VI

VISUAL SPACE

Vision was the last of the senses to evolve and is by far the most complex. Much more data are fed to the nervous systems through the eyes and at a much greater rate than through touch or hearing. The information gathered by a blind man outdoors is limited to a circle with a radius of twenty to one hundred feet. With sight, he could see the stars. The talented blind are limited to an average *maximum* speed of two to three miles an hour over familiar territory. With sight, man has to fly faster than sound before he begins to need aids to avoid bumping into things. (At a little over MACH 1, pilots have to know about other planes before they can be seen. If two planes are on a collision course at these speeds, there is no time to get out of the way.)

In man the eyes perform many functions; they enable him to:

1. Identify foods, friends, and the physical state of many materials at a distance.
2. Navigate in every conceivable terrain, avoiding obstacles and danger.
3. Make tools, groom himself and others, assess displays, and gather information as to the emotional state of others.

The eyes are usually considered to be the principal means by which man gathers information. However important their function as "information gatherers," we should not overlook their usefulness in conveying information. For example, a look can punish, encourage, or establish dominance. The size of the pupils can indicate interest or distaste.

VISION AS SYNTHESIS

A keystone in the arch of human understanding is the recognition that man at certain critical points synthesizes experience. Another way of stating this is that man learns while he sees and what he learns influences what he sees. This makes for great adaptability in man and enables him to exploit past experience. If man did not learn as a result of seeing, camouflage, for example, would always be effective and man would be defenseless against well-camouflaged organisms. His capacity to penetrate camouflage demonstrates that he alters perception as a result of learning.

In any discussion of vision it is necessary to distinguish between the retinal image and what man perceives. The talented Cornell psychologist James Gibson, to whom I will repeatedly refer in the course of this chapter, has technically labeled the former the "visual field" and the latter the "visual world." The visual field is made up of constantly shifting light patterns—recorded by the retina—which man uses to construct his visual world. The fact that man differentiates (without knowing that he does so) between the sense impressions that stimulate the retina and what he sees suggests that sensory data from other sources are used to correct the visual field. For a detailed description of the basic distinctions between the visual field and the visual world, the reader is referred to Gibson's basic work, *The Perception of the Visual World.*

As he moves through space, man depends on the messages received from his body to stabilize his visual world. Without such body feedback, a great many people lose contact with reality and hallucinate. The importance of being able to integrate visual and kinesthetic experience has been demonstrated by two psychologists, Held and Heim, when they carried kittens through a maze along the same track on which other kittens were allowed to walk. The kittens that were carried failed to develop "normal visual spatial capacities." They did not learn the mazes nearly as well as the other kittens. Kinesthesia as a corrective to vision was experimentally demonstrated time and again by the late Adelbert Ames and

the other transactional psychologists. Subjects viewing a distorted room which looked rectangular were given a stick and told to hit a point near a window. They invariably would miss the mark on the first few tries. As they gradually learned to correct their aim and were able to hit the target with the tip of the stick, they saw the room not as a cube but in its truly distorted shape. A different, more individual example would be the mountain that never looks the same once it has been climbed by the viewer.

Many of the ideas presented here are not new. Two hundred and fifty years ago Bishop Berkeley laid some of the conceptual foundations of modern theories of vision. Even though many of Berkeley's theories were rejected by his contemporaries, they were indeed remarkable, particularly in view of the general state of science at the time. Berkeley argued that man actually judges distance as a consequence of the interrelation of the senses with each other and with past experience. He held that we do not "immediately perceive by sight anything besides light and colors and figures; or by hearing anything but sounds." A parallel is drawn with hearing the sound of an unseen coach. According to Berkeley, one does not, strictly speaking, "hear the coach"; one hears sounds that have become associated in the mind with coaches. Man's ability to "fill in" visual details based on auditory cues is exploited in the theater by the sound effects man. In the same sense, Berkeley denies that distance is immediately seen. Words like "high," "low," "left," and "right" get their primary application from kinesthetic and tactile experience.

> . . . Suppose I perceive by sight the faint and obscure idea of something which I doubt whether it be a man, or a tree, or a tower, but judge it to be at the distance of about a mile. It is plain I cannot mean that what I see is a mile off, or that it is an image or likeness of anything which is a mile off, since that every step I take towards it the appearance alters, and from being obscure, small, and faint, grows large, clear and vigorous. And when I come to the mile's end, that which I saw first is quite lost, neither do I find anything in the likeness of it.

Berkeley was describing the highly self-conscious visual field of the scientist and the artist. Those who criticized were

basing their judgments on their own culturally patterned "visual worlds." Like Berkeley, only much later, Piaget stressed the relationship of the body to vision and stated that "spatial concepts are internalized action." However, as the psychologist James Gibson has pointed out, there is an interplay between vision and body knowledge (kinesthesia) that was not recognized by Berkeley. There are purely visual cues to the perception of space such as the fact that the visual field expands as you move toward something and contracts as you move away from it. One of Gibson's great contributions lies in making the point explicit.

The need to know more about the basic processes that underlie man's "subjective" experiences has recently been recognized by scientists in widely divergent fields. What has been discovered about the sensory inputs demonstrates that they could not produce the effects that they do in the absence of synthesis at higher levels in the brain. Paradoxically, a door, a house, or a table is always seen as being the same shape and color despite great changes in the angle from which it is perceived. As soon as the eye movement is examined, it is revealed that the image cast on the retina can never be the same because the eye is in constant motion. Once this is recognized it becomes essential to discover the process that enables man to see as stationary that which is recorded on the retina as constantly moving. This feat, accomplished by synthesis within the brain, is duplicated when man listens to people talking.

Linguists tell us that when the details of speech sounds are analyzed and recorded with great consistency and accuracy, it is often difficult to demonstrate clear-cut distinctions between some of the individual sounds. It is a common experience for travelers who land on a foreign shore to discover that they cannot understand a language they learned at home. The people of the country don't sound like their tutor! This can be very disconcerting. Anyone who finds himself in the midst of people speaking a totally unfamiliar language knows that at first he hears an undifferentiated blur of sounds. Only later do the first crude outlines of a pattern begin to emerge. Yet once he has learned the language well, he is synthesizing so successfully that he can interpret an extraordinarily wide range

of events. Much that would otherwise have been unintelligible gibberish is now understood.

The theory that talking and understanding is a synthetic process is easier to accept than the idea that vision is synthesized, because we are less aware of actively seeing than we are of talking. No one thinks he has to learn how to "see." Yet if this idea is accepted, many more things are explainable than is possible under the older, more widespread notion that a stable, uniform "reality" is recorded on a passive visual receptor system, so that what is seen is the same for all men and therefore can be used as a universal reference point.

The concept that no two people see exactly the same thing when actively using their eyes in a natural situation is shocking to some people because it implies that not all men relate to the world around them in the same way. Without recognition of these differences, however, the process of translating from one perceptual world to another cannot take place. The distance between the perceptual worlds of two people of the same culture is certainly less than that between two people of different cultures, but it can still present problems. As a young man, I spent several summers with students making archaeological surveys in the high deserts of northern Arizona and southern Utah. Everyone on these expeditions was highly motivated to find stone artifacts, arrowheads in particular. We marched along in single file with the typical head-down, ground-scanning gaze of an archaeological field party. In spite of their high motivation, my students would repeatedly walk right over arrowheads lying on top of the ground. Much to their chagrin, I would lean down to pick up what they had not seen simply because I had learned to "attend" some things and to ignore others. I had been doing it longer and knew what to look for, yet I could not identify the cues that made the image of the arrowhead stand out so clearly.

I may be able to spot arrowheads on the desert but a refrigerator is a jungle in which I am easily lost. My wife, however, will unerringly point out that the cheese or the leftover roast is hiding right in front of my eyes. Hundreds of such experiences convince me that men and women often inhabit quite different visual worlds. These are differences which cannot be attributed to variations in visual acuity. Men and

women simply have learned to use their eyes in very different ways.

Significant evidence that people brought up in different cultures live in different perceptual worlds is to be found in their manner of orienting themselves in space, how they get around and move from one place to the next. In Beirut, I once had the experience of having come within a short distance of a building I was looking for. An Arab from whom I asked directions told me where the building was and gestured in the general direction I should go. I could tell by his behavior that he thought he was indicating where the building was, yet I couldn't for the life of me tell which building he was referring to or even which of three streets it was on, all visible from where we were standing. Obviously, we were using two entirely different systems of orientation.

THE SEEING MECHANISM

How there can be such great differences in the visual worlds of two people becomes clearer if it is known that the retina (the light-sensitive part of the eye) is composed of at least three different parts or areas: the fovea, the macula, and the region where peripheral vision occurs. Each area performs different visual functions, enabling man to see in three very different ways. Because the three different types of vision are simultaneous and blend into each other, they are not normally differentiated. The fovea is a small circular pit in the center of the retina containing roughly 25,000 closely packed color-sensitive cones, each with its own nerve fiber. The fovea contains cells at the unbelievable concentration of 160,000 cells per square millimeter (an area the size of the head of a pin). The fovea enables the average person to see most sharply a small circle ranging in size from 1/96 of an inch to 1/4 of an inch (estimates differ) at a distance of twelve inches from the eye. The fovea, also found in birds and the anthropoid apes, is a recent development in evolution. In the apes, its function appears to be associated with two activities, grooming and sharp distance vision required by tree life. In man, needle-threading, removal of splinters, and engraving

are some of the many activities made possible by foveal vision. Without it there would be no machine tools, microscopes, or telescopes. In short, no science and no technology!

A simple demonstration illustrates the tiny size of the area covered by the fovea. Pick up any sharp, bright object, such as a needle, and hold it steady at arm's length. At the same time, pick up a similar pointed object in the free hand and slowly move it toward the first object until both points are in a single area of clearest vision and can be seen clearly *without shifting the eyes at all.* The two points have to be virtually overlapping before they can be seen that clearly. The most difficult part is to avoid shifting the eyes away from the stationary point toward the moving point.

Surrounding the fovea is the macula, an oval, yellow body of color-sensitive cells. It covers a visual angle of 3 degrees in the vertical plane and 12 to 15 degrees in the horizontal plane. Macular vision is quite clear, but not as clear and sharp as foveal vision because the cells are not as closely packed as they are in the fovea. Among other things man uses the macula for reading.

The man who detects movement out of the corner of his eye is seeing peripherally. Moving away from the central portion of the retina, the character and quality of vision change radically. The ability to see color diminishes as the color-sensitive cones become more scattered. Fine vision associated with closely packed receptor cells (cones), each with its own neuron, shifts to very coarse vision in which perception of movement is enhanced. Connecting two hundred or more rods to a single neuron has the effect of amplifying the perception of motion while reducing detail. Peripheral vision is expressed in terms of an angle, approximately 90 degrees, on each side of a line extending through the middle of the skull. Both the visual angle and the capacity to detect motion can be demonstrated if the reader will perform the following experiment. Make two fists with the index fingers extended. Move them to a point adjacent to, but slightly behind, the ears. Looking straight ahead, wiggle the fingers and slowly advance both hands until motion is detected. Thus even though man sees less than a one-degree circle sharply, the eyes move so rapidly as they dart around painting in the details of the visual world

that one is left with the impression of a much wider clear area than is actually present in the visual field. The fact that attention is focused on foveal and macular vision in coordinated shifts also maintains the illusion of broad-band clear vision.

Let us use a limited setting to illustrate the types of information one receives from the different areas of the retina. American convention prohibits staring at others. However, a man with normal vision, sitting in a restaurant twelve to fifteen feet from a table where other people are seated, can see the following out of the corner of his eye. He can tell that the table is occupied and possibly count the people present, particularly if there is some movement. At an angle of 45 degrees he can tell the color of a woman's hair as well as the color of her clothing, though he cannot identify the material. He can tell whether the woman is looking at and and talking to her partner but not whether she has a ring on her finger. He can pick up the gross movements of her escort, but he can't see the watch on his wrist. He can tell the sex of a person, his body build, and his age in very general terms but not whether he knows him or not.

The structure of the eye has many implications for the design of space. These have not to my knowledge been determined or reduced to a set of principles. A few can be suggested, however, with the understanding that design based on knowledge of the structure and function of the eye is only in its infancy. For example, movement is exaggerated at the periphery of the eye. Straight edges and alternate black and white bands are particularly noticeable. This means that the closer the walls of any tunnel or hallway, the more apparent the movement. In the same way, trees or regularly spaced pillars will exaggerate the sense of movement. This feature of the eye causes drivers in countries like France to slow down when they enter a tree-lined road from an open highway. To increase the speed of motorists in tunnels, it is necessary to reduce the number of visual impacts that flash by at eye level. In restaurants, libraries, and public places, cutting down on movement in the peripheral field should reduce the sense of crowding somewhat, whereas maximizing peripheral stimulation should build up a sense of crowding.

STEREOSCOPIC VISION

The reader may have wondered why nothing has been said so far about stereoscopic vision. After all, isn't the sense of visual distance or space due to the fact that man has stereoscopic vision? The answer is yes and no; yes, only under certain very limited conditions. One-eyed people can see in depth very well. Their greatest liability is impaired peripheral vision on their blind side. Anyone who has ever looked in a stereoscope can sense in a minute its limitations and at the same time know the narrowness of any scientific explanation of depth perception based solely on this feature of human vision. Usually, within a few seconds of looking into a stereoscope, there is a strong urge to move the head, to change the view and to see the foreground move while the background stands still. The very fact that the view is stereoscopic emphasizes that it is also fixed and stationary, an illusion.

Gibson, in his book *The Perception of the Visual World*, provides welcome perspective on the conventional view that depth perception is primarily a function of the stereoscopic effect produced by two overlapping visual fields.

> It has been commonly believed for many years that the *only* important basis for depth perception in the visual world is the stereoscopic effect of binocular vision. This is a widely accepted opinion in the medical and physiological study of vision, opthalmology. It is the belief of photographers, artists, motion picture researchers, and visual educators who assume that a scene can be presented in true depth only with the aid of stereoscopic techniques, and of writers and authorities on aviation who assume that the only kind of test for depth perception which a flier needs to pass is a test of his stereoscopic acuity. This belief is based on the theory of the intrinsic cues for depth, which is rooted in the assumption that there exists a class of experiences called innate sensations. With the increasing tendency to question this assumption in modern psychology, the belief is left without much foundation. *Depth, we have argued, is not built up out of*

sensations but is simply one of the dimensions of visual experience. (Italics mine.)

It is not essential to dwell longer on this point. Putting something in its place will broaden our view somewhat and add to the understanding of the extraordinary processes that man uses in his perception of the visual world. While it is well to recognize that stereoscopic vision is a factor in depth perception at close distance (sixteen feet or less), there are a great many other ways in which man builds an image of the world in depth. Gibson has done much to isolate and identify the elements that go to make up the three-dimensional visual world. His studies date back to World War II when pilots found that in a crisis, having to translate from instrument panel needle readings to a moving three-dimensional world was too time-consuming and could be fatal. Gibson was given the task of developing instruments that would produce an artificial visual world, replicating the real world so that aviators could fly along electronic highways in the sky. Investigating man's various systems of depth perception as he moves through space, Gibson identified not one or two but thirteen! Because the subject is somewhat complex, the reader is referred to the original work, summarized in the Appendix, which should be required reading for all students of architecture and city planning.

It is clear from Gibson's work and from the extensive studies by the transactional psychologists that the visual sense of distance goes far beyond the so-called laws of linear perspective of the Renaissance. An understanding of the many different forms of perspective makes it possible for us to understand what artists have been trying to tell us for the past hundred years. Everything that is known of man's art in all of his various past cultures indicates that there are great differences that transcend mere stylistic convention. In America linear perspective is still the most popular art style for the general public. Chinese and Japanese artists, on the other hand, symbolize depth in quite a different way. Oriental art shifts the viewing point while maintaining the scene as constant. Much of Western art does just the opposite. In fact, a most significant difference between the East and the West although it is reflected in the art far transcends the field of art. Space itself is perceived entirely differently. In the West, man perceives the objects but not the spaces between. In Japan, the spaces are perceived, named, and revered as the *ma*, or intervening interval.

Chapters VII and VIII will examine art and literature as keys to people's perceptual worlds. Only on rare occasions do the worlds of art and science merge. This happened during the Renaissance and again in the late nineteenth and early twentieth centuries when the French Impressionists studied the physics of light. We may now be approaching such a period again. Contrary to popular belief among many experimentally inclined psychologists and sociologists, the productions of artists and writers represent rich, unmined beds of hard data on how man perceives. To be able to distill and identify the essential variables of experience is the essence of the artist's craft.

VII

ART AS A CLUE TO PERCEPTION

The Painter's Eye, a remarkable little book by the American artist Maurice Grosser, affords one of those rare opportunities to learn from the artist himself just how he "sees" his subject and uses his medium to convey this perception.

Of particular interest to the student of proxemics is Grosser's discussion of portraiture. The portrait, he says, is distinguished from any other sort of painting by psychological nearness, which "depends directly on the actual physical interval—the distance in feet and inches between the model and the painter." Grosser sets this distance at four to eight feet. Such a spatial relation of the artist to his subject makes possible the characteristic quality of a portrait, "the peculiar sort of communication, almost a conversation, that the person who looks at the picture is able to hold with the person painted there."

Grosser's ensuing description of how the artist works on a portrait is fascinating not only for what it reveals of technique but also for its lucid discussion of how men perceive distance as a function of social relationships. The spatial relationships he describes are almost identical to those I observed in my research and those Hediger observed in animals.

> At more than thirteen feet away . . . twice the usual height of our bodies, the human figure can be seen in its entirety as a single whole. At this distance . . . we are chiefly aware of its outline and proportions . . . we can look at a man as if he were a shape cut out of cardboard, and see him . . . as something as *having little connection with ourselves.* . . . It is only the solidity and depth we see in nearby objects that produce in us feelings of sympathy and kinship with things we look at. At twice its

height, the figure can be seen at once. It can be comprehended at a glance . . . understood as a unit and a whole. . . . At this distance whatever meaning or feeling the figure may convey is dominated, not by expression or features of the face, but by the position of the members of the body. . . . The painter can look at his model as if he were a tree in a landscape or an apple in a still life—the *sitter's personal warmth does not disturb him.*

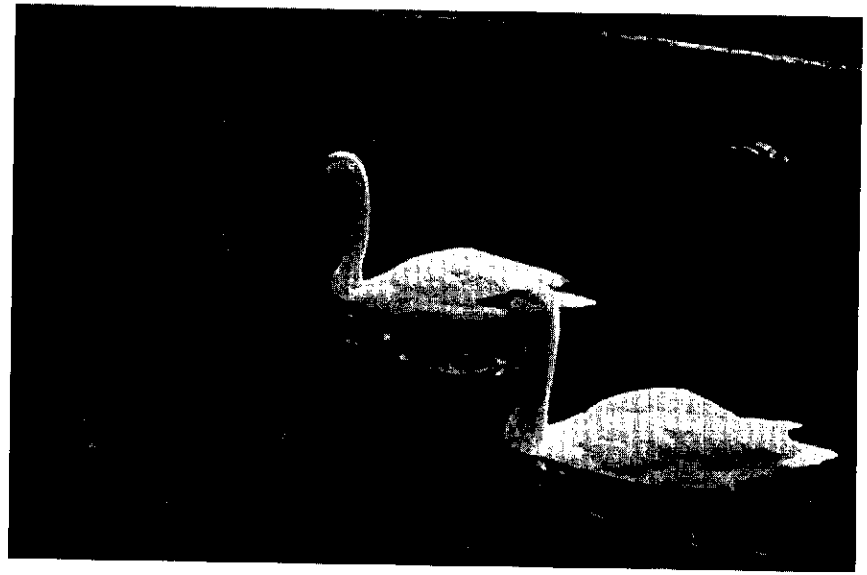
But four to eight feet is the portrait distance. At this distance the painter is near enough so that his eyes have no trouble in understanding the sitter's solid forms, yet he is far enough away so that the *foreshortening* of the forms presents him no real problem. Here, *at the normal distance of social intimacy and easy conversation,* the sitter's soul begins to appear. . . . Nearer than three feet, within touching distance, the soul is far too much in evidence for any sort of *disinterested* observation. Three feet is the sculptor's working distance, not the painter's. *The sculptor must stand near enough to his model to be able to judge forms by sense of touch.*

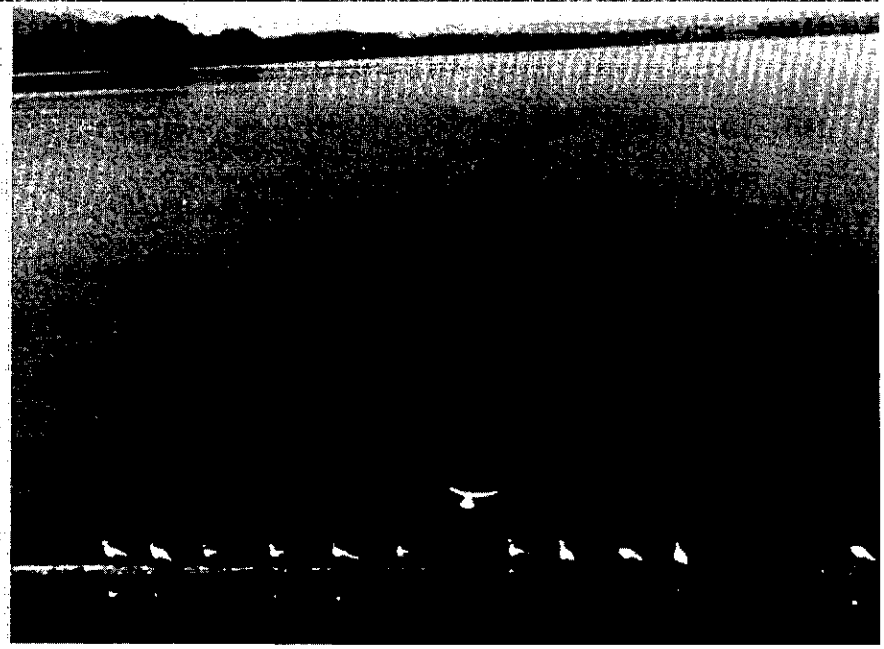
At touching distance, the problems of foreshortening make the business of painting itself too difficult. . . . Moreover, at touching distance, the sitter's personality is too strong. The influence of the model on the painter is too powerful, too disturbing to the artist's necessary detachment, *touching distance* being not the position of visual rendition, but of motor reaction of some physical expression of sentiment, like fisticuffs, or the various acts of love. (Italics mine.)

The interesting point about Grosser's observations is that they are consistent with proxemic data on personal space. Although he does not use the terms, Grosser distinguishes between what I have called intimate, personal, social, and public distances. It is also interesting to note how many specific clues to distance Grosser mentions. They include touching and non-touching, bodily warmth, visual detail and distortion when intimately close, size constancy, stereoscopic roundness, and the increasing flatness that becomes noticeable beyond thirteen feet. The significance of Grosser's observations is not restricted to the distance at which pictures are painted but lies in his statement of the unconscious, culturally molded spatial frames that both the artist and his subject bring to the

PLATE 1 *(above).* Male walruses sleeping among the rocks on Round Island, Alaska, give a perfect example of contact behavior.

PLATE 2 *(below).* Non-contact species, such as these swans, avoid touching.





PLATES 3 AND 4. *Personal distance* is the term applied by the animal psychologist H. Hediger to the normal spacing that non-contact animals maintain between themselves and their fellows. The birds sunning on a log and the people waiting for a bus both demonstrate this natural grouping.

PLATES 5 AND 6. These two photographs of people in conversation illustrate two of man's four distance zones. In PLATE 5 the *intimate distance* between the two subjects clearly reflects the aggressive and hostile nature of their feelings at the moment. PLATE 6 shows three acquaintances maintaining the far phase of *personal distance* from each other.

PLATES 7 AND 8. Impersonal business is generally conducted at *social distance*, varying from four to twelve feet depending on the degree of involvement. People who work together tend to maintain close social distance in their standing and seating positions.

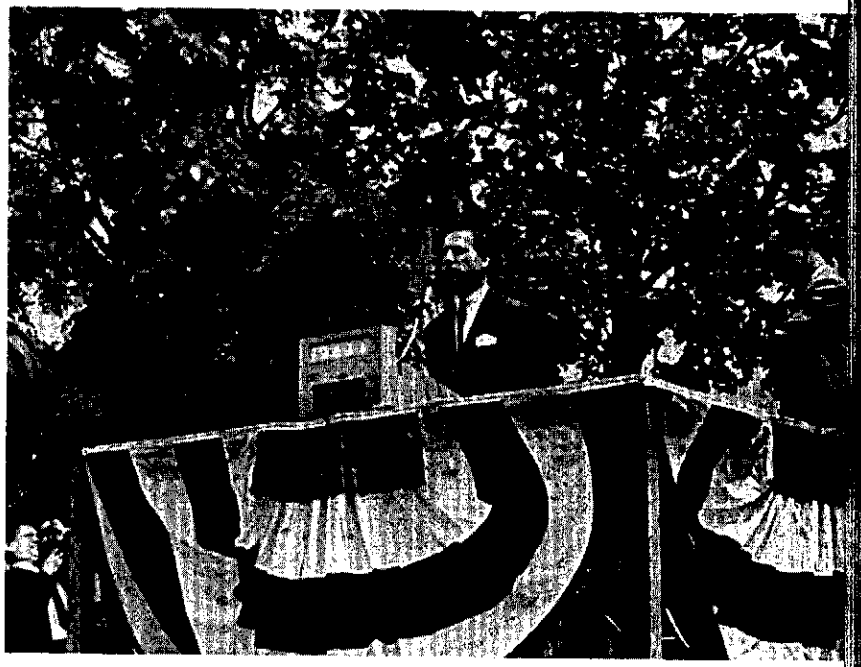
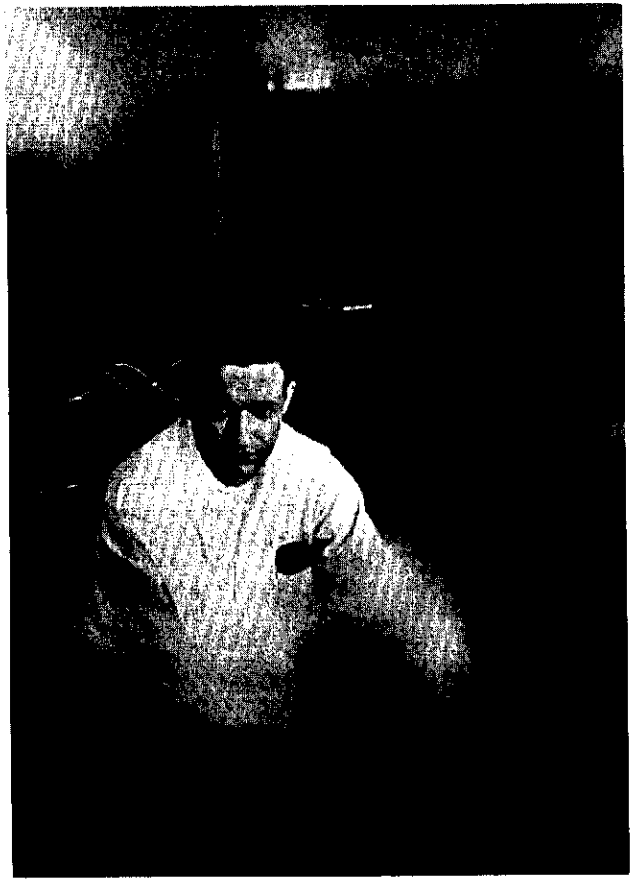


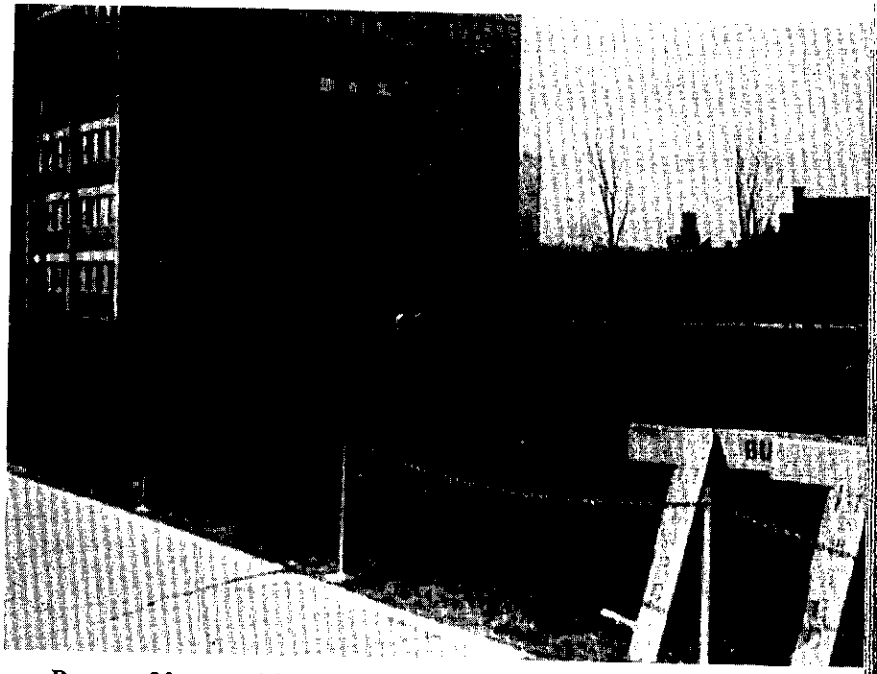
PLATE 9. Public distance is well outside the circle of personal involvement. The voice is exaggerated or amplified, and much of the communication shifts to gestures and body stance. This is the distance of public address and theatrical performance.

PLATES 10, 11 AND 12. Visual comprehension of another body changes with distance and, together with the olfactory and tactile sensations experienced, determines to a large extent the degree of involvement with that body.

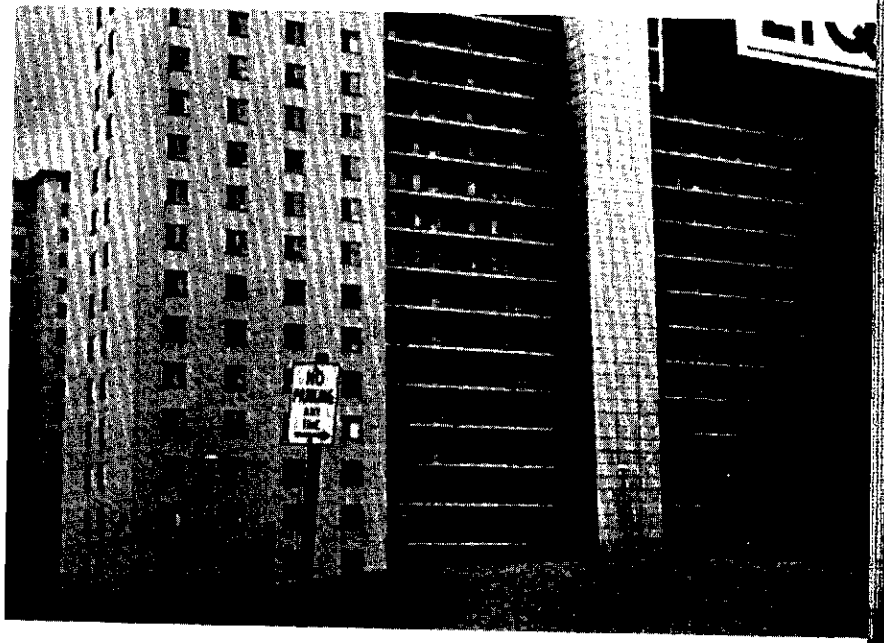
PLATE 10 *(above)* is a photograph of one eye of the subject taken at intimate distance. The distortion of features and sharp detail provide a visual experience that cannot be confused with any other distance.

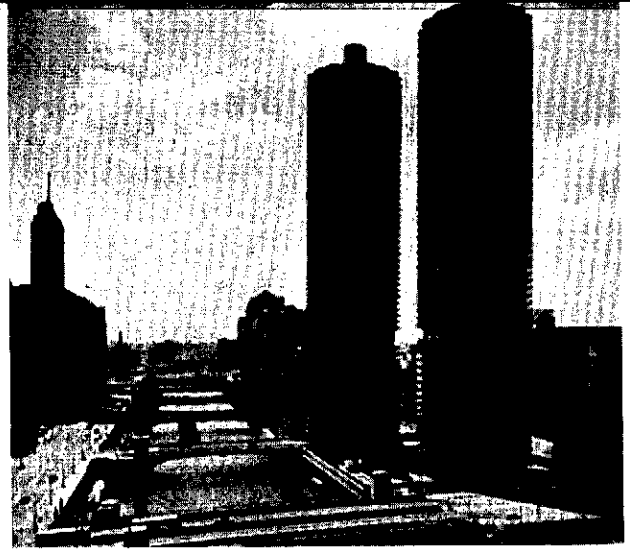
In PLATE 11 *(below)* the subject is photographed at personal distance. Visual distortion of the features is no longer apparent while facial details are still discernible. At this distance, the form, substance, and surface textures of objects are prominent and clearly differentiated.





PLATES 23 AND 24. Public housing constructed for low income groups often dresses up and hides but fails to solve many basic human problems. High-rise apartment buildings are less distressing to look at than slums but more disturbing to live in than much of what they replaced.

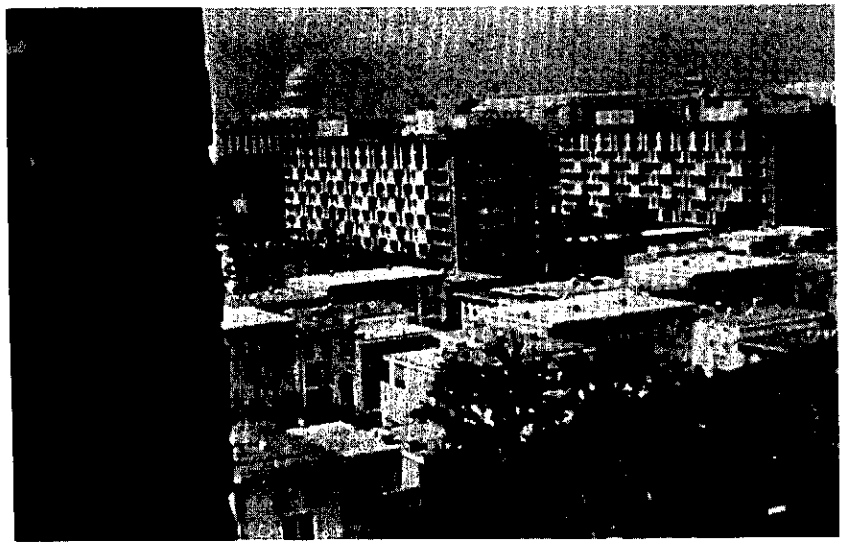




PLATES 25 AND 26. Two recent residential developments give hope that the gradual strangulation of the hearts of the cities can be reversed.

PLATE 25 *(above)*. In Marina City, Chicago, Bertrand Goldberg has designed circular apartment towers with lower floors that spiral upward and provide open-air, off-street parking facilities for the residents. Complete with marketing and entertainment facilities, the towers offer protection from weather and traffic disturbances.

PLATE 26 *(below)*. Another promising approach to civic design is that developed by Chloethiel Smith, a Washington, D.C., architect. In her southwest Washington apartments, she has managed to create interesting, esthetically satisfying, diverse, and humanly congenial solutions to problems of urban renewal.



sitting. The artist, trained to be aware of the visual field, makes explicit the patterns governing his behavior. For this reason, *the artist is not only a commentator on the larger values of the culture but on the microcultural events that go to make up the larger values.*

CONTRAST OF CONTEMPORARY CULTURES

The art of other cultures, particularly if it is very different from our own, reveals a great deal about the perceptual worlds of both cultures. In 1959, Edmund Carpenter, an anthropologist working with an artist, Frederick Varley, and a photographer, Robert Flaherty, produced a most remarkable book, *Eskimo*. Much of it is devoted to Aivilik Eskimo art. From plates and text, we learn that the perceptual world of the Eskimo is quite different from our own, and that an important feature of this difference is the Eskimo's use of his senses to orient himself in space. At times in the Arctic there is no horizon separating earth from sky.

> The two are the same substance. There is no middle distance, no perspective, no outline, nothing the eye can cling to except thousands of smoky plumes of snow running along the ground before the wind--a land without bottom or edge. When the winds rise and snow fills the air, visibility is reduced to a hundred feet or less.

How can the Eskimo travel across miles of such territory? Carpenter says:

> When I travel by car, I can, with relative ease, pass through a complex and chaotic city--Detroit, for example --by simply following a handful of highway markers. I begin with the assumption that the streets are laid out in a grid and the knowledge that certain signs mark my route. Apparently, the Aivilik have similar, though natural, reference points. By and large, *these are not actual objects or points, but relationships;* relationships between, say, contour, type of snow, wind, salt air, ice crack. (Italics mine.)

The direction and the smell of the wind, together with the

feel of ice and snow under his feet, provide the cues that enable an Eskimo to travel a hundred or more miles across *visually undifferentiated waste*. The Aivilik have at least twelve different terms for various winds. They integrate time and space as one thing and live in acoustic-olfactory space, rather than visual space. Furthermore, representations of their visual world are like X rays. Their artists put in everything they know is there whether they can see it or not. A drawing or engraving of a man hunting seal on an ice floe will show not only what is on top of the ice (the hunter and his dogs) but what is underneath as well (the seal approaching his breathing hole to fill his lungs with air).

ART AS A HISTORY OF PERCEPTION

For the past few years, Edmund Carpenter, the anthropologist, Marshall McLuhan, Director of Toronto's Center for Culture and Technology, and I have been studying art for what it can tell us about how artists use their senses and how they communicate their perceptions to the viewer. Each of us has approached the subject in his own way and has conducted his studies independently of the others. We have, however, found insights and stimulation in each other's work and are in agreement that there is much to be learned from the artist about how man perceives the world. Most painters know that they are dealing with relative degrees of abstraction; whatever they do depends on vision and must be translated into other senses. Paintings can never directly reproduce the taste or smell of fruit, the touch and texture of yielding flesh, or the note in an infant's voice that makes the milk begin to flow in a mother's breasts. Yet both language and painting symbolize such things; sometimes so effectively that they elicit responses close to those evoked by the original stimuli. If the artist is very successful *and the viewer shares the artist's culture*, the viewer can replace what is missing in the painting. Both the painter and the writer know that the essence of their craft is to provide the reader, the listener, or the viewer with properly selected cues that are not only congruent with the events depicted but consistent with the unspoken language and

culture of their audience. It is the artist's task to remove obstacles that stand between his audience and the events he describes. In so doing, he abstracts from nature those parts which, if properly organized, can stand for the whole and constitute a more forceful, uncluttered statement than the layman might make for himself. In other words, *one of the principal functions of the artist is to help the layman order his cultural universe.*

The history of art is almost three times longer than that of writing, and the relationship between the two types of expression can be seen in the earliest forms of writing, such as the Egyptian hieroglyphics. However, very few people treat art as a system of communication which is historically linked with language. If more people were to take this view they would find that their approach to art would change. Man is used to the fact that there are languages which he does not at first understand and which must be learned, but because art is primarily visual he expects that he should get the message immediately and is apt to be affronted if he doesn't.

In the next few pages I will try to describe a little of what it is possible to learn from the study of art and architecture. Traditionally both art and architecture have been interpreted and reinterpreted in terms of the contemporary scene. A most important point to remember is this: modern man is forever barred from the full experience of the many sensory worlds of his ancestors. These worlds were inevitably integrated and deeply rooted in organized contexts which could be fully understood only by the people of the times. Modern man must guard against jumping to conclusions too quickly when he looks at a 15,000-year-old painting on the walls of a cave in Spain or France. By studying the art of the past it is possible to learn two things: (a) something from our own responses about the nature and organization of our own visual systems and expectations, and (b) some notion of what the perceptual world of early man *may* have been like. However, our present-day picture of their world, like the museum pot which has been patched and mended, will always be incomplete and only an approximation of the original. *The greatest criticism one can make of the many attempts to interpret man's past is that they project onto the visual world of the past the*

structure of the visual world of the present. Projection of this sort is due in part to the fact that few people are aware of what was learned by the transactional psychologists referred to earlier, namely that man actively though unconsciously structures his visual world. Few people realize that vision is not passive but active, in fact, a transaction between man and his environment in which both participate. Therefore, neither the cave paintings of Altamira nor even the temples at Luxor can be counted on to evoke the same images or responses today as when they were created. Temples like Amen-Ra at Karnak are full of columns. To enter them is like walking into a forest of standing petrified logs, an experience which can be quite disturbing to modern man.

The paleolithic cave artist was apparently a shaman who existed in a sense-rich world which he took for granted. Like a very young child, he was apparently only dimly aware that this world could be experienced as separate from himself. He did not understand many natural events, particularly since he had no control over them. Indeed, it is likely that art was one of man's first efforts to control the forces of nature. For the shaman-artist to *reproduce* an image of something may have been his first step in gaining control over it. If this is true, each painting was a separate creative act to bring power and good hunting but was not seen as art with a capital *A*. This would explain why the figures of the deer and the bison of Altamira, while well drawn, are not related to each other, but rather to the topography of the surface of the cave. Later these same magic images were reduced to symbols, which were reproduced again and again, like prayer beads, to multiply the magical effect.

I must explain to the reader that my thinking regarding the interpretation of early art as well as architecture is influenced by two men who devoted their lives to this subject. The first is the late Alexander Dorner, art historian and museum director and student of human perceptions. It was Dorner who taught me the great significance of the work of Adelbert Ames and the transactional school of psychology. Dorner's book, *The Way Beyond Art,* was years and years ahead of its time. I find that I keep returning to it and as my understanding of man grows so does my appreciation for Dorner's insights.

More recently, I have begun to make the acquaintance of the work of the Swiss art historian Sigfried Giedion, author of *The Eternal Present.* While I owe a debt to both these men I must take on my own shoulders full responsibility for reinterpreting their thinking. Both Dorner and Giedion became involved in perceptions. Their work has shown that by studying man's artistic productions, it is possible to learn a great deal about the sensory world of the past and how man's perception changes as does the nature of his awareness of perception. For example, the early Egyptian experience of space was very different from our own. Their preoccupation apparently was more with the correct orientation and alignment of their religious and ceremonial structures in the cosmos than with enclosed space per se. The construction and the precise orientation of pyramids and temples on a north-south or east-west axis had magic implications designed to control the supernatural by symbolically reproducing it. The Egyptians had a great geometric interest in sight lines and plane surfaces. We also note in Egyptian murals and paintings that everything appears flat and that time is segmented. There is no way of telling whether one scribe in a room is doing twenty different things or twenty different scribes are going about their business. The classical Greeks developed real sophistication in the complete integration of line and form and in the visual treatment of edges and planes that has seldom been equaled. All of the intervals and straight edges of the Parthenon were carefully executed and arranged so as to appear equal, and deliberately curved so as to look straight. The shafts of the columns are slightly thicker in the middle in order to preserve the appearance of tapering uniformly. Even the foundation is higher in the middle by several inches than at the ends in order to make the platform on which the columns rest appear absolutely straight.

People reared in contemporary Western culture are disturbed by the absence of inside space in those Greek temples that are sufficiently preserved to give some sense of their original form, such as the 490 B.C. Hephaisteion (also known as the Thesion) in the Agora in Athens. The Western idea of a religious edifice is that it communicate spatially. Chapels are small and intimate while cathedrals are awe inspiring and re-

mind one of the cosmos by virtue of the space they enclose. Giedion states that domes and barrel vaults are present from "the very beginning of architecture . . . and the oldest pointed arch, found in Eridu, goes back to the fourth millennium." However, the potential of the dome and the vault in creating "superspace" was not realized until the first five centuries A.D. by the Romans. The capacity was there but the awareness of the relationship of man to large enclosed spaces was not. Western man did not see himself *in* space until later. As a matter of fact, man has only gradually begun to fully experience himself in space on the level of everyday life using all his senses. As we shall see, evidence for the dissynchronous development of sensory awareness also occurs in art.

For many years I had been puzzled by what seemed to be a paradox in the development of art. Why was it that Greek sculpture was a full thousand years ahead of Greek painting? Mastery of the human figure in sculpture was achieved in classical Greece before the middle of the fifth century B.C. Epitomized in the bronze "Charioteer of Delphi" (470 B.C.), Myron's "Discus Thrower" (460–450 B.C.), and particularly in the "Poseidon" in the Museum at the Acropolis in Athens, there can be no doubt that the ability to express the essence of moving, active, vibrating man in bronze and stone had been recorded forever. The answer to the paradox lies in the fact that sculpture, as Grosser points out, is primarily a tactile and kinesthetic art, and if one views Greek sculpture in these terms it is easier to comprehend. The message is from the muscles and joints of one body to the muscles and joints of another.

I must at this point explain why the reader has not been provided with pictures of the Greek sculpture referred to in the text and why there will be few pictures of paintings later on or why it is that the single chapter in this book where one might expect to find illustrative material contains very little. The decision *not* to illustrate many of the examples was not easy. However, to have done so would have contradicted one of the main points of this book, which is that most communications are in themselves abstractions of events that occur on multiple levels many of which are not at first apparent.

Great art also communicates in depth. Sometimes it takes years or even centuries for the complete message to come through. In fact, one can never be sure that real masterpieces have yielded their last secret and that man knows all there is to know about them. To understand art properly one has to view it many times and enter into a discourse with the artist through his work. To do this there should be no intermediaries, because one needs to be able to perceive *everything*. This rules out reproduction. Even the best reproduction can do no more than remind the viewer of something he has already seen. It is at best a memory aid and should never be confused with or used as a substitute for the real thing. Take the matter of scale, which is an important limiting factor in reproductions. All works of art are created on a certain scale. Altering the size alters everything. In addition sculpture is best experienced when it can be touched and viewed from several angles. Most museums make a great mistake in not letting people touch sculpture. My object in this chapter is to motivate the reader to view and re-view art and to establish his own personal relationships with the world of art.

An analysis of paintings of the Middle Ages reveals how the artist of that time perceived the world. The psychologist Gibson identified and described thirteen varieties of perspectives and visual impressions which accompany the perception of depth. The medieval artist had some knowledge of six of these. *Aerial perspective, continuity of outline,* and *upward location in the visual field* had been mastered. *Texture perspective, size perspective,* and *linear spacing* were partially understood. (See Appendix for a summary of James Gibson's isolates of depth.) A study of medieval art also reveals that Western man had not yet made the distinctions between the visual field (the actual retinal image) and the visual world, which is what is perceived. For man was depicted not as he is recorded on the retina, but as he is perceived (human size). This explains some of the remarkable and peculiar effects in the painting of that time. The National Gallery in Washington has several medieval paintings which illustrate this point: Fra Filippo Lippi's "Rescue of St. Placidus" (mid-fifteenth century) shows the background figures as actually larger than the two monks praying in the foreground, while Sassetta's

"Meeting of St. Anthony and St. Paul" shows the two saints as only slightly larger than two other figures on a path on the side of a hill in the background. Among the thirteenth and fourteenth century paintings in the Uffizi Palace in Florence one can also see numerous examples of the medieval visual world. Gherardo Starnina's "Thebais" depicts a harbor scene viewed from above—the boats in the harbor are *smaller* than the people on the shore behind them, while human scale is held constant at all distances. Much earlier fifth century mosaics at Ravenna are in a different cultural tradition (Byzantine) and are self-consciously and deliberately three-dimensional in *one* effect only. Scrolls and mazes seen at close range illustrate a knowledge that an object, line, plane, or surface that eclipses or overlaps another object or surface will be seen in front of that object (Gibson's continuity of outline). From their mosaics one would gather that the Byzantines were accustomed to living and working at very close range. Even when animals, buildings, or towns are depicted the visual effect is one of extraordinary closeness in Byzantine art.

With the Renaissance three-dimensional space as a function of linear perspective was introduced, reinforcing some medieval spatial concepts and eliminating others. Mastery of this new form of spatial representation began to draw attention to the difference between the visual world and the visual field and therefore the distinction between what man knows to be present and what he sees. Discovery of the so-called laws of perspective where the perspective lines are made to converge on a single point is thought to have been largely the work of Paolo Uccello whose paintings can be seen in the Uffizi Gallery in Florence. Whether Uccello was responsible or not, once the laws of perspective were discovered they spread rapidly and were pushed very quickly to their ultimate expression by Botticelli in an incredible painting called "Calumny." However, there was an inherent contradiction in Renaissance painting. To hold space static and organize the elements of space so as to be viewed from a single point was in reality to treat three-dimensional space in a *two-dimensional manner*. Because the stationary *eye* flattens things out beyond sixteen feet, it is possible to do just this—treat space optically.

The *trompe l'oeil* so popular in the Renaissance and succeeding periods epitomizes visual space as seen from a single point. Renaissance perspective not only related the human figure to space in a mathematically rigid way by dictating its relative size at different distances but caused the artist to accustom himself to both composition and planning.

Since the time of the Renaissance, Western artists have been caught in the mystical web of space and the new ways of seeing things. Gyorgy Kepes, in *The Language of Vision*, mentions that Leonardo da Vinci, Tintoretto, and other painters modified linear perspective and created more space by introducing several vanishing points. In the seventeenth and eighteenth centuries, Renaissance and Baroque empiricism gave way to a more dynamic concept of space which was much more complex and difficult to organize. Renaissance visual space was too simple and stereotyped to hold the artist who wanted to move about and bring new life to his work. New kinds of spatial experiences were being expressed, which led to new awarenesses.

For the past three centuries, paintings have ranged from the highly personal and visually intense statements by Rembrandt to Braque's contained kinesthetic treatment of space. Rembrandt's paintings were not well understood during his lifetime and it would appear that he was the living manifestation of a new and different way of viewing space which today is considered reassuringly familiar. His grasp of the difference between the visual field and the visual world, referred to earlier, was truly remarkable. In contrast to the Renaissance artist, who examined the visual organization of distant objects with the *viewer* held constant, Rembrandt paid particular attention to how one sees if the *eye* is held constant and does not move about but rests on certain specific areas of the painting. For many years I had never really appreciated Rembrandt's knowledge of vision. Increased understanding came unexpectedly one Sunday afternoon in the following way. Visually, Rembrandt's paintings are very interesting and tend to catch the viewer in a number of paradoxes. Details that look sharp and crisp dissolve when the viewer gets too close. It was this effect that I was studying (how close could I get before the detail broke down) when I made an important discovery about

Rembrandt. Experimenting with the viewing of one of his self-portraits, my eye was suddenly caught by the central point of interest in the self-portrait, Rembrandt's eye. The rendition of the eye in relation to the rest of the face was such that the whole head was perceived as three-dimensional and became alive *if viewed at the proper distance.* I perceived in a flash that Rembrandt had distinguished between foveal, macular, and peripheral vision! He had painted a stationary *visual field* instead of the conventional visual world depicted by his contemporaries. This accounts for the fact that looked at from proper distances (which have to be determined experimentally) Rembrandt's paintings appear three-dimensional. The eye must be permitted to center and *rest* on the spot that he painted most clearly and in greatest detail at a distance at which the foveal area of the retina (the area of clearest vision) and the area of greatest detail in the painting match. When this is done, the registry of the visual fields of both the artist and the viewer coincide. It is at this precise moment that Rembrandt's subjects spring to life with realism that is startling. It is also quite evident that Rembrandt did not shift his gaze from eye to eye as many Americans do when they are within four to eight feet of the subject. He painted only one eye clearly at this distance. (See "Oriental Potentate" in the Amsterdam Museum and "Polish Count" in the National Gallery of Art in Washington.) In Rembrandt's paintings one can see a growing awareness and increasing self-consciousness concerning the visual process which quite clearly foreshadows the nineteenth century impressionists.

Hobbema, a Dutch painter contemporary with Rembrandt, communicated the sense of space in a very different, more conventional way for his times. His large, remarkably detailed paintings of country life contain several separate scenes. To be properly appreciated they should be approached within two to three feet. At this distance at eye level, the viewer is forced to turn his head and bend his neck in order to see everything in them. He has to look *up* into the trees and *down* to the brook and *ahead* at the scenes in the middle. The result is truly remarkable. It is like looking out a large plate-

glass window on a Dutch landscape of three hundred years ago.

The perceptual world of the impressionists, surrealists, abstract and expressionist artists have shocked succeeding generations of viewers because they do not conform to popular notions of either art or perception. Yet each has become intelligible in time. The late nineteenth and early twentieth century impressionists foreshadowed several features of vision that were later technically described by Gibson and his fellow researchers. Gibson makes a clear-cut distinction between ambient light, which fills the air and is reflected from objects, and radiant light, which is the province of the physicist. The impressionists, realizing the importance of ambient light in vision, sought to capture its quality as it filled the air and was reflected from objects. Monet's paintings of the Cathedral at Rouen, all depicting the same façade but under different conditions of light, are as explicit an illustration of the role of ambient light in vision as one could expect to find. The important point about the impressionists is that they shifted their emphasis from the viewer back out into space again. They were self-consciously trying to understand and depict what happened in space. Sisley, who died in 1899, was like most impressionists a master of aerial perspective. Degas, Cezanne, and Matisse all recognized the built-in, containing and delineating quality of lines symbolizing edges. Recent research on the visual cortex of the brain shows that the brain "sees" most clearly in terms of edges. Edges like Mondrian's apparently produce a sort of cortical jolt beyond that experienced in nature. Raoul Dufy caught the importance of the after-image in the transparently luminous quality of his paintings. Braque showed clearly the relationship between the visual and the kinesthetic senses by consciously striving to convey the *space of touch.* The essence of Braque is almost impossible to get from reproductions. There are many reasons for this but one of them is that the surfaces of Braque's paintings are highly textured. It is the texture that pulls you in close so that you are in reach of the objects he has painted. Properly hung and viewed at the correct distance, Braque's paintings are incredibly realistic. Yet it is impossible to know this from a reproduction. Utrillo is a captive of visual space perspec-

tive, though freer than the Renaissance artists. He does not try to remake nature; yet he somehow manages to convey the impression that you can walk around in his spaces. Paul Klee relates time to space and the dynamic perception of changing space as one moves through it. Chagall, Miró, and Kandinsky all seem to know that pure colors—especially red, blue, and green—come to a focus at different points in reference to the retina and that extreme depth can be achieved with color alone.

In recent years, the sense-rich work of Eskimo artists has been cherished by collectors of modern art, partly because the Eskimo approach is similar in many ways to that of Klee, Picasso, Braque, and Moore. The difference is this: everything the Eskimo does is influenced by his marginal existence and is related to highly specialized adaptations to a hostile, demanding environment which allows almost no margin for error. The modern artists of the West, on the other hand, have through their art begun to consciously mobilize the senses and to eliminate some of the translation processes required by objective art. The art of the Eskimo tells us that he lives in a sense-rich environment. The work of modern artists tells us just the opposite. Perhaps this is the reason why so many people find contemporary art quite disturbing.

One cannot in a few pages do justice to the history of man's growing awareness; first of himself, second of his environment, then of himself scaled to his environment, and finally of the transaction between himself and his environment. It is only possible to sketch in the broad outlines of this story, which demonstrates more and more clearly that man has inhabited many different perceptual worlds and that art constitutes one of the many rich sources of data on human perception. The artist himself, his work, and the study of art in a cross-cultural context all provide valuable information not just of content but even more important of the *structure* of man's different perceptual worlds. Chapter VIII explores the relationship of content and structure and draws examples from another art form, literature, that is also rich in data.

VIII

THE LANGUAGE OF SPACE

Franz Boas was the first anthropologist to emphasize the relationship between language and culture. He did this in the most simple and obvious way, by analyzing the lexicon of two languages, revealing the distinctions made by people of different cultures. For example, to most Americans who are not ski buffs snow is just part of the weather and our vocabulary is limited to two terms, snow and slush. In Eskimo, there are many terms. Each describes snow in a different state or condition, clearly revealing a dependence on an accurate vocabulary to describe not just weather but a major environmental feature. Since Boas' time anthropologists have learned more and more about this most important relationship—language to culture—and they have come to use language data with great sophistication.

Lexical analyses are usually associated with studies of the so-called exotic cultures of the world. Benjamin Lee Whorf, in *Language, Thought, and Reality*, went further than Boas. He suggested that every language plays a prominent part in actually molding the perceptual world of the people who use it.

> We dissect nature along lines laid down by our native languages. The categories and types that we isolate from the world of phenomena we do not find there . . . on the contrary, the world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds—and this means largely by the linguistic systems in our minds. We cut nature up, organize it into concepts, and ascribe significances as we do, largely because we are parties to an agreement to organize it in this way—an