception of amodal phenomena is independent 
of constituent groupings of sensations. Reed writes, "If even some cases of perceiving 
are sensationless, then perception in general is unlikely to be based on sensations."181 
Gibson would conclude from this that the direct perception of the environment is 
grounded on detecting information and not on having sensations. This information is 

179 The term "constancy hypothesis" was first coined and criticized by the Gestalt psychologists. The term 
has two related meanings. Firstly, it is the idea that individual stimuli are invariably and uniquely related 
with particular individual sensations. Secondly, it is the idea that individual sensations invariably give rise 
to particular individual percepts in the visual field. My thesis focuses on the second meaning of the 
constancy hypothesis. I am contending that Gibson's experimental and theoretical work amply confirms 
that such an invariable connection between individual sensations and individual percepts does not exist. 
Therefore, perception is not indirect in the traditional sense. 
1966, p. 205. 
181 Reed, Edward, *James J. Gibson and the Psychology of Perception*, New Haven, Yale University Press, 
1988, p. 270.
sufficient to explain the persistence of surfaces, even if they are (temporarily) out of
sight.

In summary, Gibson’s description of the information-based theory of perception
diffs from the Cartesian and Berkelean approaches, because it does not define depth-
perception as an inferential procedure whereby the mind represents a three-dimensional
world from a two-dimensional patchwork of sensory points on the stimulated retina.
Instead, Gibson describes the environmental information that is normally available to
perception, which is to say, information that is about and intrinsic to the environment.
Thus, in characterizing the information used to specify the continuation of surfaces in
depth, Gibson does not refer to forms or patterns in two-dimensions. On the contrary, his
theory suggests a “radically new basis for explaining the perception of solid
superimposed objects, a new theory based not on cues or clues or signs but on the direct
pick-up of information.” This is a theory of direct perception because vision is not
mediated by retinal information or the inputs of the optic nerves, nor is it a mental
representation of things “out there,” constructed on the basis of momentary sensory
inputs. Visual perception is the activity of acquiring information from the ambient optic
array via active explorations. For Gibson, the claim that the third dimension of space is
somehow lost in the two-dimensional retinal image is simply false. Depth is not added
to, or derived from the “ghostly scintillations” on the stimulated retina, nor does it need
to be. Depth is intrinsically signified by the visible solid angles in the ambient optic
array and their corresponding perspectival transformations from a moving point of
observation. These optical transformations and the underpinning invariant structures

---

183 Ibid., p. 83.
constitute the information upon which space perception is founded. Such is the conceptual framework of Gibson’s anti-sensationalist, information-based theory of the direct perception of space under the new doctrine of ecological specificity.

Section 4: Direct Perception and the Theory of Affordances

As discussed in section one, what sets Gibson’s theory apart from theories of indirect perception is his rejection of representationalism. Traditionally, representationalism is an “understanding of the place of mind in a world such that our only knowledge of reality comes through the representations we have formed of it within ourselves”¹⁸⁴ (my italics). This gives the impression that perception, like knowledge, is a subjective interpretation of the world outside of thought. Consequently, representational theories analyze perceived depth as though it took place wholly inside the perceiver, in the inferences and associations of the perceivers mind. In contrast, Gibson’s model shows that perceived depth is an ecological property, not a mental property of inner representations. For exactly this reason, Gibson is committed to the idea that perception gives us a veridical encounter with a real environment with depth. Crucially, we do not grasp the spatiality of the environment through representations. Our perceptual grasp is direct and (therefore) unmediated by conceptual schemes.¹⁸⁵

In isolation, this claim may be inadequate because it overlooks what is most distinctive about the ecological approach. Gibson contends that while perceivers entertain a direct apprehension of the physical layout of surfaces in depth, they do not perceive naked properties of the material world, stripped of all significance. Rather, we perceive what the environment affords to our bodies, that is, it shows what we can do

¹⁸⁵ For example, the inferential and associative (mental) frameworks of Descartes and Berkeley.
with and in the environment. What we can do depends on us. Gibson calls these perceived features of the environment, which are there for our acting bodies, affordances. In this final section, I offer a treatment of Gibson's controversial theory of affordances. Thereafter, I will contrast Gibsonian affordances with Cartesian inferences and Berkelean associations, in order to arrive at several conclusions about the nature of perception in general.

Simply put, affordances are the perceived functional properties of objects, places and events in relation to an individual perceiver. By functional properties, Gibson means that affordances specify the acts or behaviors permitted by these objects, places and events in the environment. He writes, "The affordances of the environment are what it offers ... [perceivers] ... what it provides or furnishes, either for good or ill."186 Thus, functional properties set up the possibilities for action in the environment. To cite Harry Heft's example, a surface in the environment may be perceived as "sit-on-able"187 for an individual, if it meets certain criteria dictated by the specificities of this individual's body. For example, the surface must appear supportive of the individual's weight and be positioned approximately knee-high. The more a surface deviates from these criteria, the less it will be perceived as offering the relevant functional property, the affordance of sitting.

In this context, the claim that affordances are environmental properties that vary in relation to the individual perceiver is made clearer. A "feature of the environment," writes Heft, "may present certain affordance possibilities for one individual, but not for

---

another, owing to ... functional properties"¹⁸⁸ of both the individual and the environment. For example, a surface affords locomotion for an individual if and only if the functional properties of this individual are compatible with the functional properties of this sector of the environment.¹⁸⁹ Carello and Michaels comment, while a wall provides the affordance of being walk-on-able for a fly, whose "feet are sufficient to cause an adhesive force to balance the downward force created by the effects of gravity on the animal’s mass,"¹⁹⁰ the ecological relation between a human and the (same) wall does not afford such a balance. Thus, a wall provides the functional property of being walk-on-able for some species but not others. In this regard, Gibson stresses the relational quality of affordances. The ecological relations between the perceiver and the environment constitute the various properties that are inherently significant to an individual perceiver in that context. Simply put, an affordance is the perceptual/behavioral meaning of these ecological relations (for a perceiver). To claim that "a chair affords sitting" or that it is "stand-on-able" says that when an individual perceives a chair, she is directly aware that chairs can be used for the performance of these (and other) actions. Therefore, Gibson’s theory of affordances expresses the tight coupling of perceiving and acting for embodied perceivers.

In *The Ecological Approach*, Gibson offers a conjoint treatment of perceiving and acting. This treatment is necessitated by the idea that perceptions and actions are always performed with reference to the same environment. If perceptions are to be useful they

¹⁸⁹ Carello and Michaels (1981) schematize Gibson’s notion of affordance as follows: “A situation or event X affords action Y for a perceiver Z on occasion O if certain relevant compatibilities between X and Z obtain.” (p. 43) Presumably, these “relevant compatibilities” are the functional properties of environments and individual perceivers.
must be executed in the performance of effective actions on the environment. If actions are to be effective they must be constrained by direct perception.\textsuperscript{191} From this Gibson would conclude that the information that specifies the environment must provide a basis for activity, and activity must provide a means for the performance of direct perception. Hence, the reciprocity of perceiving and acting is the key to understanding the relation between the theory of affordances and the theory of direct perception. To elaborate, I will consider an argument in support of this assertion made by Carello and Michaels. Thereafter, I will describe how the theory of affordances undercuts inferential and associational models of indirect perception.

For Gibson, the primary use of perception is to provide a veridical encounter with a real environment, and to inform perceivers of those aspects of the environment that play a role in the organization of their activities. From the ecological standpoint, “The successful control of activity requires the availability of certain kinds of stimulus information”\textsuperscript{192} in the environment. Thus, in order to cope with the environment in ways that bring about the realization of goals and pursuits, perceivers detect properties in the ambient optic array that permit the relevant behaviors. For instance, consider the relationship between the act of approaching a particular object (i.e., a tree) and its informational support in the ambient optic array. In order to approach the tree, one must act in such a way as to keep that object at the center of the expanding projection in the ambient optic array. The expanding projection “specifies approach, while the rate of expansion specifies the imminence of arrival.”\textsuperscript{193} To avoid collision with the tree the

\textsuperscript{192} Ibid., p. 48.
\textsuperscript{193} Ibid., p. 48.
actor will have to slow down and eventually stop her gait when the tree is projected to a one-hundred and eighty degree visual angle in the ambient optic array.

This example shows the reciprocity of perception and action, and reinforces the claim that activities require an informational support wherein the ambient optic array permits the guidance of activity. As the perceiver moves, her actions open up new possibilities for the detection of information. This information can then be used to guide subsequent movements as in a perception-action loop. On this account, the perceptual control of action is not a one-way street from individual sensations to motor responses. Perception directs actions in the environment. These, in turn, generate a flow of perspective transformations and enable the detection of invariants in ecological information. Affordances are those invariant properties in the ambient optic array that specify the meaningful dimensions of interaction the perceiver has with the environment. Hence, what individuals directly perceive are the affordances of events (i.e., the possibilities for meaningful action), rather than their intrinsic physical compositions.

As Carello and Michaels point out, "This is the innovation of affordances. That chairs afford sitting and cliffs afford avoiding is news to no one; but for Gibson, it is the affordance that is perceived." We directly perceive what actions can be entered into with respect to the environment vis-à-vis affordances. Hence, affordances are items of our immediate visual experiences. This is a particularly striking aspect of Gibson's theory. On traditional accounts, meaning is considered to be a function of abstract

---

194 As it is in Descartes's theory, which states that the senses are mechanisms for passively receiving external stimuli which actuate reflex-based motor responses in the body.
thought, and therefore, as fundamentally distinct from the information perceived. The concept of the affordance is different, insofar as it suggests that meaning is a distinctive feature of (direct) perceptual experience and the environment. But meaning is a vague term. It is crucial to distinguish between the *perceptual meaning* of affordances and the *conceptual meaning* associated with philosophical and scientific concepts.197 This distinction is introduced by Heft in an attempt to clarify Gibson’s position. Affordances are a part of the flow of perceptual experience, and are specified by ecological information generated by an active perceiver. By contrast, concepts are abstractions from the flow of perceptual experience. They are the result of second-order, cognitive processes. This is another way of saying that “affordances are *directly* perceived,” whereas “concepts are derived and categorical.”198 Categorization is not a necessary precondition for the direct perception of affordances. Categorical thinking is abstracted from direct perceptual experience; it is a way of conceptualizing it and creating concepts that are ultimately derived from it. As Gibson puts it, “You do not have to classify and label things in order to perceive what they afford.”199

From Gibson’s point of view, inferential and associative accounts make exactly this kind of mistake. They confuse perceptual with conceptual meaning by making the former a species of the latter. This is an example of what I have called the experience error.200 In this instance, the experience error is the fallacy of transforming the information for perception (the perceptual meaning which refers to the environment as it

198 Ibid., p. 128.
200 Chapter One, Section Three
figures for an individual perceiver that interacts with it) into ideational contents organized through a conceptual framework in the mind. Theories of indirect perception presuppose the existence of these cognitive processes, which supposedly have the function of structuring meaningful, perceptual experience from meaningless sensations via concepts. Importantly, the concepts are fixed in advance of the perceptual experiences they give rise to. As a result, the perceptual meanings of these experiences always refer back to the concepts qua organizational.

To put it differently, theories of indirect perception assume that “bits of sensation are interchangeable, determinate independent of their context, atomic.”^201 Only perceptions can be called meaningful. However, because they also assume that perceptions are derived from sensations, just as conclusions are derived from premises, theories of indirect perception wrongly suppose that the constitution of perceptual meaning is a two-stage process of (1) acquiring neutral sensations and (2) accruing perceptual meanings to sensations vis-à-vis concepts. In Chapters One and Two, I characterized these conceptual models as inferential and associational, respectively. In both cases, the constitution of perceptual meaning is an event that occurs wholly inside the perceiver’s mind.

The theory of affordances criticizes these representational theories of perceptual meaning, which appeal to conceptual frameworks fixed in advance of the perceiver’s moving, ecological relation to the environment. In Gibson’s estimation, theories that root perception in the a priori or the a posteriori, in deductive or inductive systems established in advance of acts of perception, are pitched at the wrong level. Perceptual meaning does not transcend the environment. Rather, perception is the detection of

invariants in the flow of stimulus information generated when the perceiver moves. Such invariants specify reciprocal information about the perceiver and the environment, without any necessary appeal to organizational concepts. In this respect, the information for perceiving affordances is already present in the visual stimuli; their possibilities are ordered into the structure of the stimulus array as such. Hence, to perceive an aperture in a surface is to perceive the (possible) functional opportunity of passing through it. To perceive that a surface is level and solid is to perceive that it is "walk-on-able"\(^{202}\) and so forth.

For Gibson, the same logic applies to the spatial properties of the environment. The ecological relation between the perceiver and the environment constitutes the environment as having spatial dimensions that are inherently significant. Contra Descartes, then, the organism never deals in objective measurements, which can only afford further measurements. Rather, the organism deals in "strides, striking distances and safe removes."\(^{203}\) The child, frightened by a storm, does not measure the small space beneath coffee table, before taking shelter. Rather, she perceives the affordance of a safe hiding place. On the other hand, the same space does not afford hiding activities for a full grown adult (save for contortionists). Thus, the theory of affordances contains a developmental aspect, as well. Affordances are not fixed in advance of perception. Rather, they vary in relation to the individual perceiver.\(^{204}\)

Accordingly, the available information for perceiving the separation of surfaces in depth, or surface layout, is the same information for the perception of what it affords. In


\(^{204}\) For instance, to the toddler a rigid, vertical surface (i.e., a wall) mainly affords collision, whereas the same wall (if appropriately textured) may afford climbing for an adult.
the ecological approach to vision, observers do not begin by perceiving a layout of neutral surfaces in depth. Affordances are not added to the perception of surface layout, as though they were mental contributions made by a perceiving subject. Thus, we no longer have to assume that there is (1) a sensation-based perception of a thing's shape, size, relative distance-from-here, etc. and then (2) the accrual of meaning to the immediately perceived sensation. The information for the former is inextricable from the latter, and they are detected in exactly the same fashion. Therefore, Gibson's ecological approach surpasses the traditional theories of Descartes and Berkeley. In the specific context of space perception, traditional accounts typically analyze depth as if it took place wholly inside the perceivers' mind. However, for Gibson, it takes place between the perceiver and the environment. Depth perception is perception of the perceiver's relation to the environment, and that relation involves life and movement. It is neither on the side of the perceiver (subjective), nor on the side of the environment (objective). It crosses between them, and is, therefore, pregnant with its own meaning.\footnote{Merleau-Ponty, Maurice, \textit{The Visible and the Invisible}, Trans. Alphonso Lingis, Illinois. Northwestern University Press, 1965, pp. 132-133.} Gibson's theory of affordances expresses this very fact.
Conclusion

The accepted view of perception is still that the percept is never completely determined by the physical stimulus. Instead, the percept is something essentially subjective in that it depends on some contribution made by the observer himself. Perception goes beyond the stimuli and is superimposed on sensations.²⁰⁶

At the outset of this thesis, the question was posed as to what constitutes the *immediate* objects of awareness in visual experience. In the preceding chapters, I have outlined three attempts to answer this question. I characterized the first two as *indirect* theories of perception. These theories claim that *sensations* are immediately perceived and are then used as the raw material for *perceptions*. Descartes and Berkeley propose alternative mental operations, whereby the mind constructs the visible world from out of the (immediately apprehended) sensory inputs. However, I have rejected these mentalistic doctrines in place of a third option, which I have characterized as a Gibsonian theory of *direct* perception. I will now consider them in sequence.

In Chapter One, I described Descartes's *inferential* approach to visual perception. For Descartes, an inference is an unconscious, intellectual operation that deduces one order of information from another, using *a priori* principles. In the visual perception of objects in space, Descartes claims that the relevant information is inferred mathematically. This is part and parcel of Descartes's physiological model, wherein vision is mediated by the retinal inputs and the inputs of the optic nerves. This presents an obvious problem. If the pattern of light stimuli projected on to the retina specifies a merely two-dimensional collection of data, then how do observers perceive the three-dimensional world? It would seem that the stimulus radically underdetermines the perceptual experience. To solve this problem, Descartes integrates perspective geometry

into the visual processes. He urges that, given a direct sensory awareness of the measured distance between the two eyes (which the mind immediately apprehends, using ocular sensations as cues), the mind can infer the distance of an object in space by “locating it on strait lines that we can imagine to be drawn” by that inferential process. This process amounts to following the path of light rays from the eye to the object.

Distance perception is a simple triangulation based on the same operation. Given a direct perception of the distance along the baseline of the two eyes and the vergence angle, the mind can infer, “as if by a natural geometry,” the distance between the object and the baseline.

Descartes’s answer to the question, “what is immediately perceived?” appeals to a kind of representationalism. Given direct access to sensory information, the mind is able to reconstruct an internal model of the environment through a series of inferential processes. These processes are, in turn, responsible for the representation of the three-dimensional, visual world as perceived in thought. Descartes posits a separation between (what Morris calls) thought-space and world-space, wherein thought comes to represent to itself world-space. I have argued that this is precisely why Descartes’s theory of distance perception is indirect.

In Chapter Two, I described Berkeley’s rebuttal to the geometrical approach to visual perception. While Berkeley agrees with Descartes that the objects of immediate perception (i.e., sensations) are non-spatial, he argues that perspective geometry, which results from perception, is hardly the appropriate framework in which to analyze the perception of distance. The reason for this is, “when the mind perceives any idea not


208 Ibid., p. 105.
immediately and of itself, it must be by means of some other idea\footnote{Berkeley, George, An Essay Toward a New Theory of Vision, USA, The Bobbs-Merrill Company, 1963, sec. 9.} of which the mind is immediately aware. This is Berkeley’s principle of principles in the *NTV*. Whatever leads me to form a particular judgment on any occasion, it must be something of which, on that occasion, perceivers are conscious. It is evident that lines and angles are not amongst the items of perceivers’ immediate awareness, since perceivers do not see lines and angles running out from their eyes, converging upon an object in space. While perspective geometry is a useful theoretical device for measuring distances, metric information plays little or no role in judging them by naked vision alone. As Warnock points out, the contour lines on a map are useful devices for the science of cartography, but they are useless in helping us to judge the height and distance of hills by sight. Therefore, the appeal to geometry cannot be invoked to explain the experience of perceiving distance.

While Berkeley considered distance perception to be an essentially subjective operation of the mind, something superimposed on sensations, he resisted the temptation to reduce it to an innate idea. Berkeley proposed a model of distance perception whereby the mind learns to associate visual sensations with ideas of distance. In accordance with the principle of principles, Berkeley replaced the geometrical cues of Descartes with empirical cues; that is to say, cues that are “effectively available to the visual system.”\footnote{Atherton, Margaret, Berkeley’s Revolution in Vision, New York, Cornell University Press, 1990, p. 83.} Berkeley singled out three. First, he points to the muscular sensations that accompany the movements of the eyes. The eyes rotate inward for near objects and outward for distant objects (to a parallel limit). These rotations produce a collection of sensations, of which the mind is immediately aware. Secondly, Berkeley uses the focus of the object in...
the visual field as a cue for determining distance – a more confused appearance being correlated with a closer proximity. The third cue, which is really an extension of the second, is the ocular strain experienced when the observer strives to keep the approaching or receding object in focus. Different kinds of strain generally correspond to different extents of perceived distance. These are Berkeley’s primary cues. What is significant is that these cues do not require a geometrical interpretation, for “if eye turning or confused vision are represented at all, they are represented as such, as eye turnings or confused vision, and not as lines and angles.” Thus, while the geometrical cues and methods of estimating distance are abstract and theoretical, Berkeley’s are concrete and perceptual. They draw on the resources of experience itself.

As Berkeley saw it, the most important difference between his list of cues and those of the geometrical opticians is that

Whereas there is a necessary connection between the angle our eyes make at the object, or the divergency of rays of light falling on the pupil, and the distance of the object, in the case of sensations in the muscles in the eye, or the seeing of a thing confusedly, there is only a contingent connection between these phenomena and the distance of the object seen. In other words, the connection between the cues for distance and the actual distance of the object in space has to be discovered a posteriori, “in the same way we discover that smoke is a sign of fire.” This is why Berkeley is hesitant to describe the procedure, whereby the mind derives distance perceptions from sensations, as inferential. Cartesian inferences are based on deductive principles, which enable the visual system to calculate a percept from the immediate sensory data. Berkelean associations involve a mental

---

213 Ibid., p. 19.
synthesis of past and present experiences, whereby perceivers develop the habit of associating one order of sensory information with another. Since Berkeley thought that visual experience lacked inherent spatiality, and that distance was registered only by the sense of touch, he hypothesized that optical information acted as a cue for tangible consequences in the environment. For Berkeley, vision is essentially a guide to movement and touch. Gibson makes a similar claim, although he rejects the representational underpinnings of Berkeley’s theory.

In Chapter Three, I proposed Gibson’s theory of direct perception as an alternative to the sensation-based theories of perception. In opposition to his predecessors, Gibson argues that perception is a non-inferential (i.e., unmediated) awareness of things in the surrounding environment. Perceptions are not mental composites of discrete sensations, nor do sensations mediate perceptions. Instead, perception is a form of direct access to the world. It is a process of detecting information. Since the environment itself is the sole repository of perceptual information, perception does not require an inference or intermediary to bridge the gap between the perceiver and the perceived environment. They are in direct contact with each other. There is no separation between them.

Like Berkeley, Gibson emphasizes “the pragmatic significance of vision.”

Observers see the world in order to get around and to look at things in it. Hence, the purpose of vision “is not to provide experiences having distinct phenomenal visual qualities,” but rather, to “provide knowledge about the environment.” As Schwartz explains, this is a point of agreement between Berkeley and Gibson. In the NTV, visual

---

Ibid., p. 126.
perception is primarily a device for tracking reality, which Berkeley characterizes in terms of the permanent tangible world. Visual phenomena act as cues for tangible phenomena, which provide stability to our approximations of the spatial layout of the environment. For instance, tangible ideas of size remain invariably the same, despite their position in space relative to a point of observation. However, this is untrue of the fluctuating visual experiences of size. An immediately perceived visual object seems to vary in height and width, depending on the distance and orientation of the perceiver.

According to Berkeley, perceivers learn to associate the visual and the tangible over time and with experience. For Berkeley, tangible experiences are (pragmatically) the most important, because they play a central role in the organization of our activities and the preservation of our bodies. Berkeley writes that:

> For this end the visive sense seems to have been bestowed on animals, to wit, that by the perception of visible ideas ... they may be able to forsee the damage or benefit which is like to ensue upon the application of their own bodies to this or that body which is at a distance; which foresight how necessary it is to the preservation of the animal, everyone's experience can inform him.\(^\text{216}\)

In the *Ecological Approach*, Gibson echoes Berkeley's contention that the theory of vision ought to address its pragmatic significance, more so than merely providing an exact description of the fluctuating phenomenal aspects of the visual field. Gibson describes vision as a "keeping-in-touch with the world, an experience of things rather than a having of experiences."\(^\text{217}\) Thus, while Gibson agrees with Berkeley that vision is a guide to behavior in the world, he denies that the visual perception of the world

---


depends upon intermediate stages of cognitive activity. Perceiving is not a matter associating modally distinct groupings of sensations (i.e., visual sensations with tangible sensations). The output of the visual system is non-cognitive in nature, which is to say, it is not constructed or inferred on the basis of ratiocination. Rather, perception is a matter of detecting information intrinsic to the visible world. While it is true that sensations often accompany the detection of information, the "inflow of information does not coincide with the inflow of sensation; they are at least semi-independent."^{218}

This seemingly paradoxical notion that sensations are not basic to perceptions becomes intelligible, only when the senses are considered as perceptual systems. To this end, Gibson offers the following prospectus: "We shall have to conceive the external senses in a new way, as active rather than passive, as systems rather than channels, and as interrelated rather than mutually exclusive."^{219} Thus, unlike the traditional notion of the senses as distinct, passive channels for sensations, the perceptual systems actively search out information in the environment, by paying attention to whatever is constant in the changing stimulation. They are "ways of seeking and extracting information about the environment from the flowing array of ambient energy."^{220} Ambient light, as I have characterized it, pervades the entire visible environment and surrounds every point of observation. Perception is, therefore, a matter of picking up on this omni-directional flux of light, which acquires its structure from the persisting and changing features of the environmental layout. Only insofar as ambient light has structure does it specify the diverse features of the environment. To serve as information, it is a necessary

---

^{219} Ibid., p. 47.
^{220} Ibid., p. 5.
precondition that "the light at the point of observation has to be different in different
directions...or there have to be differences in different directions...in order for it to
contain any information."\textsuperscript{221} These differences are "principally differences in
intensity"\textsuperscript{222} produced by the microstructures of the surfaces from which they are
reflected. Over the course of evolution, visual systems were specified for the purpose of
picking up on these differences.

According to Gibson, "when ambient light at a point of observation is structured it
is an ambient \textit{optic array}\textsuperscript{223} (my italics). It constitutes the stimulus information for
vision. Gibson describes the ambient optic array in terms of visual solid angles, which
converge to every point of observation. These are the angles of intercept, which are
primarily determined by the geometrical layout of the persisting environment. As the
point of observation moves, the solid angles of the array (projected to the moving point of
observation) begin to move as well. Gibson calls the optical laws governing these
changes the \textit{perspective structure} of the ambient optic array. Underlying the perspective
structure is an \textit{invariant structure} that does not change. For instance, as the observer
walks around the rectangular table top, and the visual solid angles projected to the
moving point of observation flow through transformations, the invariant relations among
the four angles of the tabletop are revealed. Thus, the invariant structure of the array is
detected by the visual system, only when the observer is permitted to move and the
perspective structure starts to \textit{flow} (and when such information is relevant to the visual
system).

\textsuperscript{221} Gibson, James J., \textit{The Ecological Approach to Visual Perception}, New Jersey. Lawrence Erlbaum
\textsuperscript{222} Ibid., p. 51.
\textsuperscript{223} Ibid., p. 92.
In Gibson’s doctrine of ecological specificity, the concept of the structured ambient optic array as stimulus information for perception is intended to replace the older sensation-based theories, which commence with the two-dimensional patchwork of points on the retina. In making the transition from retinal information to the ambient optic array, Gibson extricates the theory of vision from the extreme subjectivism of Descartes and Berkeley. In Gibson’s model, the information for the separation of surfaces in depth is already specified in the structure of the ambient optic array (when considered from a moving point of view). Hence, perceiving depth is not a mental addition to a depthless manifold. By enriching the concept of the stimulus so as to include the entire array, Gibson avoids the difficulty of reconstructing a continuous three-dimensional world from a fleeting, two-dimensional array of sensory points on the retina (the one-point argument).

For Gibson, distance is not a line directed endwise toward the eye, which projects only one point on the retina. This is precisely why Descartes and Berkeley considered the perception of distance to be indirect. However, when distance is considered as “extending along the ground instead of through the air ... then it is not invisible.” Rather, “it is projected as a gradient of the decreasing optical size and increasing optical density”\[^{224}\] of the features of surfaces, mapped directly into the ambient optic array. Gibson argues that living perception does not occur in abstract geometrical space. It occurs in the living space of the environment, composed of textured and adjoining surfaces. Thus, the one-point argument confuses “the Z-axis of a Cartesian coordinate

system with the number of paces along the ground to a fixed object." Perception is not a mental reconfiguration of an array of discrete points on the retina. It is a matter of detecting sequential transformations and invariants in the changing, ambient optic array. Therefore, perception of the spatial properties of the environment is a one-stage process of detecting information, not a "two-stage process of first perceiving flat forms [on the retina] and then interpreting the cues for depth." For Gibson, two-dimensional form perception is not basic. What is basic is the manner in which the structure of the ambient optic array specifies aspects of the real, physical environment – in this case, the spatial layout of adjoining surfaces (and the affordances which present themselves).

Of course, on Gibson's account, perceivers do not begin by detecting a layout of neutral surfaces in depth to which meanings are subsequently attached. According to Gibson, we directly perceive the affordance properties of spaces and three-dimensional objects in the environment. Thus, the environment to be perceived is not the naked, physical environment (which Descartes sought to describe solely in geometrical terms). It is the natural habitat of perceivers, that is, this is the environment to and in which their perceptual systems have evolved in order to support the perceiving and utilizing of the affordances of that environment. For exactly this reason, I argued (in Chapter Three, section three) that the information for perceiving the spatial properties of the environment already is the information for perceiving what the environment affords (and vice versa). Thus, for Gibson, affordances are among the items of our immediate or direct perception.

If the theory of affordances is successful, if it has explanatory power, it is because it surpasses the conceptual dialectic of traditional accounts and places perception on an

---

226 Ibid., p. 150.
entirely new footing. On Gibson’s theory, visual perception is not a one-way street from retinal stimulation and the production of sensory cues to perceptual representations in the mind. This kind of model presupposes the existence of an inferential or associative process, which mediates between sensations and perceptions. I have called this indirect perception. The theory of affordances is Gibson’s definitive attempt to tip the scale toward direct perception. It is supposed to prove that meaningful perception is not a subjective, mental event. Rather, meaningful perception is informed by the perceiver’s bodily interaction with the environment. Affordances are higher order, relational properties of environmental information and are directly perceived on the basis of that information. As objects of direct perception, affordances emerge within and reflect perceptual activity. In this way, Gibson’s theory of affordances provides both a positive account for overcoming representationalism in visual theory, and a negative account, or sustained attack, on the doctrine of atomic sensation and the use of perceptual inferences and associations as explanatory concepts in visual theory. By making perception direct, Gibson effectively renders these concepts unnecessary. Such is the basis of a Gibsonian transition from inference to affordance.
Bibliography


