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Perceiving, Anticipating, and Imagining

What is the relation between perception and mental imagery? It has often been suggested, by myself (Neisser, 1967) among others, that the same processes underlie both. More specifically, it has been assumed that while the early processing stages of a percept may be missing from the development of the corresponding image, their later stages (resulting in awareness) are more or less the same. Yet this cannot be right; it would leave us in continual doubt about whether we were seeing something or merely imagining it. Common experience suggests, however, that such doubts rarely arise in the waking lives of ordinary people. (The apparently contrary evidence of Perky's (1910) experiment can probably be ignored. Although her subjects did seem to confuse pictures with images, the demand characteristics of the experiment actually gave them little choice. Segal's (1971, 1972) extended efforts to replicate Perky's work produced some cases of "incorporation" but few documented instances of confusion.) I shall argue here that imaging and perceiving are not confusable, because they differ fundamentally—as sharply as a phenotype differs from a genotype, or a plan from an action. Indeed, I shall suggest that images are precisely plans for the act of perceiving.

How are we to think of perception itself? The most popular current view treats it as a case of information-processing (e.g., Lindsay & Norman, 1972; Posner, 1973; Massaro, 1975). Perceiving is assumed to begin with the stimulation of a sensory surface, and to

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end with the formation of a "percept," given in consciousness. Visual perception, for example, begins when neural mechanisms in the retina, called "detectors," respond to features of the retinal image. Information about these features is passed on to the higher states, where it is combined with stored information. This series of processes eventually results in a perceptual experience. Theories of this genre are inevitably illustrated with flow charts, like the one caricatured in Figure 1. Information arrives at the left, is processed through various stages, and eventually reaches its mysterious destination at the right. The whole train of events is inflicted on a passive perceiver, who takes what he is given and must be grateful for it.

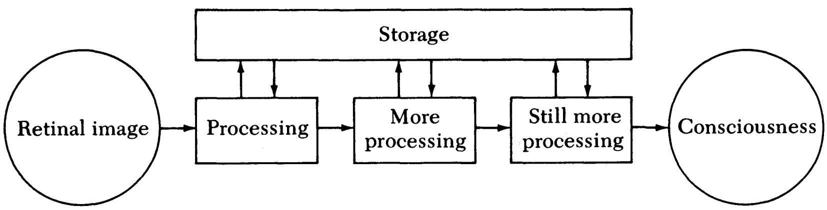

Figure 1. The internal flow chart model of perception. Reprinted with permission from *Cognition and Reality* (Figure 1) by Ulric Neisser, W. H. Freeman and Company. Copyright © 1976.

There is some supporting evidence for this view. Certain neural mechanisms do respond selectively to features of the retinal image; their existence has been demonstrated both neurophysiologically and psychologically (e.g., Hubel & Wiesel, 1959; Lindsay & Norman, 1972). Nevertheless, such a model leaves many questions unanswered. How does it happen that different people notice different things? How are units formed, so that some portions of the input are treated as belonging to one object, some to another? How are successive glances at the same scene integrated with one another? And what about mental images?

In an information-processing model, an image is treated as a train of processes that arises in the middle of the apparatus instead of at the left-hand end and then proceeds along the sequence normally. To *see* a unicorn is to have one's retina stimulated by unicorn-shaped rays of light and to process the resulting detector activity through (say) eight stages. To *imagine* a unicorn is to skip the first two stages or so and begin the processing a little further along. How, then, do we know whether we are seeing or imagining one? Moreover, how would we go about *looking for* unicorns if we wanted to see them? The model makes no provision for perceptual search.

Another difficulty for the passive information-processing model concerns the use of information from several sensory modalities. In real life we constantly listen to things we are also looking at, and often touch them as well. How are all these inflows coordinated? How do we know which ones to filter out and which to admit to the inner sanctum?

A particularly serious problem is posed by the fact that perception is generally accurate and veridical. It must be, if it is to play a useful role in our lives. As psychologists, we sometimes overlook the accuracy of perception in our fascination with *illusions*, which have made claims on our theoretical interest far out of proportion to their ecological significance. In real life, perceptual illusion is as rare as political illusion is common; people usually see the sizes, shapes, colors, positions, and potential manipulability of objects quite accurately. The most fundamental problem for theories of perception is to account for this success, achieved despite the inadequacy of every momentary retinal image. It is far from clear whether the presently fashionable mixed bag of sophisticated detectors and corrections based on past experience can do so satisfactorily. At one time I thought it would help to insist (1967) that perceiving is a "constructive" process rather than a passive one. I still think so, but this claim does not really come to grips with the basic question: how do we know just what to construct?

The accuracy of perception under ordinary conditions suggests that the optically-available information is highly *specific*: so specific that we can make only one construction, the right one. If this is true, however, the notions of "construction" and "processing" seem almost superfluous. One is tempted to abandon them altogether, as J. J. Gibson has done (1966). He insists that invariant features of the optical array specify the real environment quite precisely, and need not be "processed" at all. For Gibson, a theory of perception need only describe the information that is being picked up. But although there can be no doubt that such a description is necessary, it does not seem sufficient. Another part of the psychologists's job is surely to describe the perceiver's contribution: the internal structure that accepts and uses information. There must be processes in the perceiver that are attuned to the relevent information in the environment. What do they do? Did they evolve merely to fashion "percepts" out of "stimuli"?

There is another and more natural alternative, which becomes plausible as soon as one examines ordinary perceptual acts more closely. Such as examination soon reveals (and undermines) several assumptions that have been accepted uncritically for many years. It has traditionally been assumed that visual perception is something discrete (i.e., beginning at one point in time and ending at another) and intrapsychic (occurring entirely inside the head). In fact, however, visual perception is a continuous activity. We look at things over extended periods of time, through many fixations. For this reason, looking must involve the *anticipation* of information as well as its pickup. I suggest that it depends on certain crucial internal structures, or "schemata," that function as anticipations and as plans. It is these schemata, together with the information actually available in the environment, that determine what is seen. Perception is indeed a constructive process, but what is constructed is not an inner image to be admired by an inner man; it is a plan for obtaining more information. At any moment the perceiver anticipates that a certain sort of information will become available, and he gets ready to accept it. Often he actively explores with his eyes or his hands in order to obtain more of it. The outcome of these explorations modifies the original schema, permitting it to direct further explorations and to prepare for still more information. This cycle is diagrammed in Figure 2.

Perceptual activity is not restricted to a single sensory system. Even newborn babies look in the direction from which a sudden sound has come: initial information in one modality leads to exploration in another. Adults have sophisticated schemata that accept information from many sources simultaneously and direct explorations of many kinds. When we look at someone who is speaking, the visual information about his lip movements supports the auditory information about the movements of his tongue and his articulators. We call this "hearing him speak," but it is really a multimodal enter-

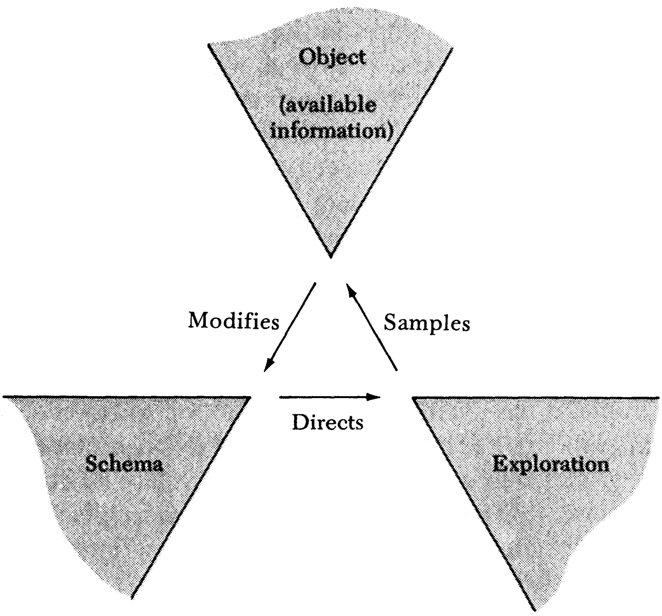

Figure 2. The perceptual cycle. Reprinted with permission from *Cognition and Reality* (Figure 2) by Ulric Neisser, W. H. Freeman and Company. Copyright © 1976.

prise because it is based on multimodal anticipations. When these anticipations are not fulfilled, as in a dubbed movie, the result can be very disturbing.

The anticipatory schema plays a critical role in every perceptual act. Nevertheless it is not a "percept," nor does it produce one anywhere in the perceiver's head. I submit that perceiving does not involve any such things as "percepts." We perceive, attend to, and are conscious of objects and events, not ghostly mental representations. The schema is just one phase of an ongoing interaction with the environment. Perception is the entire cycle illustrated in Figure 2, not any single part of it. It never occurs instantaneously, and it does not just happen in the head.

The idea that visual perception is continuous over time represents a radical break with most perceptual theory. Despite their disagreements, for example, the Gestalt psychologists and their classical opponents shared the assumption that visual perception begins with a pattern on the retina and ends with a percept in the mind. It is time, I think, to give up this assumption. It is already clear that the analogues of the assumption in other perceptual fields are unacceptable. In speech perception, we have finally rid ourselves of the notion that phonemes (or any units) are perceived one by one, independent of context. Where haptic perception is concerned (the active exploration of objects with our hands), no one would ever have been tempted by such a notion in the first place. It hangs on only in vision.

This assumption has had, and is still having, serious consequences. For example, it has created a virtual addiction to the tachistoscope as an experimental tool. By limiting the subject to a single brief flash of light, falling willy-nilly onto a receptor system he does not have time to adjust, this tempting device allows one to specify just when perception "begins." A great many clever experiments have been conducted with tachistoscopic techniques, but I think they have misled us. In the normal course of events perception does not "begin" at a sharply specified moment at all, and it ends only when the perceiver is tired of looking at something.

Consider a few natural examples of perception. In one very frequent case, a perceiver at rest watches a moving object: a running animal, perhaps, or a thrown ball. Usually he follows the object with his eyes. Even an infant only a few days old can track an optical motion under the right conditions, and adults are highly skilled at doing so. Successful tracking of this sort implies both anticipation and information pickup. Information about how the object is moving determines how the eyes and the head must move in order to follow it. When these movements have been made, still more information about the object and its motion can be acquired, leading to still further tracking. It is obvious, then, that this kind of perception is cyclical and extended in time.

If the moving object turns, or tumbles, or has limbs that shift their positions, more information becomes available. Parts of the object occlude and reveal other parts as it goes. The projected shapes and sizes of its surfaces at the eye of the observer keep changing. These changes do not result in confusion or blur, as they would if the static retinal image were the basis of perception. On the contrary, they represent information that can be used. The perceiver who pays attention to such a moving object continually develops general anticipations of its coming movements, which are continually being confirmed and made specific by the movements that actually occur. Indeed, that is what "paying attention" means. In recent experiments at Cornell, Becklen and I (1975) have superimposed the optical images of two natural events, both involving motion, and asked subjects to attend to one while ignoring the other. They find this very easy to do. They need no special "filtering mechanism" to block out the unwanted event; they simply do not follow it. It is as easy to follow one movement and ignore others as it is to follow one conversation and ignore another in a crowded room; the same principles apply in both cases. Nor are eye movements necessary for this kind of attention, although they naturally occur unless they are deliberately prevented (Littman & Becklen, 1976). What people see depends on the anticipations they develop, the perceptual explorations they carry out, and the information they find available; in other words, on the perceptual cycle in which they are engaged.

This principle applies not only to continuous and familiar motions; it is equally applicable when a new object enters the field of view. In laboratory studies, new visual objects are often presented artificially. They appear as soon as the experimenter closes a switch to turn on some display device. This procedure is poorly adapted to the study of normal perception. Perceivers usually have a good deal of advance information about new objects before the first visual fixation, which they have acquired from various sources. As a result, their first looks are well prepared.

Suppose, for example, that an unexpected visitor arrives at my office, where I am hard at work on this manuscript. It is surprisingly difficult to define the specific instant at which I first perceive him. In most cases I will be engaged in some particular activity when he arrives, and then look up and toward the door. Why do I look? Probably either because I *hear* him or because I see him in *peripheral vision*, "out of the corner of my eye." (These two possibilities are functionally similar, since both provide information that is used to direct further perceptual exploration.) Having picked up this information, I swivel my head and eyes around for a better look. In that look, the visitor's face (say) will be properly imaged on the central fovea of my eye. But this first foveal glance is not the beginning of perception; I already have the information about his position and movement that I acquired a moment before. Nor is this all: during the next few seconds the direction of my gaze will shift repeatedly as I look at him. Each of these eye movements will be made as a consequence of information already picked up, in anticipation of obtaining more. At what moment in all this activity can perception be said to occur? There is no such moment. Indeed, I am not even aware of the fixations, or of their sequence; only of the visitor himself. What I see is not in my head but in the world, and I see it over time.

Even without the contribution of peripheral vision, my visitor would not find me perceptually unprepared. After all, he must appear in the doorway. If I am working in my office, I already know where the doorway is, and what lies beyond it, just as I know the location of other familiar objects. This means that I can anticipate the distances and possible motions of *any* arriving guest. Information about his location and movements fits into a preexisting spatial schema, or cognitive map, and thereby modifies that schema. A visitor who entered through the wall, or materialized in the middle of the room, would be more like a ghost than a person. His ghostliness would be the first thing I noticed about him, and would color everything I saw afterward. Psychologists do not believe in ghosts, of course, but they often experiment with stimuli that appear just as mysteriously.

Of course, one can see stationary objects as well as moving ones. Sitting quietly at my desk, I may decide to look at the clock on the wall, for example. I already know where the wall is, and roughly where the clock is. I continue with a series of successive glances, each of which provides more detail. An anticipatory schema directs my looking from the first, and is modified by additional information as it becomes available so that further looks can be successfully executed. The perceptual cycle diagrammed in Figure 2 applies to such stationary cases just as it does to situations involving movement.

The claim that perception involves "anticipation" is easily misunderstood. It does *not* mean that one can see only what one expects to see. If the clock has been moved or even removed since the day before, I will surely realize it. The first direct glance will provide information that changes the schema, which will direct further and more appropriate exploration of the new object. When a perceptual cycle is carried out normally, schemata soon tune themselves to the information actually available. They must do so, since people are not always in familiar environments, and they often look at unfamiliar objects. The function of perception is to acquire new information, not merely to confirm preexisting assumptions! Nevertheless, it seems equally obvious that without some appropriate preexisting structure, no information could be acquired at all.

There is a dialectical contradiction between these two requirements. We cannot perceive *unless* we anticipate, but we must not see *only* what we anticipate. If we were restricted to isolated and unconfirmed glances at the world, this contradiction would prove fatal. Under such conditions we could not consistently disentangle what we see from what we expect to see, nor distinguish objects from hallucinations. This dilemma cannot be resolved in the internal processing model of perception. Its resolution is achieved only through the perceptual cycle. Although a perceiver always has at least some (more or less specific) anticipations before he begins to pick up information about a given object, these are corrected as may be necessary while he continues to look.

Anticipation is the function of the structures that I am calling "schemata," a term borrowed from Piaget and Bartlett. My own usage of this term is somewhat different from theirs. A schema is here defined as that portion of the perceptual cycle that is inside the observer, modifiable by experience, and somehow specific to what is being observed. The schema accepts information as it becomes available, and is changed by that information. Thus it undergoes what Piaget would call *accommodation*. But there is no need to postulate any process analogous to his *assimilation*: the sensory information is not changed by the perceiver, it is merely selected. Moreover, schemata are not passive; they direct movements and exploratory activities of many kinds that make more information available, by which they are further modified.

In some respects, a schema resembles a *format* in a computer programming language. Formats specify that information must be of a certain sort if it is to be interpreted coherently. Anything else will be ignored, or will lead to meaningless results. From another side, however, a schema is like a *plan*, of the sort described some years ago by Miller, Galanter, and Pribram (1960). Perceptual schemata are plans for finding out about objects and events, plans for obtaining more information to fill in the format. They often direct exploratory movements of the eye, head, and hands. It is important to stress, however, that schemata are equally functional in cases where no overt orienting movements occur. In such cases (listening is a typical example), the acquisition of information is still determined by the perceiver's developing format. Information that does not fit the schema either alters it substantially or goes entirely unused. Perception is inherently selective.

The analogy between schemata and formats or plans is not complete. In real formats and plans, one can make a sharp distinction between form and content; this is not true of schemata. The information that fills in the format at one point in the cycle becomes a part of the format in the next, determining how further information is accepted. The schema is not only the plan but also the executor of the plan. It is a pattern *of* action as well as a pattern *for* action.

The schema at any given moment resembles a "genotype" rather than a "phenotype" as these concepts are defined in genetics. It offers a possibility for development along certain lines, but the precise nature of that development is determined only by interaction with a real environment. It would be a mistake to identify the schema with the "percept," just as it is a mistake to identify any gene with a definite characteristic of an adult organism. Perception is determined by schemata in the same sense that the observable properties of organisms are determined by their genes. It results from the interaction of schema and available information; indeed, it *is* that interaction itself.

The cyclic and anticipatory nature of perception is especially obvious in one case that has not yet been considered: motion of the observer himself. Motion always changes the available information, and in ways that can be at least roughly anticipated. A sideways shift of the head is enough to reveal new aspects of most nearby objects. More extensive movements—going around a corner or looking into a new room—present whole new layouts of objects that were previously hidden. Every occluding edge defines a region that could be brought into view by some movement, and thus marks the potential location of things presently unseen. Perceptual schemata incorporate this fact. What the perceiver will see when he has moved stands in an already defined relation to what is presently visible, so that the relative positions of objects are "known" before they are imaged on the retina. Information picked up as a result of motion is systematically related to existing schemata, and in particular to a *cognitive map* of the nearby environment.

A cognitive map is essentially a larger kind of schema. That is, it accepts information and directs action. Just as an object schema accepted information about the clock on my office wall and directed further visual exploration, so my cognitive map of the entire building and its geographical setting accepts information about the larger environment and directs my actual explorations. The schema of the clock is a part of the cognitive map, just as the clock itself is a part of the real environment. The perceptual cycle itself is embedded in a more inclusive cycle that covers more ground and more time. Figure 3 illustrates this relationship. The schema directs looking, the cognitive map directs traveling. Both are simultaneously active and offer each other mutual support.

Although perceiving and traveling are similar activities, there is a crucial difference between them. In perception, successive phases follow one another very rapidly, and we are often unaware of them. In traveling, however, there are often prolonged periods during which we anticipate objects or events that have not yet appeared. During the time it takes me to get home from my office, for example, my cognitive map is preparing to pick up the information that will become available when I get there, as well as for the territory in between. Throughout the trip I have active but still "unfulfilled" expectations. This is not an unusual circumstance: all mobile organisms must often be in such a state. The proper term for this state, I suggest, is "mental imagery."

This definition of imagery differs from more familar ones in two ways. First, it is not introspective. Any organism that anticipates the layout of objects in the environment and directs appropriate movements as a result may be said to have spatial imagery. Second, while the image represents "stored information" in a certain sense of that word, it is not ordinarily used as stimulus information would be.

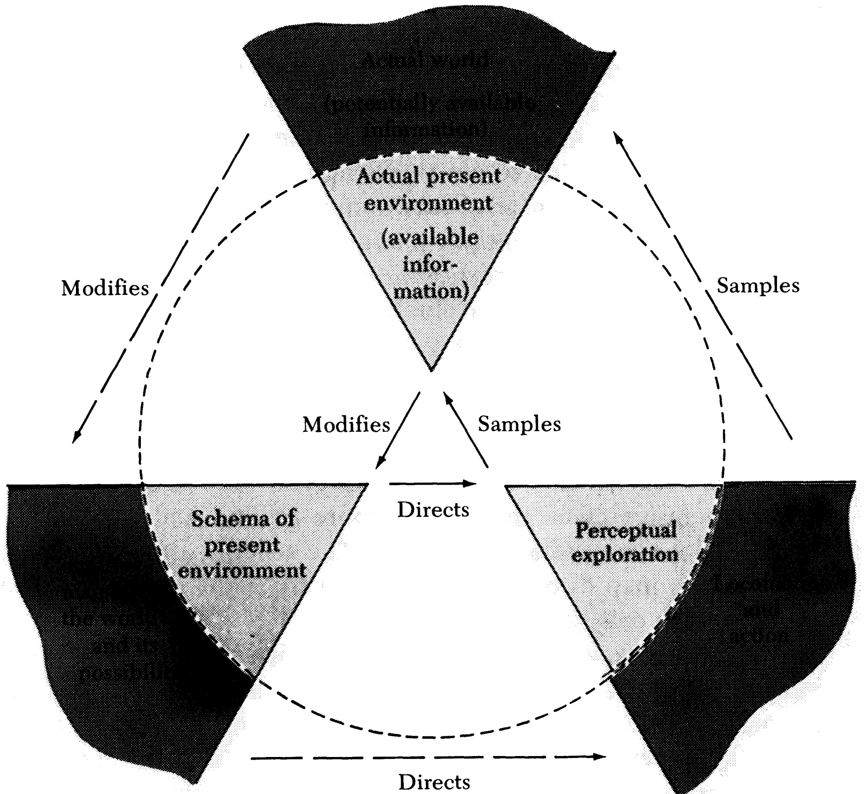

Figure 3. Perceiving as embedded in traveling. Reprinted with permission from *Cognition and Reality* (Figure 4) by Ulric Neisser, W. H. Freeman and Company. Copyright © 1976.

The traveler need not *examine* his cognitive map, as he might study a real map to determine his route. A mental image is not a picture of the world, but a plan for obtaining information from parts of it that have not yet been reached. It is the inner aspect of a spatial anticipation. When a subject reports verbally about an image, he is really reporting quite literally what he—or at least his visual system—is prepared to see. The referents of language about images are possible perceivable objects in the environment, not phantasms in the head.

It is evident that if cognitive maps are essentially perceptual anticipations, they must be flexible and easily altered. After all, the world itself changes: we find a visitor in the living room, or a package on the desk, and we replan our information-gathering activity as a result. Schemata and cognitive maps can change even while they are actively controlling behavior. All of us know how to alter them, on the basis not only of what we see but also of what we are told. If we learn that there is a body or a treasure chest or a traffic jam at a certain point on the way home, for example, it is easy to modify our perceptual anticipations and our travel plans. Many people have learned to take advantage of this flexibility in a way that gives images a secondary function. Besides being plans for traveling and looking, they can serve as mnemonic devices.

Consider first the "method of loci," a curious and ancient trick for remembering things that has intrigued contemporary psychologists to no small degree. This device, invented by the Greeks in classical times, is suitable for remembering any arbitrary list of items. To use it, you must first familiarize yourself with some series of locations along a particular route or path. (For the ancients this was often walking through a large temple with many niches and statues; nowadays a university campus is more convenient.) Once learned, such a cognitive map can be used over and over again for mnemonic purposes. To remember any particular list, simply visualize the successive items as if they were situated at consecutive spots, or "loci," along your path. When you wish to recall them, take a mental stroll along the path; you will find the items all still comfortably in place (Ross & Lawrence, 1968). Of course there is some "suspension of disbelief" involved: you need not really believe that the objects are there. But you are prepared to see them, and an appropriate test might well show that you *could* perceive them easily and quickly. That is why everyone can use this method: in many classroom demonstrations, I have never found a student unable to do so. Everyone who gets around in the world must be able to form and modify cognitive maps, and the method of loci is nothing but the use of a cognitive map for an unusual purpose.

The cognitive map is the most basic form of imagery, but not the only form. Perception is a cyclic process even when a stationary observer views a single object; anticipatory schemata play a crucial role. Normally perceptual plans and their executions succeed one another so rapidly that we are aware only of the object itself, not of the individual glances or the states of preparation that precede them. Nevertheless, these states are present, and when they are prolonged for any reason we may notice them. We call them, too, "images."

This kind of imagery underlies other imaginal mnemonic devices. When subjects remember a pair of nouns by visualizing the corresponding objects in interaction, they are preparing to see these two objects themselves, to move their eyes and their heads as would be necessary if the objects were present, and to pick up the kind of information that such movements would bring. A subject who memorizes the pair "shark-crib" by imagining a shark in a crib is making just such a plan. In this case his plan has no perceptual function—neither the shark nor the crib will actually come into view—but he can report on what he would expect to see if they did.

This interpretation explains why imagery instructions work well only with so-called concrete words (Paivio, 1971). In fact, it provides a specific definition of "concrete." Words are concrete to the extent that they denote objects that offer *anticipatable* sensory information. Nothing else can be visualized, because to visualize is to anticipate. This interpretation also explains why the objects must be imagined in some kind of *interaction*. Two objects interact, in this sense, if the perceiver must take their relationship into account in order to see them properly. That is why the shark had best be imagined inside the crib, or eating it, but not merely next to it, if they are to be remembered together.

Because schemata and cognitive maps are anticipations, they can and do represent objects that are temporarily concealed or obscured as well as those in plain sight. This suggests that one can imagine a concealing, nonpicturable relationship between two objects as easily as any other kind, and use it as a mnemonic device. It should be just as effective to imagine the crib completely inside the shark as the shark inside the crib, for example. This turns out to be true, as Nancy Kerr and I reported recently (Neisser and Kerr, 1973). Although our subjects reported that images of concealed objects were less "vivid" or "good" than other images, they were no less effective as mediators for memory. Images are not like pictures; indeed, they are not even exclusively visual. An anticipatory schema can direct reaching and touching and listening as well as looking. If a schema can be said to represent anything—and I have some doubts that it can—it represents the spatial arrangement of objects rather than just the way they look.

From this point of view, the fact that images facilitate rapid perception of an imagined object is not a minor byproduct of the act of visualizing; it is the essence of that act. To have a perceptual set for something is to have an anticipatory image. The more precisely the image anticipates the actual information to come, the more effective it will be. Posner and his colleagues have demonstrated many times that a subject who has just seen a particular letter, say a capital *A*, will respond to it more quickly if it appears again in the same form and less quickly if it now appears in a different form, say as a lower-case *a* (e.g., Posner, Boies, Eichelman, & Taylor, 1969; Beller, 1971). Indeed, facilitation occurs even if the subject is merely told what the coming letter will be, so that he can imagine it. I believe the facilitation occurs because the subjects actually *perceive* the relevant information more quickly when they are appropriately prepared. If images are essentially perceptual anticipations, this result is easily understood.

Anticipations may be formed at various levels of detail. One can look at something casually or carefully, from close up or far away, with an interest in one part of it or another. All these kinds of looking require different plans, and hence they correspond to differences in imagery. Kosslyn (1975) has recently shown that one's ability to report small details of the appearance of an imagined animal, for example, depends on how large and how close he imagines the animal to be. This need not mean that an image of a large animal is a big, detailed picture and that of a small animal a small picture: our plans for looking at a large animal are simply different from our plans for looking at a small one. Similarly, our plans for looking at a rotating or a rotated object are different from our plans for looking at an upright and stationary object, and it takes time to convert from one plan to the other.

If images are anticipatory schemata, they should serve to direct anticipatory behavior. This suggests that one should make the same kinds of eye movements in imagining something as in actually looking at it. Such a proposition cannot be tested with ordinary images, because there are too many different ways to look at things. The eye movements made in examining a chair, say, will vary with the intent, skill, and momentary inclination of the observer, and thus cannot easily be predicted. For the reason an equally wide range of eye movement patterns, including no movement at all, may occur as one *imagines* a chair, i.e., develops a particular plan for looking at it. A test becomes possible, however, if one imagines an event involving systematic motion, like a tennis match. Under these conditions, the eye movements of imagers do follow the expected pattern (Antrobus, Antrobus, & Singer, 1964). The same principle applies even to dreamers. When the content of a dream includes regular movements, as indicated by the dreamer's subsequent report, appropriate eye movements often occur (Koulack, 1972). The reason for this is not that the dreamer first has a mental picture and then moves his eyes to examine it. Rather, he just anticipates seeing something, plans to look at it, and executes as much of his plan as he can.

In summary, the reason that we do not regularly confuse imagining with perceiving—or images with objects—is that these are activities of fundamentally different kinds. Perception is a cyclic interaction with the world; an image is a single phase of that interaction. Treating them as equivalent would be like identifying fulfillment with promise, or a plant with its seed. Such a mistake is impossible under normal conditions. To be sure, we may make perceptual errors, mistaking a stranger for a friend or a tree for a looming monster. Such errors confuse objects with one another, but not images with objects. Errors occur because not enough information has been picked up; perhaps too little exploratory activity was conducted, or an anticipatory image misdirected the perceptual process. Usually enough information is picked up to correct such mistakes quickly. When they go uncorrected in the hallucinator or the dreamer, it is in some sense because he is "not really trying"; his problem is fundamentally one of motivation, not of perception.

Perceiving is like science—subject to many errors, but self-correcting in the long run. Eventually we obtain better information about the world than we had before. Let us hope this proves true of the scientific study of perception and imagery as well as of the directed activity of perceivers and imaginers.

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