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Noticing Things:
A Field Guide to Attention

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Throughout our schooling we're told, "Pay attention!" And rightly so. Attention is the engine of mental progress. It elevates our knowledge, skill, and inventiveness. Yet—surprisingly—we're told little of attention's fundamental mechanisms and how to use them to our advantage. These are the things this article explores.

Adaptation. We survive by adapting to the environment. Our elemental adaptation is neurological—an automatic sensory response to environmental difference. Difference is the basic unit of information; sensory response is the building block of knowledge and action.

Adaptation is hierarchical. First-order adaptations trigger second-order adaptations, second-order adaptations trigger third-order adaptations, and so on upward into consciousness. Our repertory of adaptations is extensive and includes conditioned behaviors, stream-of-consciousness ideations, and volitionally executed actions.

Our most advanced adaptations are behavioral responses to complex patterns of environmental difference. From this perspective, any useful invention is a successful, high-order adaptation to the environment. Darwin's theory of evolution, Edison's electric lightbulb, and Goodyear's vulcanization method are, in their own ways, the resultant gestalts of adaptive responses. Darwin's responses yielded a conceptual framework; Edison's, a physical device; and Goodyear's, a physical process.

All inventions, whether conceptual or physical, require cognitive adaptations. Cognitive adaptations are adjustments of our concepts to make them accurately represent the logical and physical structure of reality. Before Einstein could arrive at $E = mc^2$, he had to make conceptual adjustments to his world view.

A physical invention—a device or process—requires both cognitive and physical adaptations. Physical adaptations are adjustments of materials and actions to make them accurately fit the physical structure of reality.

Cognitive adaptations usually precede physical adaptations; most inventors discover a concept before they apply it. But this isn't always so. Goodyear accidently dropped a mixture of rubber and sulfur on a hot stove and serendipitously discovered the method of vulcanization. A physical adjustment triggered a conceptual adjustment!

When we begin an invention, our understanding is incomplete; perhaps false. The path to its completion is unclear. Where do we start? With the basics: perceiving differences within the domain of the problem.

Sensing vs. perceiving. There's an important distinction between sensing and perceiving. Sensing is the neurological process of detecting an environmental difference. A sensation is the neurological product of that process—our earliest adaptation to environmental difference. Much sensing is

subconscious.

Perceiving is more than sensing; perceiving requires consciousness. Perceiving is sensing with awareness. Many sensations that could register in consciousness don't. They go unnoticed because we're not attending to them. This is also true of the higher-order responses they evoke. The more of these responses we perceive, the more we know about our environment and the more efficiently we can interact with it.

Paying attention isn't always easy; perception has its obstacles. There is fatigue—both mental and physical. There is distraction—multiple things competing for attention. There is masking—the eclipsing of one thing by another (say, an object of greater brightness, an event of greater emotional significance, or a mindset incompatible with a potential perception). There is transience—too brief an exposure to a thing to detect its subtle differences (like the slight bend in what at first seems to be a straight line). There are missing perceptual prerequisites—the antecedent experiences needed to recognize an object (like the prior familiarity with 90^{o} angles that lets us spot a right triangle). And finally, there is misdirected attention—looking where the object isn't.

Even without these obstacles, the quality of attention can vary. We can merely notice an object, or we can observe it, or we can concentrate on it, or we can fixate on it. As our focus sharpens, its internal differences reveal themselves (and our surroundings recede into the background). Having a natural interest in a thing animates attention. It helps to enjoy what you're doing.

Attention can be voluntarily directed to an object or involuntarily captured by it. When undirected, attention flows to the unusual, the structurally significant, the emotionally charged. Stream-of-consciousness ideations, which are involuntary content, play an important role in invention.

Attention is paradoxical. We can choose to attend to an object, yet the things we notice about it and the order in which we notice them are unpremeditated!

A bit of Zen. Zen has some notions that fit nicely with the last few paragraphs, so we'll take a short detour to mention them. Zen teaches that (1) attention is distinguishable from its content and (2) much content is generated by the mind itself. All Zen traditions use meditation to reveal this. But their meditational methods differ.

Zen offers two alternative paths to nirvana: the path of constancy ("original mind") and the path of change ("mindfulness"). With the path of constancy, one volitionally inhibits spontaneous content from entering awareness—either by keeping the mind blank or by fixating the attention on one thing and ignoring all else. (When this fails—as it often does—the meditator empties the mind and starts over.) With the path of change, one volitionally accepts all spontaneous content and closely watches it. The path of change is the path of invention: a mindfulness of the mind at play. But both paths awaken the student to the same truth: many phenomena believed to be "out there in the world" are really "in here in the mind." Now back to the main subject.

Habituation. Attention habituates (ceases to respond) to invariance. It turns from a static stimulus to a variable one, from a constant external environment to a changing internal one—i.e., to the spontaneous ideations in the stream of consciousness. Scientists, artists, and crackpots have all utilized habituation to encourage this phenomenon—the first, to gain conceptual insights (inventor Elmer Gates sitting in his "world's darkest room"); the second, to gain expressive insights (songwriter John Fogerty staring at a blank wall); and the last, to con money from gullible fools (fortuneteller Claude Alexander "The Man Who Knows" Conlin, gazing into his crystal ball). And we, too, enjoying a pleasant shower, habituate to the water's steady sound and warm flow—and may find good ideas coming to us unbidden.

On occasion, we try to pay attention to something but can't. Our attention, having habituated to the situation, refuses its content and drifts away. Best to take a break and return later with a rested mind. We often absorb more through brief fresh encounters than through one protracted engagement. Relaxed intermittency beats coerced continuation.

Reflexivity. Thinking is reflexive. The mind responds to sensory stimuli, then—evaluating its own responses—further processes them to generate higher-order responses. The output from one operation becomes the input for the next. Normally this goes unnoticed at the periphery of awareness. Nonetheless, the end products strongly influence our behavior.

To picture how reflexivity works, consider this example. Imagine staring at an area of undifferentiated gray. The area is your perceptual field, the gray is its content, and what you are perceiving is a pervasive sameness throughout it.

Continuing to look at the area, you notice gradations of shade. The content of the field no longer seems uniform. You are perceiving difference within it.

Examining the area more closely, you observe that each shade is confined to a region of the field. Mentally, one region stands apart from another. You are perceiving separation within the field.

Comparing the regions, you discern that each has its own shape. So, not only is one region mentally separate from another, it's also distinctive. It has become a distinguishable mental entity. You are perceiving each region's individuality.

Suddenly you realize that you've seen one of these shapes before. What is it? It looks like the raised leg of an elephant. The content of your attention has shifted from a perception to an interpretation. "Raised-leg-of-an-elephant" is a cognitive overlay, a meaning your mind has projected onto your perception. (The meaning is determined probabilistically from the relative frequencies of your various life experiences.) Having inferred a raised leg, you now see the remainder of the gray area as the other parts of the elephant. The entities within your perceptual field—the separate distinctive differences—have coalesced into a recognizable gestalt.

An object's meaning only strikes us after we've processed its raw sensations. The following quote concerns the perception of visual stimuli by persons who were born blind because of congenital cataracts, but subsequently gained sight after cataract surgery.

> "Investigators of vision following operation for congenital cataract are unanimous in reporting that the perception of a square, circle, or triangle (or of sphere or cube) is very poor. To see one of these as a whole object, with distinctive characteristics immediately evident, is not possible for a long period. The most intelligent and best-motivated patient has to seek corners painstakingly even to distinguish a triangle from a circle. The newly seeing patient can frequently find a difference between two such figures shown together . . ., but the differences are not remembered. There is for weeks a practically zero capacity to learn names for such figures, even when tactual recognition is prompt and complete." D. O. Hebb. *Organization of Behavior*. Science Editions, Inc. (New York, 1961), p.28.

Mental processing doesn't stop at meaning. It continues.

From your experiences with mass and gravity, you grasp the structural effect of the elephant's raised leg. Raising the leg shifts the elephant's weight onto its three other legs. When the raised leg comes down, the elephant's weight will shift back onto it. You've now discerned the function of the leg within the "elephant system"; it manages the distribution of weight.

The elephant is not isolated from its environment; it interacts with it. There's a man standing next to

the elephant, and his foot is beneath its raised leg. If the elephant lowers its leg, its shifting weight will crush the man's foot. The function of the raised leg has an implication that extends into the environment. The function portends a drastic change in the environment's structure—the man's loss of mobility. The raised leg signals danger.

Will the elephant crush the man's foot? It's too soon to tell. Nevertheless, the implication of its raised leg elicits an emotion—fear. An emotion is an organic reaction to the consciously inferred consequences, real or implied, of a structural state. The more significant the consequences, the stronger the emotion. (A feeling is less intense and more diffuse than an emotion. A feeling—an intuition, say—is an organic reaction to the subconsciously inferred consequences of a structure.)

The validity of an inference, whether conscious or subconscious, rests with the authenticity of the experiences it's derived from. Are our personal experiences of a thing real or virtual? Do they arise from our own sensory processing or from someone else's (perhaps false) verbal account? If our experiences of it are only virtual, our emotions and feelings about it may be misbegotten.

The realization of catalysis. Let's summarize. Throughout our experience with the elephant, the environmental stimulus hasn't changed. What has changed is our conception of it; our mental state. Spontaneous neurological processing has evolved the content of our attention—from sameness, to difference, to separateness, to individuality, to meaning, to function, to implication, to emotion. At each stage, we've seen the stimulus through the lens of a concept that is one level higher than the last. The mind has been making sophisticated cognitive adaptations to its environment.

These adaptations can be thwarted by distractions, interruptions, inhibitions, and other incompatible conditions. Our armor against them is the powerful realization that attention is catalytic; it speeds the upward evolution of the mind's spontaneous content. Persistently applied, attention drives cognitive adaptation to the highest levels of elegance and originality.

Think deeply about a complex problem and you'll see this for yourself.

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