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The Role of the Percept in Visual Cognition

In his recent book (1975, p. 24) Irvin Rock remarks on the way specialists in the study of perception have staked out certain problem areas that are more or less distinguishable from those of neighboring disciplines. The field of perception can be said to lie between the field of sensory processes on the one side and of cognitive processes on the other. Investigators of sensory processes are typically concerned with the psychophysical relationship between stimulation and sensation and with the physiological mechanisms that mediate sensation. On the other hand, investigators of cognitive processes are concerned with problems that begin where preception ends. They begin with the perceived object as given and tend to concentrate on such processes as recognition, recall, association, attention, understanding, problem-solving, and thinking.

Another way to put this same point is to say that there are both an etiological and a functional story to tell about perception. The etiological story is concerned with the causal antecedents of our perceptual experience, the sorts of mechanisms, processes, and factors that go into determining the character of that experience. The functional story, on the other hand, looks to the results, the effects, of such experience on the organism's continuing adjustment to its environment. Here we are concerned with the role, the upshot, of perception in the satisfaction of the organism's needs, desires, and purposes.

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It is hard to fault either approach to the study of perception—unless, of course, it purports to be the *whole* story. It seems reasonable enough to suppose that perception falls somewhere between the S-R poles and even more narrowly, as Rock suggests, somewhere between the sensory and cognitive process with which it is so intimately connected. It is the purpose of this paper to explore just where (if anywhere) on this flow chart, this bluprint of the organism reacting to and interacting with his environment, we may best locate perceptual phenomena. I shall suggest that there is, in some quarters, a tendency to overfunctionalize perception, a tendency to assimilate it to the genuine cognitive processes to which it gives rise. I hope to nudge it, ever so slightly, away from the response and back toward the stimulus end of this spectrum.

If I understand them, many psychologists and philosophers mean to speak of a certain internal, conscious state when they speak about a subject's *perception* of an object or event. In other words, in speaking of *S*'s perception of depth or *S*'s perception of motion, they mean to refer to *S*'s perceptual state—something we might also refer to as the *way things look* to *S* or the *way he perceives* things quite apart from the way things actually are. I shall not use this terminology. I shall, instead, speak about *S*'s percepts. This terminology, although it horrifies some and is avoided by others, has a decided advantage. It clearly suggests that what we are talking about is some internal state of *S* and *not* some relationship between *S* and the objects in his environment. Although this is merely a terminological point, the terminology is important; it has been responsible for some confusion. Let me take a moment, therefore, to explain what I see as the difference between *S*'s percept of something and *S*'s perception of something, and why I prefer the former terminology.

If *S* owns a house, we can speak of *S*'s owning the house or of the house *S* owns. These are different things and not likely to be confused. We can paint the house *S* owns, but we cannot paint *S*'s ownership of the house. If *S* sells the house, his ownership ceases, but the house he owned may persist unaltered. *S*'s owning the house is a *relationship* that exists between *S* and the house; the house *S* owns is the object to which he is related.

The distinction is obvious enough in terms of this example. Yet it tends to get blurry when we move to other cases. For example,

we can distinguish between my being frightened by you, and my fright. My being frightened by you is a complex relational state of affairs that involves you as an essential ingredient; you are a *part* of this relational state. I cannot be frightened by you unless you exist. On the other hand, my fright is some internal state of me. It is something of which you are not a part although it is something of which you are the cause.

Similar remarks can be made about *S*'s perception of *O* and *S*'s percept of *O*. *S*'s perception of *O* is a relationship that exists between *S* and *O*; it is a state of affairs that cannot exist unless both *S* and *O* exist and stand in the appropriate relation to each other. *S*'s percept of *O*, however, is a state of *S alone*. It does not have *O* as a part even though it is brought about or produced by *O* (thereby allowing us to refer to it as a percept *of O*). The point can be put this way: just as my being frightened by you involves (very roughly) your producing in me a certain internal state, a state to which we may refer with the phrase "my fright," so, also, my perception of you involves (again, very roughly) your producing in me a certain internal state, a state to which we may refer with the phrase "my percept."

The confusion between *S*'s perception of *O* and *S*'s percept of *O* appears in the dispute about whether perception of something (a table, say) is possible when there is no table (no *real* table) present. If one uses the phrase "*S*'s perception of a table" to refer to *S*'s percept of a table, then it is easy enough to suppose that since *such* percepts can occur without a real table being present, one's perception of a table does not *require* a real table. This, it seems to me, is a confusion that could easily be avoided by making a clear distinction between *S*'s perception of a table (which, being a relationship between *S* and a table, requires the existence of some table) and *S*'s percept of a table. The latter is the sort of thing that *can* exist without a real table being present (although, of course, if there were no real table present, we would not refer to *S*'s percept as a percept *of* a table). We can have "table percepts" just as we can have "ghost fears" without real tables or real ghosts, but we cannot *perceive* a table or be *frightened by* a ghost without encountering the genuine articles.

This distinction, once mentioned, is rather obvious, and I assume that my readers will find it so. I remark on it, not with the intention

of saying anything novel, but only for the purpose of marking a difference and noting the somewhat confusing way this difference is sometimes expressed. In this paper I want to talk about our percepts (roughly: our perceptual experience or the way we perceive things)—a type of internal state that is typically produced in us as a result of our interactions with our surroundings. Some people, perhaps skittish about the mentalistic or imagistic connotations of the word "percept," prefer to talk about the same thing by speaking of our perception of things. For the reasons just given, I shall not talk this way. I hope it will be clear, however, that this is *just* a difference in the way we choose to talk; we *are* talking about the same thing.

I have already suggested a preliminary characterization of a percept: it is some type of internal state that is (under normal circumstances) causally dependent on the objects and events that we are said to perceive. There is, unquestionably, this type of causal dependence.[1] Nevertheless, it also seems clear from a variety of experimental studies that our percepts, though dependent to a greater or less degree on the distal and proximal stimuli, are not wholly *determined* by these stimuli. There is an obvious dependence on the state of the receptors, the neural pathways, and the brain. But even holding these variables fixed, or as fixed as we can hold them, we have efferent effects on our percepts of motion and position, the shifting perception of ambiguous figures (where there is a change in the percept without a corresponding change in the proximal stimulus), and the influence of such factors as set, attention, and past experience on the resultant percept. Gibson's advocacy of an updated psychophysical correspondence (1950, 1966) has made it more common to hear about the availablility *in* the stimulus of information formerly taken to be an enrichment *of* the stimulus (or stimulus dependent sensations) by habit, memory and inference. But this constancy hypothesis is acknowledged to have only limited validity; experiments establishing the influence of set and attention on our perception of ambiguous figures (e.g., Steinfield, 1967), our variable perception of moving forms (Johansson, 1975), and the older experiments of the transactionalists (Kilpatrick, 1952)[2] serve well enough, it seems to me, to belie any full correspondence between stimulus and percept.

Equally obvious is the underspecification of the percept by the subject's behavioral responses. Although a subject's behavior, verbal and otherwise, is (often enough) conditioned by his concurrent perceptual state, his perceptual state is only one of the many variables that go to determine his behavior and his disposition to behave (Garner, Hake, & Eriksen, 1956). This means that the percept is left underspecified by the kind of information available in the subject's overt responses. Methodologically, of course, one is forced to rely on the subject's reports and other discriminatory behavior (using, whenever possible, converging operations) in framing hypotheses about his percepts, but this is clearly the relationship between indicator and indicated. There are a variety of factors that can influence the reliability of this index. The subject's overt behavior is presumably a function, not only of his percepts, of how things look and sound to him, but also of his beliefs, attentiveness, habits, expectations, interests, purposes, and values. The notion of a response bias seems to presuppose the distinction between the percept itself and the array of behavioral responses we exploit to specify it. These other variables help to determine, not only the character of the response, but whether there is a response at all; from signal detection theory (Engen, 1972, and Swets, Tanner, & Birdsall, 1961) we learn that whether or not a response is forthcoming depends, not only on the effect of the stimulus relative to the noise, but also on what the observer *expects* in the situation and the potential consequences of his decision.

We can, of course, *call* the percept itself a kind of response—e.g., a central response—but this verbal maneuver accomplishes nothing. The fact remains that these "central responses" are as loosely associated with the overt responses in terms of which one identifies and characterizes these central states as they were when called by another name. Referring to these central states as dispositions to behave, or (Pitcher, 1971) suppressed dispositions to behave, is equally futile; we are still left with something whose character is underspecified by the available input and output data.

I shall have more to say in a moment about the relationship between a subject's responses and his percepts. For the moment I shall simply assume, without further discussion, that the idea of a percept, or a perceptual state, is the idea of an internal state which,

though conditioned by the stimulus and in turn a possible factor in the response, is not wholly determinable by either. It is this underdetermination of the percept that I mean to signal by my use of the adjective "internal" in referring to a percept as an internal state of the subject. It is internal in the sense in which the totality of stimulation and the totality of behavioral responses are external.

If this is all that could be said about the notion of a percept, there would (or should) be little debate about the existence or role of such elements in visual cognition. For there clearly are stages in the processing of sensory information that fit the characterization of a percept just given. For instance, there are neurophysiological states or processes (perhaps the neural activity in the superior colliculus) that depend on, but are not wholly determined by, the character of the incoming stimulation and that, in turn, affect (but do not wholly determine) the subject's motor responses. What is missing in my description of a percept is that feature that distinguishes this particular internal state from a variety of other intermediate stages in the processing of sensory information. The feature usually mentioned in this regard is our conscious awareness of the percept, its introspective accessibility, its phenomenal character. The idea of a percept, after all, is supposed to be the idea of an internal state that somehow constitutes our visual experience; and it is this experiential quality that is usually invoked to distinguish a percept from the variety of other internal states that can be given similar functional and etiological characterizations.

I think there is some merit in talking about our perceptual states in the language of "conscious experience" and "phenomenal appearances," but, unfortunately, the merit does not lie in the precision or illumination that such language provides. The merit in using this kind of language is that it indicates, in a rough and familiar way, what it is that we want to talk about. The trouble is that it does not supply us with the means for talking about these things in a precise enough way to allow us to determine whether what we say, or want to say, about them is true or not. Such language has the further demerit of stirring up a swarm of philosophical and terminological problems that I am anxious to avoid. Therefore I propose to retreat slightly and approach the question of what it is, specifically, that we mean to talk about when we refer to a subject's percepts in a slightly different way.

Suppose objects of type *O* have a peculiar effect on humans; they induce a kind of neurological activity (call it *N*) that quickly, in a matter of minutes, manifests itself in a periodic twitching of the cheek muscles. There is no pain or other discomfort associated with this effect, and with most subjects the twitching goes unnoticed. If we suppose that the neurological state *N* is specific to objects of type *O*, we can describe the subject's reaction to *O* in informational processing terms. The state *N* embodies information about the subject's surroundings, information to the effect that there is (or was, a few minutes earlier) an object of type *O* nearby. The involuntary twitching, being a distinctive symptom of state *N*, also contains the information that there is or was an object of type *O* nearby. There are, in a sense, coding, storage, and retrieval of information.

The fact that such a regular sequence of events can be described in informational terms should not suggest that the subjects *in whom* such information is being processed know anything related to the information passing through them. One could say, I suppose, that the subject's *body* knows that an *O* is present, but it is fairly clear that *the subject* does not (or need not) know that an *O* is present. The information passes through without becoming available to the subject himself. Although he embodies an *O*-detecting mechanism, although his nervous system is acting as a channel for the transmission, and temporary storage, of this information, the subject himself does not *have* the information about the presence of an *O*. He may not suspect that an *O* is present; he may even disbelieve in the *existence* of *O*s and act in accord with this conviction. The fact that our subject is in a certain internal state, a state that can for certain informational purposes be described as an *O*-positive state, is quite irrelevant to determining *his* cognitive capabilities. One needs more than a built in *O*-detector to be a detector of *O*s. One needs some kind of mediating process (Hebb, 1966) to convert these reflexes into perceptual responses.[3]

Our hypothetical subject might, by glancing in a mirror, realize that an *O* was nearby by noticing the abnormal twitching in his cheek. This, however, is a new and different story. He is now using his body as he might a piece of litmus paper, and his body does not know, any more than does a piece of litmus paper, what *he* can come to know by observing it. The information about the presence of an

O is now being *reprocessed* through a different system, the visual system, capable of giving the subject information that formerly, when he served merely as a conduit, was denied him.

When we speak, as we naturally do, of certain neural networks or cells as edge-detectors or movement-detectors, we should similarly bear in mind the fact that the subject himself (the *total* system, if you will) in which these detectors are found as parts, need not be able to detect either edges or movement (although from an evolutionary standpoint, it would be surprising indeed if this were so). Whether the system as a whole can detect edges depends on how its component edge-detectors are integrated into the system. That subassembly that we choose to call an edge-detector must not only detect edges, thus having *its* output conditioned by the presence of an edge, it must make this information available to the system of which it is a part for purposes of shaping *its* responses. A system cannot live on the reputation or performance record of its parts. *You* earn no cognitive credits for the detective capabilities of your parts—not unless the results are made available to you for modulation of *your* responses.

If we keep this point in mind, I think it is easier to see what kind of internal state we mean to describe when we talk about a subject's perceptual state. We do not want just any stage in the processing of sensory information, nor do we want a composite of *all* stages. We want that point in the process at which the information from the assorted detection mechanisms *is made available to the system as a whole*. We want that point in the flow of information at which further activity, if any, may be counted as responses of *the system* and not just as outputs or responses of its components. Before we reach the point at which the information is made available to the system as a whole we have detector mechanisms responding in their appointed way, but the system containing these mechanisms has not yet detected anything. After this point we have a response, the onset of behavior, by the system itself—an output that is to be accounted for, partially at least, by the information made available to the system by the foregoing processes. We have, in short, a genuine *perceptual* response.

What is to be counted as a response of the system as a whole, as genuine behavior of the system itself, and not merely as a reflex or

a response of some component of the system? This is a sticky question, and I am not really going to attempt a full answer. Dennett (1969; see also Rundle, 1972, pp. 85-86) takes an approach that I consider promising. In discussing the distinction between what he calls intelligent and nonintelligent storage of information (p. 46) Dennett describes intelligent storage as the storage of information that is *for the system*. Information *for* the system is information the system can *use*, and useful information is ultimately to be understood in terms of the system's needs and purposes. I am interested not so much in the details of this view as I am in the general program it represents and the implications of this general approach for understanding perception. For what we are now embarking upon, if we follow through this line of thought, is a shift to a functional characterization of the percept. The general outline of this approach goes something like this: perception is the pickup of information. But, as we have just seen, not all the information a system absorbs is perceptual in character. Only that is to be counted as perceptual that is made available to the system as a whole and can therefore figure, more or less directly, in the system's pattern of responses. And the *system's responses*, in contrast to the responses of its gall bladder, sweat glands, basilar membrane, or cheek muscles, are those responses that are determined, not only by the incoming stimulus information, but also by the needs, purposes, and desires of the system as a whole. Hence perception is to be understood as the pickup of information available to the organism and serviceable to it in the satisfaction of its needs and purposes.[4]

A simple analogy is available. The ordinary home thermostat monitors the room temperature and responds by sending a signal to the furnace. The signal sent to the furnace is a function of two things: the information received about the temperature of the room, and the desired temperature of the room as given by the preadjusted setting of the thermostat itself. The thermostat's response is therefore determined by *both* the information received about the temperature of the room *and* the desired state of the room as reflected in its preadjusted setting. If we trace the flow of incoming information, we can treat the bimetal strip, whose curvature depends on the ambient temperature, as a temperature detector. Its responses depend, simply, on the temperature of the room. The responses of

this crucial component, however, are not to be counted as responses of the thermostat itself. The thermostat itself has a different function than merely registering the temperature; its function or purpose is to send a signal to the furnace about the *difference* between the actual temperature and the desired temperature. In light of this function we can identify responses of the thermostat itself, in contrast with responses of its various components (e.g., the bimetal strip), as responses that are determined not simply by the incoming information, but by this information *together with* the adjusted setting indicative of the desired temperature.

At what stage is the information about the room temperature made available to the thermostat for use in determining its responses? Clearly enough, the information about the room temperature is available *in* the configuration of the bimetal strip. *That* is where the information is, but what makes this information *available* to the thermostat itself is the positioning of the bimetal strip relative to the electrical contacts completing the circuit to the furnace. Move these contacts far enough and the information, though still there *in* the thermostat, as it were, is no longer available to the thermostat. We shall have a temperature detector (the bimetal strip), but *the thermostat* cannot detect the temperature. *It* cannot detect the temperature because the information is not available to it for modulating its responses to the furnace—and *that* is its function.

The configuration of the bimetal strip in a properly manufactured thermostat is, therefore, the analogue of a percept or a perceptual state. It is that internal state of the system in which stimulus information is made available to the system as a whole for the purposes of determining its responses.[5] The system's responses, in turn, are to be measured in terms of its function, purpose, or (should it have such) needs and desires.

We now have a dual specification of a percept; the description is partly etiological, partly functional. We are talking about something that has a certain origin, something with causal antecedents in the stimulus, something that (normally, at least) embodies information about these causal antecedents. But we mean to speak of only some of these etiologically described elements, only those that also have a certain functional role to play in the behavior of the organism itself,

only those that have, or can have, *certain sorts of effects* on the output of the system as a whole.

If something like this dual characterization of a percept is even roughly correct, and it seems to me that it is, we should expect to be able to investigate perceptual phenomena from the point of view of both input and output, cause and effect, etiology and function. And this, it would appear, is our actual practice. To put it somewhat crudely, our inferences about what people see, about the character of their perceptual experience, is sometimes based on what goes in and sometimes based on what comes out. When the sleeping cat opens its eyes, looks about the room for a moment, yawns, and goes back to sleep, we may suppose that it saw us despite the absence of any overt responses to indicate that it did. And when, despite our efforts at concealment, the rabbit raises its head, tenses, and then darts into the underbrush, we suppose it somehow sensed our presence, although we might not be sure just how. There are, however, methodological reasons for placing greater, almost exclusive, reliance on the output or response end of this inferential base. For the matter under investigation is often what the relationship is between stimulus input and the percept itself, and when *this* is the empirical question under investigation one cannot, on pain of circularity, rely on the stimulus itself to determine what features will be assigned to the percept. This would trivialize the entire project. One needs an independent determination of the percept for an investigation of this sort, and the only independent basis available for defining the character of the perceptual experience is the response of the subject. In a study of this sort one is, of necessity, restricted to a response-based specification of the percept.

This methodologically induced restriction is innocent enough as long as it is properly understood as a constraint on empirical investigations of a certain sort. There is, however, a tendency to interpret it as something more fundamental, as somehow a manifestation of the underlying *functional* nature of perception itself. Restriction to a subject's responses in determining the way he perceives what he perceives fosters the idea that if something goes in and does not come out, and cannot be made to come out under properly controlled conditions, then it did not really get in—not, at least, in the

way that deserves to be called *perceptual*. To concede it a perceptual status, in the minds of some, would be to remove perception from the realm of empirical science since there is no way (given the methodological limitation) to determine that such perceptual events are occurring.

This, I suggest, is an overfunctionalization of the concept of a perceptual state. It is to take something that is functional and transform it into something that is *only* functional. But functional states also have an etiology, and it would be surprising indeed if nature were so streamlined in its operation that it could produce functional elements without, in the process, creating a few superfluous, functionally superfluous, adjuncts. Valve-lifters (Fodor's example, 1969) are certainly functional devices, and when we refer to them as valve-lifters we refer to them in explicitly functional language. But these facts should not prevent one from appreciating that what we are referring to is something that also has an origin and a nature quite independent (logically) of the purpose it serves in the larger system of which it is a part. If I were eccentric and wealthy enough, I could have my car's valve-lifters inlaid with pearls. This would not make any difference to the valve-lifter as a valve-lifter, since its performance in lifting valves would be unimpaired. But it would be a gross overfunctionalization of the notion of a valve-lifter, a confusion between *what* we were talking about with *how* we were talking about it, to argue that from a functional standpoint my valve-lifters could not be studded with pearls because such decoration would have no discernible effect on their performance in lifting valves. True enough, but the question of whether my valve lifters are so adorned is still a legitimate question; one must simply look to something other than their output or performance in answering it.

I believe a similar point can be made about our percepts or perceptual experience. Consider, first, the well-known experiments by Sperling (1960) and Averbach and Coriell (1961), in which subjects were exposed to an array of nine or more letters for a brief period (50 milliseconds). It was found that after removal of the stimulus there was a persistence of the "visual image"; subjects reported that the letters appeared to be visually present and legible at the time of a tone occurring 150 milliseconds after the stimulus had been removed. Niesser (1967) has dubbed this iconic memory—a temporary

storage of sensory information in perceptual form. It is unimportant (for our purposes) whether we think of this as the persistence of *an image* or not. What is important to notice is that although subjects could identify only three or four letters under these brief exposure conditions, *which* three or four letters they succeeded in identifying depended on the character of a later stimulus—a stimulus that only appeared 150 milliseconds *after* removal of the original array of letters. This later stimulus (a marker appearing in different locations) had the effect of shifting the subject's attention to different parts of the *persisting icon*. This was not a case of shifting the subject's attention to different parts of the *stimulus*; for, of course, the time at which the shift occurred was 150 milliseconds *after* the stimulus had been removed.

These experiments suggest that although there may be an information-extracting limitation on the subjects, the same limitations do not apply to our visual system. Although the subjects could succeed in identifying only three or four letters, information about *all* the letters was contained in the persisting icon. The visual system had information about the character of all nine letters in the array, whereas the subject had information about at most four. The availability of this information is demonstrated by the fact that after removal of the stimulus the subject could (depending on later stimulation) extract information about *any* letter in the array; hence, information about *all* the letters in the array was available *in* the persisting icon. The visual system was processing and making available a quantity of information in excess of what the subject (or the higher cognitive centers) could absorb.

The sense in which this perceptual information is available to the subject is the sense in which we might say that all the information in the public library is available to you even though you are allowed to check out only three books. The percept is like a well-stocked library; it constitutes a pool of information from which you, given your limited check-out privileges, can extract only a fraction. The remaining information is available to you in the sense that although you can leave with only a part of the whole, you can leave with *any* part of the whole. After leaving the library with your three books there is a sense in which the only information *now* available to you is the information contained in those three books you selected. You

exercised your option, you made your selection, and the information *now* available to you is but a part of what *was* available to you when you were in the library before making your selection.

There is a similar difference between perception and such higher-level cognitive processes as recognition, identification, discrimination, and learning. The subjects in the above experiment could "check out" only four letters; these are the letters they recognized or identified. But while they were *in* the library, during that fraction of a second in which the stimulus was present and the icon persisted, *all* of the letters were available to them. Once the stimulus had been removed, once the subject closed his eyes, looked elsewhere, or moved on to other things (thus leaving the library), the amount of available information was reduced; the subject was left (in short-term or long-term memory) with what he had succeeded in extracting from that larger pool of information (the percept) available to him during stimulation. These subjects perceived all nine letters in the array; this was the information available to them during (and shortly after) stimulation—available to them, not only *in the stimulus*, but *in the percept* generated by that stimulus. Though perceiving all nine letters, these subjects recognized or identified only three of four letters; this is a measure of the information they extracted from the percept, information that was available for shaping their responses (including their verbal responses to questions about *what* they had perceived). To confuse the information that was available in the percept with the information that is actually extracted, stored, and effective (or potentially effective) in determining behavior is to confuse perception with cognition. In terms of our analogy, it is to confuse the total informational resources of the library with the more limited quantity of information one extracts from it.

I am afraid this talk of libraries and the information available in the books one may or may not choose to read will make it sound as though I view the percept, the sensory information available to the subject, as a stack of mental "bulletins" that the busy homunculus has scarcely time to read. I hope not one will take my illustration that literally. I do not think the percept is something that the subject scans, perceives, decodes, interprets, or is even aware of if by "aware of" we mean something like that perceptual relation between subject and object in which we speak of ourselves as aware of flowers

and people. Quite the contrary. If the subject perceives anything, he perceives (I would argue) causal antecedents of his percept, those objects and events in his environment that the information in his percept is information *about*. My library example was only meant to illustrate the distinction between the information available to the subject and the information the subject actually extracts—the distinction I take to be fundamental between perception and cognition. If the percept is to be understood in informational terms, as I have suggested it can be, we must remember that it is the visual system, *not* (or not *necessarily*) the subject, that has the information. Whether the subject himself knows anything, whether he stands in any cognitive relation to the events and objects responsible for his percept, is a question of what sensory information he succeeds in extracting from the information embodied in this percept. The information in the percept is information available to the subject, not in the sense that *he has the information*, but in the sense that (during stimulation) *he could have had it*—perhaps not *all* of it, but certainly any part of it.

My lengthy discussion of tachistoscopic experiments may suggest that the distinctions I am urging are a special feature of such situations. Let me try, therefore, to make the same point with homelier examples. Think of occasions on which you have looked at a fairly complex scene: a crowd of youngsters playing in a schoolyard, a shelf full of books and knick-knacks, or a display of the American flag with all the stars and stripes fully visible. I think a reaction typical of such encounters is that we have seen a great deal more than we noticed or consciously attended to. There were 43 children in the playground, and although we may have seen them all, we do not know *how many* we saw. We perceived 43, but this numerical information is not information that we generally extract from such experiences. Some children wore blue shirts, some red shirts, some white shirts, but we noticed only the cute little girl in red who was jumping rope. Some children were tall, others were short, some were moving, others were still. Much of this, I submit, is information available to us in the perceptual experience, but it is not information that *we* (the subject) succeed in extracting (either consciously or unconsciously, in long-term or short-term memory) under routine perceptual conditions. Notice, I am not denying that this informa-

tion *is* extracted and processed, is made available to us by our visual systems. What I am denying is that in typical cases the *subject* extracts all this information.

It will certainly be said that I am assuming something for which I have given no argument: viz., that the visual system does make available in our percepts the kind, and variety, of information just described. Before trying to answer this charge, let me hasten to emphasize that I am not asserting or assuming any simple psychophysical correspondence between information available in the percept and information available (in the stimulus) at the retina. There is obviously a *loss* of information between that which arrives at the receptor and that which is available in the percept (and, conversely, there may be a *restoration* of information not available in the stimulus—see, e.g., Warren, 1970). If one saw all 43 children but saw some of them only peripherally, it seems unlikely that information pertaining to the color of their clothing would be available in the percept. If such color information, contained in the light reaching the retina, does not reach the color-sensitive cones in the fovea, it will obviously not be available in the resultant percept. But even with these peripherally seen children, information about their relative location, size, and spacing will be transmitted. Even if, following Neisser (1967), we suppose that the preliminary operations associated with the preattentive processes (prior to the more elaborate processing associated with focal attention) yield only segregated figural units, units that lack the richness of information available in those portions of the field to which attention is given, there is (I suggest) more information embodied in these figural units than we, as subjects, normally extract: information about the spacing, number, and relative size and position of the objects represented. Typically the output of our sensory systems overloads the information-handling capacity of our cognitive centers so that not all that is given to us in perception can be digested. The rule of seven (Miller, 1956) applies to cognition, not to perception: to the information *we* can absorb, not to the information our sensory system can absorb and transmit. If it applied to perception one would expect a sky with 10 visible stars to look the same (to generate the same precept) as one with 10,000 visible stars, and it clearly does not.[6]

Taking a cue from the tachistoscopic experiments described above, consider the following thought experiment (I do not know whether anything resembling it has been performed). Imagine yourself viewing a field containing 45 discrete objects. Recently, for example, I found myself observing an American flag manufactured around the turn of the century. It contained (as I later determined) 45 stars. Was this numerical information available to me in my percept during my first, casual, inspection of the flag? Clearly, *I* did not have this information; quite the contrary, I thought there were 48 (or perhaps 50) stars on the flag. Was this information nonetheless contained in my percept? If so, in what sense? Suppose I viewed the flag in such a way that a faint after-image was created when I turned away. Suppose, furthermore, that this after-image was projected into a carefully contrived background consisting of 45 dots spaced in such a way that each dot fell within the area of a projected star. Suppose, finally, that I could tell immediately that no star's after-image was without an enclosed dot, and no dot lacked an enclosing image (by "immediately" I mean "before the after-image faded"). We can now (knowing how many dots were on the background) say with some confidence that the after-image contained exactly 45 discrete elements. What does this tell us about the original percept? It tells us, I suggest, that our original percept of the flag contained this numerical information about the number of stars on the flag, information that I failed to extract and would, in normal circumstances, find almost impossible to extract without counting. Still, there is a clear sense in which the visual system made this information available to me, the same sense in which the tachistoscopic experiments showed that information about the unidentified letters was nonetheless available to the subjects.

Consider finally (and very briefly) an example from developmental studies. Eleanor Gibson (1969), in reporting Klüver's studies with monkeys, describes a case in which the animals were trained to the larger of the two rectangles. When the rectangles were altered in size the monkeys continued to respond to the larger of the two rectangles—whatever their absolute size happened to be. In the words of Klüver (Gibson, p. 284): "If a monkey reacts to stimuli which can be characterized as belonging to a large number of different 'dimensions', and if in doing so he reacts consistently in terms

of one relation, let us say, in terms of the 'larger-than' relation, he may be said to 'abstract'." Klüver's monkeys succeeded in "abstracting" the larger-than relation. But how shall we describe the perceptual situation *before* they learned to abstract this relation? Did the rectangles *look* different? If not, how could the monkeys ever learn to distinguish between them? It seems natural enough to say in a situation of this sort that prior to learning, prior to success in abstracting the appropriate relation, the monkey's percepts embodied the information that they only later succeeded in extracting. In such a case there is certainly learning taking place, but I see no reason to suppose that there is any change in perception, any change in the percept, any change in the information *available to* the monkeys. And if one thinks of *perceptual* learning, as it is common to think of it (Epstein, 1967), as the modification of the percept as the result of repeated experience, I see no reason to think of this as a case of *perceptual* learning at all. Indeed, a great many instances of so-called perceptual learning seem to me to be obviously cases of learning, but just as obviously *not* cases of perceptual change.

The situation becomes even clearer if we present our monkeys with three rectangles and try to get them to abstract the "intermediate-size" relation. This more difficult problem proved capable of solution by chimpanzees (Gibson, p. 292), but let us suppose our monkeys are incapable of solving the problem. Once again, what shall we say about the perceptual situation? Since the monkeys have abstracted the "larger-than" relation, the three rectangles must look different to them; the intermediate rectangle looks smaller than the larger one and it looks larger than the smaller one. But the information about which rectangle is intermediate, though obviously available in the percept itself, is not, and apparently *cannot* be, extracted by the monkey.[7] Here is an instance in which the difference between *perception*, the kind of sensory information *available* to the organism, and *cognition*, the kind of information *actually extracted* from that which is made available, is most obvious and compelling.

In conclusion, let me simply say that the idea of a percept is a functional notion, but only in an indirect way. It is functional in the same way a library with too many books for anyone ever to read is functional. It is functional in that it defines the informational upper limit of what can be functional. But if, in our efforts to understand

perception, we restrict ourselves to what *is* functional, we shall be missing most of what is fundamental and characteristic of perception itself.[8] We shall, I suggest, be neglecting what it is about perception that makes it, in contrast to its discursive and cognitive consequences, so rich, concrete, and informationally profuse. Just as most libraries contain more than we can ever take from them, we perceive more than we will, or can, ever know.

Notes

1. The causal theory of perception, understood as a philosophical theory about the meaning or truth conditions for the statement that *S* percieves *O*, makes the existence of such a causal dependence between *O* and *S* a *necessary consequence* of the fact that *S* perceives *O*. See Grice (1961), pp. 121 ff.

2. The experiments I have in mind are those demonstrating the "Honi" phenomenon and those with a trapezoidal window and intersecting bar, in which perceptual differences emerged as a result of different assumptions about the rigidity of the bar.

3. I have heard it said that vaccination produced memory. Apparently this was to be called memory because the subject's response to some later, similar event (exposure to smallpox) was modified as a result of his previous exposure. The subject "learned" something. The subject may, of course, remember the inoculation, but his immunity to smallpox is not itself a case of memory. Or, if it is to be called memory, then tempered metals, watered lawns, and sun-tanned skin have very good memories indeed. I have no objection to speaking of this as a kind of memory, but I think it should be carefully distinguished from the kind of memory we mean to describe when we say that the subject (not just his body) remembers being inoculated.

4. It should be noted that the usefulness of the response to the organism as a whole (the appropriateness of the response) does not itself confer on the internal informational state that generates that response a *perceptual* status. Even if *O*s were dangerous predators and cheek-twitching tended to frighten them away, this would not mean that our subjects thereby perceived *O*s. What is required is that the response (whether useful or not) *be* a response of the system as a whole, that it be generated, in part at least, *by* the needs or desires of the system whose perceptual capacities are in question.

5. If we take time into account there is also information embodied in the bimetal strip about the rate of change of temperature, information that thermostats are not designed to extract. Unlike human subjects, they are not properly wired to allow them to "shift attention" to this additional piece of information; hence this piece of information is not available to them in the way analogous information is available to human subjects.

6. J. R. Pierce (1961, pp. 248-49) makes a similar point in discussing the information processing capacity of subjects:

Now, Miller's law and the reading rate experiments have embarrassing implications. If a man gets only 27 bits of information from a picture, can we transmit by means of 27 bits of information a picture which, when flashed on a screen, will satisfactorily imitate any picture? If a man can transmit only about 40 bits of information per second as the reading rate experiments indicate, can we transmit TV or voice of satisfactory quality using only 40 bits per second? In

each case I believe the answer to be no. What is wrong? What is wrong is that we have measured what gets *out* of the human being, not what goes *in*. Perhaps a human being can in some sense only notice 40 bits/sec. worth of information, but he has a choice as to what he notices. He might, for instance, notice the girl or he might notice the dress. Perhaps he notices more, but it gets away from him before he can describe it.

7. If the monkey *cannot* extract the information, in what sense is it *available* to the monkey? The same sense in which information about *all* the letters in the array was available to the subjects in the experiments of Sperling, Averbach, and Coriell (although the subjects *could* not extract *all* this information), and in the same sense in which the information about the number of stars was available to me in my thought experiment (although I could not extract this information during brief inspection). Our conviction that this information was available to the monkeys, in their percepts, is based on our knowledge that the information that was available (relating to the "larger than" relationship) required (logically) the availability of the information about which rectangle was of intermediate size. That is, if we grant that the information that A is larger than B, and that B is larger than C, is available to the monkey in his perception of the rectangles, we are committed to treating the information that B is intermediate in size as also available. This is simply to say that the context "Information ——is available to S" is transparent to substitution of logically equivalent expressions, whereas the context "S knows that ——" is not.

8. Dennett (1969, p. 78) denies *content* to all those elements in (what I am calling) the percept for which there is no "demonstrably appropriate chain between the afferent and the efferent." As I understand this, Dennett is denying any content to the perceptual experience other than that which is somehow extracted by the organism for use in determining its motor responses. I think this is an unfortunate restriction in the idea of "content" and represents a mistaken conflation of perception with recognition (or cognition).

References

Averbach, E., & Coriell, A. S. Short-term memory in vision. *Bell System Technical Journal*, 1961, 40, 309-328.

Dennett, D. C. *Content and consciousness*. London: Routledge & Kegan Paul, 1969.

Engen, T. Psychophysics. In J. W. Kling & Lorin A. Riggs (Eds.), Woodworth and Schlosberg's *Experimental psychology* (3rd ed.). New York: Holt, Rinehart and Winston, 1972.

Epstein, W. *Varieties of perceptual learning*. New York: McGraw-Hill, 1967.

Fodor, J. *Psychological explanation*. New York: Random House, 1968.

Garner, W. Hake, H. & Eriksen, C. Operationism and the concept of perception. In Peter A. Fried (Ed.), *Readings in perception: Principle and practice*. Lexington, Mass.: D. C. Heath and Co., 1974. (Reprinted from *Psychological Review*, 1956, 63.)

Gibson, E. *Principles of perceptual learning and development*. New York: Appleton Century Crofts, 1969.

Gibson, J. *The perception of the visual world*. Boston: Houghton Mifflin Company, 1950.

Gibson, J. *The senses considered as perceptual systems*. New York: Houghton Mifflin, 1966.

Grice, P. The causal theory of perception. *Proceedings of the Aristotelian Society, Supplementary Volume XXXV*, 1961.

Hebb, D. O. *A textbook of psychology* (2nd ed.) Philadelphia: Saunders, 1966.

Johansson, G. Visual motion perception. *Scientific American*, 6 June 1975, 232, 76-88.
Kilpatrick, F. P. *Human behavior from the transactional point of view*. Washington, D.C.: Department of the Navy, 1952.
Miller, G. A. The Magic Number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 1956, 63, 81-97.
Neisser, Ulric. *Cognitive Psychology*. New York: Appleton Century Crofts, 1967.
Pierce, J. R. *Symbols, signals and noise*. New York: Harper & Row, 1961.
Pitcher, George. *A theory of perception*. Princeton, N.J.: Princeton University Press, 1971.
Rock, I. *An introduction to perception*. New York: Macmillan, 1975.
Rundle, B. *Perception, sensation and verification*. Oxford: Clarendon Press, 1972.
Sperling, G. The information available in brief visual presentations. *Psychological Monographs*, 1960, 74 (11).
Steinfeld, G. J. Concepts of set and availability and their relation to the reorganization of ambiguous pictorial stimuli. *Psychological Review*, 1967, 75 (6), 505-522.
Swets, J. Tanner, W., & Birdsall, T. Decision processes in perception. *Psychological Review*, 1961, 68, 301-340.
Warren, R. M. Perceptual restoration of missing speech sounds. *Science*, 1970, 167, 392-393.