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A Plea for Visual Thinking

Rudolf Arnheim

Perception and thinking are treated by textbooks of psychology in separate chapters. The senses are said to gather information about the outer world; thinking is said to process that information. Thinking emerges from this approach as the "higher," more respectable function, to which consequently education assigns most of the school hours and most of the credit. The exercise of the senses is a mere recreation, relegated to spare time. It is left to the playful practice of the arts and music and is readily dispensed with when a tight budget calls for economy.

The habit of separating the *intuitive* from the *abstractive* functions, as they were called in the Middle Ages, goes far back in our tradition. Descartes, in the sixth *Meditation,* defined man as "a thing that thinks," to which reasoning came naturally; whereas imagining, the activity of the senses, required a special effort and was in no way necessary to the human nature or essence. The passive ability to receive images of sensory things, said Descartes, would be useless if there did not exist in the mind a further and higher active faculty capable of shaping these images and of correcting the errors that derive from sensory experience. A century later Leibniz spoke of two levels of clear cognition.[1] Reasoning was cognition of the higher degree: it was *distinct,* that is, it could analyze things into their components. Sensory experience, on the other hand, was cognition of the lower order: it also could be clear but it was *confused,* in the original Latin sense of the term; that is, all elements fused and mingled together in an indivisible whole. Thus artists, who rely on this

1. Leibniz, *Nouveaux Essais sur l'entendement humain* (Paris, 1966), bk. 2, chap. 29.

inferior faculty, are good judges of works of art but when asked what is wrong with a particular piece that displeases them can only reply that it lacks *nescio quid,* a certain "I don't know what."

In our own time, language has been designated as the place of refuge from the problems incurred in direct perceptual experience; this in spite of the fact that language, although a powerful help to our thinking, does not offer in and by itself an arena in which thinking can take place. Thus the very title of a recent collection of articles by Jerome S. Bruner suggests that in order to arrive at knowledge the human mind must go "beyond the information given" by direct sensory experience.[2] Bruner adopts the belief that the cognitive development of a child passes through three stages. The child explores the world first through action, then through imagery, and finally through language. The implication is, unfortunately, that with the arrival at a next level the earlier one falls by the wayside. Thus when the child learns to go beyond a particular constellation directly given to his eyes, the ability to restructure the situation in a more suitable way is not credited by Bruner to the maturing of perceptual capacity but to the switch toward a new processing medium, namely, language. Thus language is praised as the indispensable instrument for essential refinements of the mind of which in fact language is little more than a reflector.

Since experts insist that perception offers nothing better than the fairly mechanical recording of the stimuli arriving at the sensory receptors, it is useful to respond with a few examples which show that perception transcends constantly and routinely the mere mechanical recording of sensory raw material. (I am limiting myself in the following to visual perception.) At a fairly simple level, the psychologist Roger N. Shepard and his coworkers have shown that visual imagination can rotate the spatial position of a given object when a different view is needed to solve a problem, for example, in order to identify the object with, or distinguish it from, a similar one. This is worth knowing. But reports by artists and scientists indicate that visual imagination is capable of much more spectacular exploits. Indeed, the imagination of the average person demands our respect.

2. Jerome S. Bruner, "The Course of Cognitive Growth," in *Beyond the Information Given,* ed. Jeremy S. Anglin (New York, 1973), pp. 325–51.

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Let me use an example cited in an article by Lewis E. Walkup.[3] The solution of the puzzle should be attempted without the help of an illustration. Imagine a large cube made up of twenty-seven smaller cubes, that is, three layers of nine cubes each. Imagine further that the entire outer surface of the large cube is painted red and ask yourself how many of the smaller cubes will be red on three sides, two sides, one side, or no side at all. As long as you stare at the imagined cube as though it were nothing better than a pile of inert building blocks and as long as you take only a diffident, haphazard nibble at this or that small cube, you will feel uncomfortably uncertain. But now change your visual conception of the cube into that of a centrically symmetrical structure, and in a flash the whole situation looks different! What happens first is that suddenly the imagined object looks "beautiful"—an expression that mathematicians and physicists like to use when they have attained a view that offers a surveyable, well-ordered image of a problem's solution.

Our new view shows one of the twenty-seven cubes surrounded by all the others, which cover it like a shell. Shielded from the outside, the one central cube obviously remains unpainted. All the others touch the outside. We now look at one of the six outer surfaces of the large cube and notice that it presents a two-dimensional version of the three-dimensional image from which we started: we see, on each of the six surfaces, one central square surrounded by eight others. That central square is obviously the one painted surface of a cube—which gives us six cubes with one surface painted. We now proceed to the linear dimension of the twelve edges that constitute the large cube and find that each edge has three cubes and that the one in the center rides on two surfaces, like a gable. The two surfaces it exposes to the outside make for a cube painted on two sides, and there are twelve of those cubes. We are left with the eight corners, which cover three surfaces each—eight cubes with three of their sides painted red. The task is done. We hardly need now to add one + six + twelve + eight, to make certain that we have accounted for all twenty-seven cubes—so sure are we of the completeness of our solution.

Did we go beyond the information given? In no way. We only went beyond the poorly structured pile of blocks a young child would be able to perceive. Far from abandoning our image, we discovered it to be a beautiful composition, in which each element was defined by its place in the whole. Did we need language to perform this operation? Not at all; although language could help us to codify our results. Did we need intelligence, inventiveness, creative discovery? Yes, some. In a modest way, the operation we performed is of the stuff good science and good art are made of.

3. Lewis E. Walkup, "Creativity in Science through Visualization," *Perceptual and Motor Skills* 21 (1965): 35–41.

Was it seeing or was it thinking that solved the problem? Obviously, the distinction is absurd. In order to see we had to think; and we had nothing to think about if we were not looking. But our claim goes farther. We assert not only that perceptual problems can be solved by perceptual operations but that productive thinking solves any kind of problem in the perceptual realm because there exists no other arena in which true thinking can take place. Therefore it is now necessary to show, at least sketchily, how one goes about solving a highly "abstract" problem.

For the sake of an example, let me ask the old question of whether free will is compatible with determinism. Instead of looking up the answer in Saint Augustine or Spinoza, I watch what happens when I begin to think. In what medium does the thinking take place? Images start to form. Motivational forces, in order to become manipulable, take the shape of arrows. These arrows line up in a sequence, each pushing the next—a deterministic chain that does not seem to leave room for any freedom (fig. 1a). Next I ask What is freedom? and I see a sheaf of vectors issuing from a base (fig. 1b). Each arrow is free, within the limits of the constellation, to move in any direction it pleases and to reach as far as it can and will. But there is something incomplete about this image of freedom. It operates in empty space, and there is no sense to freedom without the context of the world to which it applies. My next image adds an external system of a world minding its own business and thereby frustrating the arrows that issue from my freedom-seeking creature (fig. 1c). I must ask: Are the two systems incompatible in principle? In my

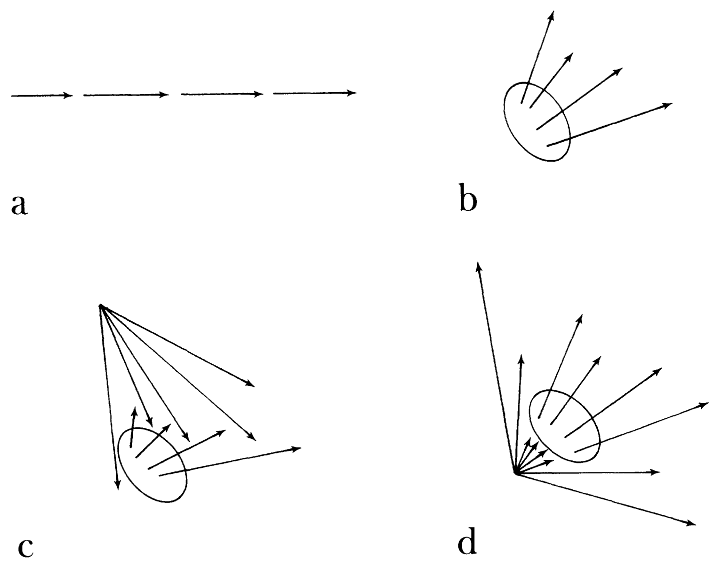

Fig. 1.

imagination I start restructuring the problem constellation by moving the two systems in relation to each other. I come across one pattern in which the arrows of my creature remain intact by being fitted to those of the environmental system (fig. 1d). The creature is no longer the prime mover of its motivational forces, each of which is fitted now into a sequence of determining factors of type 1a. But in no way does this determinism impair the freedom of the creature's vectors.

The thinking has barely started, but the description of these first steps will suffice to illustrate some remarkable properties of the thought model. It is an entirely concrete percept although it does not spell out the images of particular life situations in which freedom arises as a problem. While being concrete the model is entirely abstract. It draws from the phenomena under investigation only those structural features to which the problem refers, namely, certain dynamic aspects of motivational forces.

By no means is my imagery only a by-product of the "real" thinking going on in some other region of my mind. It is no epiphenomenon but the very arena in which the action takes place. All the needed features of the problem are sufficiently represented, and my mind will make forays into images of actual life situations only for the purpose of checking on whether those constellations of forces correspond to the ones represented in my model.

But, someone might say, I could investigate the problem also in an entirely nonvisual way, namely, by means of purely conceptual propositions. Could I? We have already excluded language as an arena of thought since words and sentences are only a set of references to facts that must be given and handled in some other medium. But yes, there is a nonvisual medium capable of solving a problem in an entirely automatic fashion as soon as all pertinent data are supplied. Computers function in this way, without any need to consult perceptual images. Human brains can produce approximations of such automatic processing if they are put under sufficient educational pressure or deprivation, even though a brain is not easily prevented from exercising its natural ability to approach a problem by structural organization.

But it can be done. The other day, my wife bought twenty envelopes at seven cents each at the local university store. The student at the cash register punched the key of seven twenty times and then, to make sure that she had done it often enough, proceeded to count the sevens on the sales slip. When my wife assured her that the sum of $1.40 was correct, she looked at her as though she were privy to superhuman inspiration. We supply children with pocket calculators; but we must consider that the saving in time and effort is made at the expense of precious elementary training of the brain. Genuine productive thinking starts at the simplest level, and the basic operations of arithmetic offer fine opportunities.

When I assert that thinking is impossible without recourse to perceptual images, I am referring only to the kind of process for which terms like "thinking" or "intelligence" ought to be reserved. A careless use of these terms will help to make us confuse purely mechanical, though immensely useful, machine operations with the human ability to structure and restructure situations. My analysis of the cube was an example of a problem solution at which a machine could arrive only mechanically. Another example comes from the performances of chess players.[4] It is well known that the ability of chess players to retain whole games in their memories does not rely on a mechanical copy of the arrangements of pieces on the board, preserved in eidetic imagination. Rather a game presents itself as a highly dynamic network of relations in which each piece comes with its potential moves—the queen with her long, straight outreach, the knight with his crooked hop—and with the endangerments and protections of its particular position. Each piece is meaningfully held in its place by its function in the total strategy. Therefore any particular piece does not have to be remembered piecemeal—which would be much more cumbersome.

Or think of the difference between a machine reading letters or digits—a purely mechanical procedure—and a young child figuring out how to draw a picture of a tree (fig. 2). Trees as seen in nature are intricate entanglements of branches and foliage. It takes truly creative structuring to discover in such a jumble the simple order of a vertical trunk from which the branches issue, one by one, at clear angles and serve in turn as bases for the leaves. Intelligent perceiving is the child's principal way of finding order in a bewildering world.

Visual structuring occurs in two ways which, for lack of more precise terms, I call the *intuitive* and the *intellectual* mode. What happens when someone tries to "take in" the pattern of figure 3, whose five shapes are vaguely reminiscent of a painting by Kasimir Malevich, *The Sensation of Flight?* One can take cognizance of the picture by simply looking at it. In that case, all the properties of the five elements—their size, shape, and color, their distances and directions in relation to one another and to the quadrate frame—will be projected, by means of the eyes, upon the brain field of the visual cortex, where they all blend into an indivisible but highly organized structure. The result is a true *cognitio confusa,* in which every component is dependent on every other. The structure of the whole controls the parts and vice versa.

This "intuitive" mode of cognition is available only through perception. The process of structuring, in which each element receives its character by taking its place in the whole, occurs to some extent below the level of consciousness. What the viewer "sees" in the picture is

4. Alfred Binet, "Mnemonic Virtuosity: A Study of Chess Players," *Genetic Psychological Monographs* 74 (1966): 127–62.

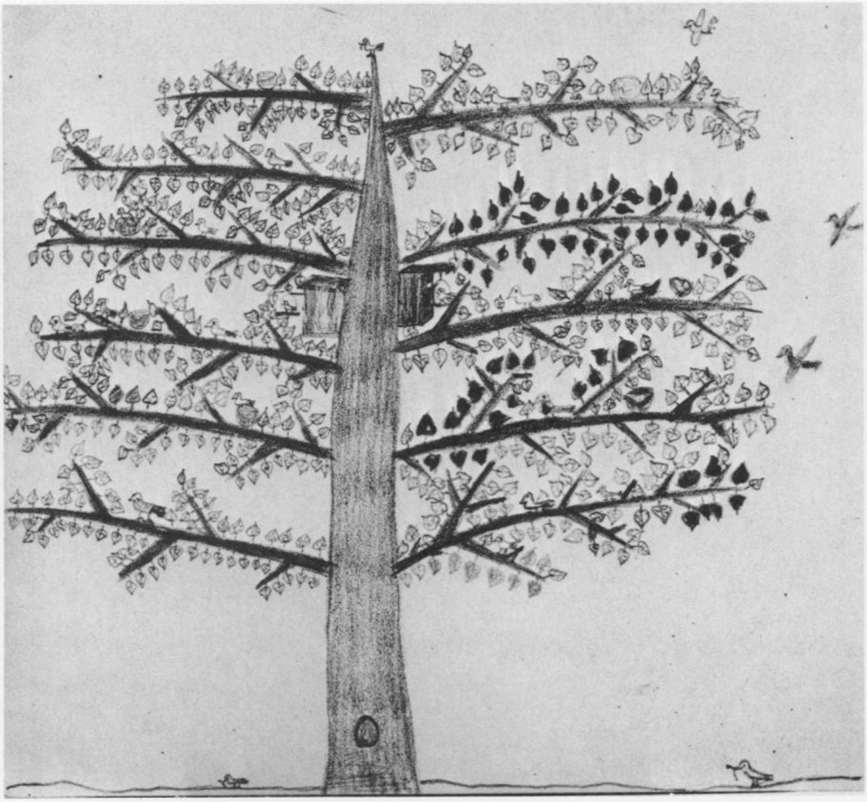

FIG. 2.—Courtesy Gertrude Schaefer-Simmern.

already the outcome of that organizational process. Only when someone struggles to discover the order of a complicated composition does he experience within himself something of the shaping process in search of the final image.

Intuitive perception conveys the experience of a structure but does not offer its "intellectual" analysis. For that purpose each element of the image must be defined independently. Its particular shape, size, and color are established in isolation, after which the various relations between the elements are explored one by one. The intellectual mode of cognition must sacrifice the full context of the image as a whole in order to obtain a self-contained description of each component. This is the scientific method, which contents itself with an approximation of the true phenomenon but gains analytical exactness. The method is as visual as direct perception but it must draw a fence around each of the elements and consider them in succession rather than in a synoptic overview.

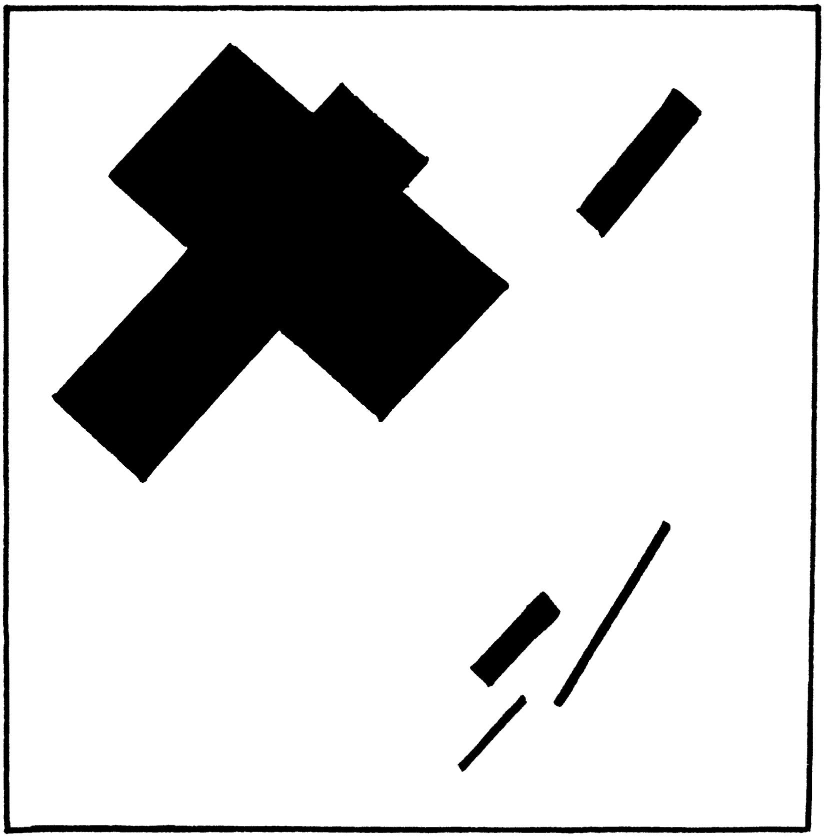

Fig. 3.

In recent years the duality of human cognition has captured the popular imagination through the discovery that the two modes of functioning correspond to different locations in the crust of the cerebral hemispheres. Somehow these physiological findings seem to have put the stamp of authentic reality on mental distinctions that have been acknowledged since antiquity. Not only that, but the symmetrical location of the two functions in the two halves of the brain has come to symbolize the fact that these functions are of equal dignity and therefore should receive equal consideration, especially in education. Given the traditional view that perceiving is inferior to reasoning, this reevaluation is entirely welcome. At the same time, the popular symbolic image, gained from a superficial knowledge of the actually quite complex physiological facts, tends to reinforce the prejudice that the intuitive and the intellectual modes of cognition function in separation from each other and that, in fact, different individuals and different professions come under either the one or the other heading. This is a harmful misunderstanding. Everything we are learning about the mental functioning of scientists and artists strengthens the conviction that the intimate interaction between intuitive and intellectual functioning accounts for the best results in both fields. And the same is true for the average schoolchild and student.

In conclusion I would like to cite a testimony coming from an unexpected source, a presidential address of the psychologist B. F. Skinner, to which, it seems to me, not enough attention has been paid although it was presented more than twenty years ago.[5] In opposition to the usual statistical treatment of experiments based on a large number of subjects, Skinner recommended the careful scrutiny of individual cases. Mass experiments are based on the rationale that by compounding the behavior of many subjects one causes accidental factors to cancel out, which lets the underlying lawful principle show up in its uncontaminated purity. "It is the function of learning theory," said Skinner, "to create an imaginary world of law and order and thus to console us for the disorder we observe in behavior itself." He became disenchanted with this procedure through his interest in the training of individual animals. For that purpose the lawfulness of average behavior offered little consolation. The performance of the particular dog or pigeon had to be flawless to be usable.

This led to attempts to clean the individual case of whatever was not pertinent to it. In addition to perfecting the practical performance of the animal, this method had two advantages. It induced a positive scrutiny of the modifying factors, which in the statistical procedure simply dropped out as so much "noise." In addition, however, the method reduced the scientific practice to "simple looking." Whereas the statistics divert the psychologist's attention from the actually observed cases to the manipulation of purely numerical data, that is, to the refuge "beyond the information given," the cleaned-up individual case makes a type of behavior directly perceivable. It displays for the observant eye the interaction of the relevant factors.

With this enjoyable spectacle of the behaviorist all but holding hands with the phenomenologist who endeavors to see the essential truth through the unhampered inspection of the perceptually given experience, I rest my case. Perhaps we are witnessing the beginning of the convergence of approaches which, under the impact of the evidence, will return to the intelligence of the senses its rightful privilege.

5. B. F. Skinner, "A Case History in Scientific Method," *American Psychologist* 11 (May 1956): 221–33.