

Angie Keefer: AN OCTOPUS IN PLAN VIEW

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It was researched and written by Angie Keefer in Hudson, NY; edited by Stuart Bailey & David Reinfurt in Los Angeles & New York; the eight parts individually spoken and recorded as audio files by Isla Leaver-Yap & Shannon Ebner in a specially-constructed breeze-block cabin at the Frieze Art Fair in London; then re-edited, stuck together, and played as a whole to a dedicated audience on the 31st floor of the Chrysler Building back in New York. The deliberately circuitous nature of this process explains some of the more wayward allusions in the text.

What follows is an extended, re-edited version of the original audio essay, currently archived at www.thechryslerseries.com.

I. The etymology of the word “octopus”

Octopus. Noun. A mollusk with eight sucker-bearing arms, a soft sac-like body, strong beak-like jaws, and no internal shell. A taxonomic genus within the family octopodidae. Origin: Greek, from OKTO-, meaning “eight,” plus -POUS, meaning “foot.” Plural: debatable.

Octopus. The word migrated to English in the late 1700s by way of New Latin, or NEO-Latin, as it is sometimes called—and which means the same thing, but with a Greek prefix, which is like saying “new” in an antiquated way. A product of moveable type, New Latin evolved as a living tongue between the invention of the printing press and the beginning of the 20th century, when it was embalmed and shelved once more. Unlike classical Latin, its u’s were not v’s; its l’s were not j’s; its s’s looked like swooning f’s, except at the ends of words, when they looked like s’s. This was Latin resuscitated as the international language of scientific taxonomy.

According to the tidy rules of Latin declension, the New Latin plural of “octopus” would be “octoPI.” Fine. But according to the *Oxford English Dictionary*, a foreign word that enters the English fray must be treated like an English word, and duly adhere to the untidy rules of ENGLISH declension, in which case the plural of “octopus” would be “octoPUSES,” with an Anglicized tail: -e, -s. Okay, “octopuses.” Also fine. However, the correct PRIMARY plural, per today’s *Revised O.E.D.*, is not “octopuses,” in fact, but a word you’ve probably never heard unless you speak Greek: “octoPODES.”

“Octopodes”? Surely “octopus” would do just as well for the plural as the singular—like “deer” or “moose.” To complicate matters further, in a demonstration of native recalcitrance, the American *Merriam-Webster Dictionary* lists all three as acceptable plural forms. And bulwark American publications like the *New York Times* deploy both “octopuses” and “octopi” regularly, though “octopuses” has reportedly been gaining ground over the past thirty years.

In summary, both are used today to indicate more than one octopus, neither word is properly Greek or Latin or incorrect, while the ultra-correct “octopodes” is used solely in accounts of its own disuse.

Right. But who cares, besides biologists who are mildly annoyed when journalists interrupt them during interviews to ask, “Don’t you mean to say octoPI?” If we encounter an octopus in the wild, it will most likely be alone—the shallow water species aren’t especially sociable—so the point is practically moot. And if one DID make the linguistic gaffe, who among us would know to rebuke my “octopi” with her “octopodes” anyway? Spellcheck doesn’t even recognize the word. How does a centuries-old controversy sustain itself with stakes this low?

Between the mid-1700s and the publication of the *O.E.D.* well over a hundred years later, English grammarians from various camps attempted to codify the principles of the English language and set fixed rules for its proper expression, which they hoped could then be referenced to settle momentous disputes like this one and thus prevent further decay of the already-ulcerated English tongue.

From the 18th-century reform grammarians’ point of view, English was pervaded by corruption and consequently in need of refinement. Theirs was a purist movement, and so rife with infighting among zealous splinter groups. Whereas some adherents campaigned to saddle the unruly English declension with normative, Latinate standards (like “octopi”) —others, like Ann Fisher, esteemed author of the reportedly influential *Practical New Grammar, With Exercises of Bad English: Or, an Easy Guide to Speaking and Writing the English Language Properly and Correctly*, advocated for modern, English orthography (like “octopuses”).

The rise in literacy attending the relatively cheap availability of books like Fisher’s apparently compelled a popular interest in words, their definitions, and rules regarding their usage. Mid-18th-century readers of every ilk seem to have been alarmed to discover the slipperiness of language and mobilized at once to head off the imminent mudslide toward nonsense. Readers were rushing en masse to correct themselves, and the science of linguistics had entered its nascent stage.

Ten years after Fisher’s *Grammar* appeared—and still a few years yet before an “octopus” entered the English lexicon—Samuel Johnson’s *Dictionary of the English Language: In Which The Words Are Deduced From Their Originals*, was published and greeted with even greater public

enthusiasm, despite its unwieldy title which is nearly four times as long as my abridgement here. The only word in the neighborhood of where “octopus” would soon appear that is still familiar to us today, is “ocular.” It means: *depending on the eye, known by the eye.*

The ancient Greeks considered the question of whether words have an inherent relationship to the things they name, but failed to arrive at a consensus. Opinions were divided among the Analogists, who thought language logical, regular, and predictable; and the Anomalists, who were skeptical. From the discord, etymology emerged as the investigation of

WORDS ... in relation to MEANING ... over TIME

Modern linguists, however, are definitive on the point: language is arbitrary, they say, coming down firmly on the side of the Anomalists. There is no inherent relationship between sound utterances and the concepts to which they refer. Linguistic meaning is created when arbitrary sounds are *codified within a community of speakers.* And this codification of meaningless components into an infinitely mutable, transmissible system is the foundation of symbolic communication.

Despite all efforts to solidify a given linguistic system, a language in use is generally a language in flux, constantly in the throes of what H.L. Mencken called “the fluent and ever-amazing permutations of a living and rebellious speech.” The mainstream view on linguistic change, at least since the 1700s, has been that language is proceeding inexorably toward decline. This implies a prelapsarian linguistic moment, during which some inherently correct system of grammar reigned over a state of perfect communication—a mythical Babel, conjured to explain static on the line as a legacy punishment from God for man’s ambition. George Orwell summed up the idea neatly in his essay “Politics and the English Language:” “Our civilization is decadent, and our language—so the argument runs—must inevitably share in the general collapse.” Orwell agreed with the 18th-century grammarians’ perspective that “if thought corrupts language, language can also corrupt thought,” but he differed on who or what the culprits of corruption are and why or how to thwart them. To quote Orwell at length,

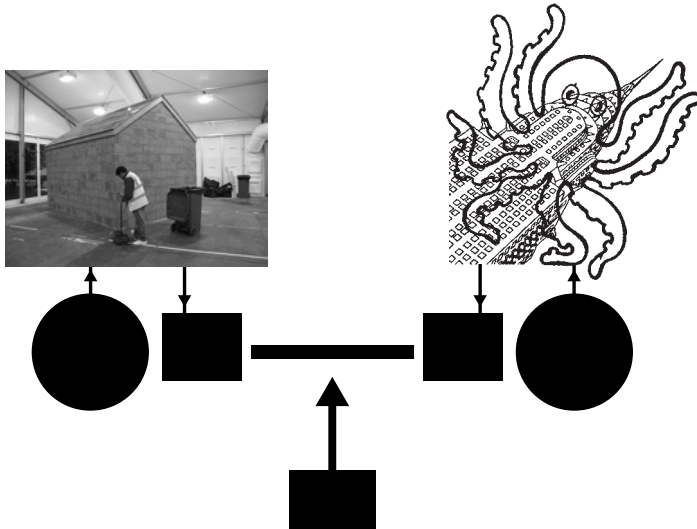
the defense of the English language ... has nothing to do with the setting up of a "standard English" which must never be departed from. On the contrary, it is especially concerned with the scrapping of every word or idiom which has outworn its usefulness. It has nothing to do with correct grammar and syntax, which are of no importance so long as one makes one's meaning clear. What is above all needed is to let the meaning choose the word, and not the other way about. When you think of a concrete object, you think wordlessly, and then, if you want to describe the thing you have been visualizing, you probably hunt about till you find the exact words that seem to fit it. When you think of something ABSTRACT you are more inclined to use words from the start, and unless you make a conscious effort to prevent it, the existing dialect will come rushing in and do the job for you, at the expense of blurring or even changing your meaning. Probably it is better to put off using words as long as possible and get one's meaning as clear as one can through pictures or sensations. Afterwards one can choose—not simply ACCEPT—the phrases that will best cover the meaning, and then switch round and decide what impression one's words are likely to make on another person. This last effort of the mind cuts out all stale or mixed images, all prefabricated phrases, needless repetitions, and vagueness generally.

Words lose their usefulness, either because they are so SELDOM spoken that they become unfamiliar to the community, or because they are so OFTEN spoken—in the form of "prefabricated phrases," to borrow Orwell's term—that the ritual of their use evacuates their potential to convey specific meanings. But why should words and phrases work any less well for being well-worn, if meaning is a factor of codification and repetition in the first place?

Orwell's depiction of the corruption of language is akin to a problem that Claude Shannon described three years later. The father of what became known as Information Theory, Shannon devised a mathematical schema to describe how information is altered through its transmission.

In a communication system, a message consists of INFORMATION, which is transmitted from a SOURCE, via a SIGNAL. The signal travels along a CHANNEL to reach a RECEIVER at a DESTINATION on the other end. To give a simple example: one person speaks/transmits a message,

and another listens/receives. Or, in the case of a more complicated AUDIO transmission: the message could be a written text, and the signal could be sound waves created by a reader's voice, which are recorded, compressed, encoded, and transmitted digitally from a hut in London via satellite to, say, New York, halfway up the Chrysler Building—where the recording is decoded, decompressed and played back for a dedicated audience.



According to Shannon, however, distortion—or noise within the transmission channel—is an inevitable part of ANY communication, and so information is always lost.

Next to the scale of time described by Shannon's theory, in which the transmission of an encoded message between any two points in the world is nearly instantaneous, etymology would have to be redefined as the study of words in relation to meaning over an AMBER category of time. In other words, the time of etymological evolution is so extenuated relative to the condensed time of a telegraph or satellite transmission, as to be practically eternal. Nevertheless, Shannon's engineering problem is not too far from Orwell's concern for clear meaning in language. Whether bits or words, the fundamental problem remains: how should a system be designed so that information conveyed through a channel retains maximum source fidelity?

For Orwell, language is a means of transmitting information in the form of images held in one's mind. Particular words should be chosen by a

speaker or writer to encode particular information in anticipation of it being later DEcoded by a listener or reader in a particular way. But encoding and decoding are NEVER complete. Words, grammar, and the mental acuity of individuals—including memory and attention, to name only two of myriad factors—are imprecise means of codification and transmission. There is a variable threshold of complexity on both sides, beyond which information is distorted or lost.

Shannon proposed that one reliable way of combatting information loss is to incorporate some appropriate amount of REDUNDANCY into the signal. The ideal amount and quality of redundancy would ensure that, even if a signal WERE distorted by noise in the channel, an adequate portion of the original message could still get through to the receiver. In the example of the audio transmission between London and New York, then, noise in the channel might be caused by, say, background sounds at the source, solar interference with satellite frequencies across the Atlantic, or the groan and buzz of an air conditioning system at the destination. A sufficient redundancy quotient would ensure that salient information makes it through, regardless of such interference.

Shannon was dealing with bits, not meaning, whereas Orwell's subject was language printed on a page—a far less noisy channel than a satellite transmission, or even speech. They were working on different orders of complexity. Yet if we agree that what we call meaning amounts to *an evolving consensus over the significance of meaningless bits of information*—like arbitrary sounds and signs, like the plural form of the word “octopus”—it may be useful to place Claude Shannon and George Orwell on a single gamut when considering how meaning changes over time, and so whether something like the difference between octopi, octopuses, and octopodes makes any difference at all.

Redundancy rings of Orwell's “prefabricated phrases, needless repetitions, and vagueness generally,” but somewhere on a graph that charts the progression from newly-minted to well-worn, there exists an optimal span of repetition, where the meaning of a word and the frequency of its use align over a period of time before inevitably diverging.

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II. The inside-outedness of its eyeball

There's a line from a Tom Stoppard play engraved on a plaque in the sidewalk on 41st Street, near 5th Avenue, right across from the main branch of the New York Public Library. I stumbled over it one afternoon this summer, on my way to the library to check out books about octopuses' brains. The plaque is part of one of those public art campaigns I distrust, as a rule, like the Metro-Transit Authority-sponsored poetry series that appears on the backlit ad-spaces in subway cars. But on a rainy afternoon, walking down a forgettable block, on the south side, facing west, watching a forgettable stretch of concrete pass under my feet, the message on this plaque landed in front of me with the force of an air conditioning unit dropped out of a third-floor window.

It was a high-impact non sequitur:



A unit of information, according to Claude Shannon, is a BIT—the smallest unit of information. It is an electrical signal, a binary digit, tantamount to a yes or a no. Get lots of bits going over telegraph wires, and combinations add up to messages that add up to currency in a symbolic communication system—a language. One of Shannon's findings was that the amount of information in a symbol, such as a letter or a word, is INVERSELY PROPORTIONAL to the frequency with which it occurs, which is another way of saying what Orwell knew intuitively—that phrases lose their meaning when they're overused.

As it happens, Electrical bits, plus an inverse relationship between recurrence and meaning is also a pretty good explanation of VISION in ten words or less, abiding a free verse interpretation of physicist Richard Feynman's writing on optics, and biologist J.Z. Young's studies of octopus and human brains. According to Feynman, "The eye is a piece of brain that is touching light, so to speak, on the outside." Seeing is FEELING light. What you ultimately see is not an image projected upside down on your retina, but an ordered selection your brain has abstracted and codified from the infinite, unordered flux of information surrounding it—information in the form of electromagnetic energy touching the eye. Information in the form of light.

Here's how it works. Presently, light, a.k.a. electromagnetic energy, is passing through your cornea—the transparent part of the white, outer layer of your eyeball—and entering your body by way of a hole called the pupil. As light enters your eye, the iris—the colored membrane surrounding the pupil—adjusts automatically, contracting or dilating to change the size of the opening and modulate the amount of light coming in. Next, the light hits the lens located directly behind the pupil, which also adjusts automatically, thinning or thickening to focus, bend, and project the passing light onward, through the clear, gelatinous liquid that fills the cavity of your eyeball, toward the far wall of your eye's interior surface, where it makes physical contact with your retina.

Here things get considerably more complicated, but to summarize: after the light comes in and touches the retina, chemical and electrical reactions occur and register as nervous impulses, which are then transmitted to the brain. Visual information is assembled in the brain from a SEQUENCE of these signals, meaning that whatever information the brain compiles into symbols, and which you subsequently understand to be what you are seeing, is ascertained ONLY OVER TIME, and that means ONLY THROUGH CHANGE, which means motion. Vision is enabled by constant, rapid motion. Automatic movements of your eye are occurring now on a scale that can be observed, at a rate of about five per second, and at a much higher rate on an unnoticeable, micro-scale. And the brain determines the direction of these automatic eye motions based on PREDICTIONS about what information will be most USEFUL.

This bears repeating. You are making predictions about what you see, and these predictions determine how your eye moves, and how your eye moves determines what information reaches your ganglion cells, and some portion of this information—some portion of the light encoded by your eye-brain—is what you THINK YOU SEE. It's a circle.

The vertebrate eye develops in embryo over the first few weeks, taking shape as the optic vesicle folds in upon itself behind the lens placode, establishing the inner and outer layers of the optic cup. This folding process is called “invagination,” meaning a folding inward to create a cavity. It is a crucial step in the formation of the eyes of all vertebrates, which is surprising since the result doesn't make sense from an engineering perspective. Due to invagination, the nerve cable that connects the eye to the rest of the brain ends up all the way inside the optic cup, so it has to poke backwards through the layers of the retina to reach behind the eyeball to the brain. This is why we have a blind spot in the middle of our vision. Another strange inefficiency of the arrangement is that our photoreceptors are buried under several layers of cells, so light has to pass through those several layers before it reaches the rods and cones, which are situated inconveniently—and inexplicably—on the outermost layer of the retina.

In other words, our eyes are inside-out.

As it happens, nature has evolved an eye almost like ours, but in reverse. This right-side-out eye belongs to certain cephalopods, including octopuses, squids, and their ilk. It is a single-lens structure with an iris, a lens, and a retina—just like the human eye; and light enters the eyeball and is projected against the retina—just as IN the human eye. The cephalopod eyes even develop in a similar way to the vertebrates' albeit with one crucial exception: no folding back and forth occurs, so the part of the system that becomes the optic nerve remains sensibly on the outside, and their equivalent to our photoreceptors end up on the inside, with no extra layers to buffer incoming light.

Current research indicates that octopuses are colorblind, though they see and distinguish complex information including shapes, brightness, and spatial orientation, just as humans do. UNlike humans, they can also

perceive the plane of polarization of light. This may indicate that the octopus has the ability to communicate with its own kind by manipulating the polarization of light reflected off its skin, meanwhile evading detection—or at least decoding—by other animals, including us.

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III. How the subject disappears into its context

I am holding a photocopy of selections from *The Anatomy of the Nervous System of Octopus Vulgaris* by J.Z. Young, Master of Arts, Doctor of Science, Fellow of the Royal Society, Professor of Anatomy, University College London and Stazione Zoologica, Naples, published by Oxford University Press in 1971. The 690-page original is not a work I could recommend in good faith to the casual reader, though it is carefully written and handsomely illustrated. *The Anatomy* is a detailed account of the octopus brain, the output of a 25-year study that began in 1946. At the time of its publication, the book presented the most thorough rendering of the nervous system of any non-vertebrate.



Detail of an octopus brain from Dr. J.Z. Young, *The Anatomy of the Nervous System of Octopus Vulgaris* (Oxford University Press, 1971)

Photos of microscopic sections of the brain and schematic drawings of the traffic among its numerous lobes appear throughout *The Anatomy*. The photos resemble satellite imagery of wetlands, in which light-colored landmasses are broken up by a lacy network of veins before disintegrating completely into liquid darkness. Together with the schematics, which on first blush seem to be instructions for baroque dance routines, the book's illustrations could be a masterplan for the restructuring of some shadowy organization headquartered in a remote and forbidding part of the world.

Picture in your mind's eye figure 9.1, a schematic found on the second page of a chapter called "The Superior Frontal-Vertical Lobe System." Four centers of activity on the right side of the drawing are each bound by a circle of the same size. These circles are oriented in two rows of two, and are adjacent, like the leaves of a lucky clover. Through the circles pass a number of curved lines ending in arrows. Some of the lines originate from much smaller circles and seem to indicate, by their arrows, that the smaller circles might move from their points of origin to other centers, making the leap, for example, from clover petal VU1 to clover petal VU2 next door. Others of the arrow-headed lines are long, and take off from the VU and VL corrals on the right side of the illustration in a swooping journey toward the left side. Each of these long lines eventually diverges in a different direction from the main channel of activity and passes through a number of tiny question marks peppering the field, which seem to be hazards protecting a figure marked "classifying cell" at the leftmost of the illustration, as all of the lines fall short of reaching this apparent Holy Grail. Those that aren't thwarted by question marks are headed off instead by the labels MEMORY CELLS, TASTE, ATTACK, RETREAT, and, most alarmingly, PAIN, each of which causes a pointed line to turn back upon itself and crisscross the others in a chaotic tangle of subverted aggression.

The caption beneath states that while the connections between some lobe circuits are well established, others—such as those of the classifying and memory systems of the optic lobes—are less certain. Hence the question marks.

Dr. Young was specifically interested in *the neural basis of learning.*

He chose to examine the octopus because he found the species relatively “resistant to the insults of experiment.” At the time, scientists wishing to study the brain and behavior of animals had two options for resolving such gray areas. If you wanted to figure out how some part of an organism functioned, you could either destroy the part in question or run a current through it, then observe the behavioral changes. If you remove a certain part of the octopus’s vertical lobe, for example, and observe that it continues to attack an object from which it has received a terrifying shock, you can infer that the vertical lobe has something to do with its ability to learn restraint. Without its vertical lobe, the octopus will suffer from a lack of inhibition, and will behave like an arrow-headed line cycling through an endless loop of ATTACK, PAIN, RETREAT. Again ... ATTACK ... PAIN ... RETREAT PAIN RETREAT PAIN! PAIN!! PAIN!!!. And so on, without ever engaging the proper classifying cells and memory cells that would prevent this traumatic repetition.

Aristotle had observed the common octopus in the waters of the Mediterranean around 350 BC. He was not impressed with the octopus’s intelligence, though he substantiated this judgment with the rather perplexing evidence that one under study was “stupid enough” to approach a man’s hand placed into water. He marveled, however, at the terror the octopus instilled in the minds of crawfish, whom he claimed to have witnessed dying of fright when caught in the same net.

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Octopus Vulgaris (hereafter OV) is a member of the genus Octopus, of the family Octopodidae, in the order Octopodida of the class Cephalopoda. Most of the Octopodidae, which includes more than 90 percent of all Octopod species, are BENTHIC, meaning they live on the sea floor instead of drifting about in higher waters. They are found all over the world, from the Arctic to the Antarctic. The octopus, of which there are 100 extant species, inhabits the warmer coastal regions—primarily the tropics—at depths ranging from the shallow intertidal zones to 500 metres, and usually hangs out on the sea floor. The OV, whom Aristotle encountered, is solitary, and relatively inactive during business hours, preferring to do most of his prowling between nightfall and the wee hours of the morning. Otherwise, downtime is spent in a den, which may be

a crevice, a pile of rocks, or some configuration of shells and debris he or she has assembled.

Like every animal, the octopus is uniquely adapted to its particular habitat. Its brain has evolved to suit its environment. In Dr. Young's words, "By examining the details of the organization of the brain APPROPRIATE TO EACH HABITAT we can draw conclusions about the SIGNIFICANCE OF THE PATTERNS of connectivity. Thinking backwards from this idea, then, what kind of brain would be appropriate for an octopus—a highly mobile, solitary, shape-shifting, home-making, sea-dwelling, nocturnal predator with eight arms, big eyes and a beak? Simply put, one that is large, complicated, and decentralized.

The OV's mind is dispersed throughout its body. Its neurons are arranged hierarchically, with different centers delegating different types of responses. In fact, there are far more nerve cells in its arms than its central brain, and its body parts can act semi-autonomously. Many of its basic responses occur under local control, which means the operations staff proceeds in routine activities without middle management having to file paperwork with headquarters first. Local operations include the movement of the arms and control of the suckers. According to Young, "This principle of decentralization leaves the central ganglia of the system free to organize the behaviour of the whole animal."

The highest level of the octopus's neural organization is concerned with relating motivations, or drives, with accumulated experience; in a word—memory. Memory is the basis of learning. It is a complex physical process, the biological purpose of which is to provide information that will allow an animal to make future decisions based on past experience. Young taught his octopuses to differentiate good objects from bad by administering electric shocks or rewards of food, and, contrary to Aristotle's assessment, found the octopus to be a fast learner. The octopus could discriminate between desirable and undesirable after only a few trials, and such lessons were sometimes retained for months—a significant portion of its life-span. Young's memory studies focused on "the nature of the plasticity of nervous tissue," and the question of how it changes to be "more effective in the future." His primary thesis was that learning entails *making selections among a range of possible responses

to a given stimulus,* and that this process of selection entails the co-ordination of many different centers, connected by a flow of information.

In the brains of higher organisms like octopuses and humans, Young emphasized that the determining factor in specific memory formation is not the requisite quantity of chemicals but the PATTERNS OF CONNECTIVITY; that new behavior is likely to be the result of new connections; and new connections will be made in response to the unexpected environmental stimulus that interrupts familiar patterns: the non sequitur. Through this ongoing process of remembering and learning, remembering and learning, brains are physically modified by directly “adaptating” to changes in their physical environments. The context MAKES the subject.

Dr. Young retired just three years after the conclusion of his study and publication of *The Anatomy*, but continued his research long after retirement, though he began to spend more time writing and lecturing to a lay audience in attempt to bring the findings of neuroscience to bear on our basic understanding of knowledge and thought. He recognized, however, the circularity of the ambition. “Can the brain be said to study the brain?” he asked. “If all speech is influenced by the particular social system of the speaker can there be any metasociety standing outside all the others? Can there be a metalanguage with which to describe languages?”

Young believed a biological model of the brain could provide the means to dispose of the perceived dichotomy between subject and object. This model would correspond to a communication system in which *vitality is equal to a flow of information.* He writes:

Information in a living system is a feature of the order and arrangement of its parts, which arrangement provides the signs that constitute a “code” or “language” [...] when the signs of the code are transmitted along suitable channels they provide the control that helps to MAINTAIN THE ORDER THAT IS THE ESSENCE OF LIFE. So the concepts of signs and information, and of coding and language, are closely related to the nature of life itself, and like life they are not simple at all.

In the late 1980s, Young published a book called *Philosophy and the Brain*, which originated from a series of lectures he gave called *Philosophers*

USE Your Brains—a title he rejected as “altogether too arrogant and provocative” for a book, though his point of view regarding philosophical approaches to describe the inner workings of the mind was admittedly skeptical. In it, he made the case that information from the fields of biology and neuroscience could expand understanding of the self, beyond what could be known only by introspection. He drew upon his research to provide an alternate definition of knowledge as part of the biological process of information gathering necessary to sustain life. For example: perception, being the bodily interpretation of information, is a construct adapted by subjects to fit their contexts.

Young believed that:

Living precedes thinking, and the fundamental basis of all human knowledge may be said to be awareness of life. “Cogito, ergo, sum”—“I think therefore I am”—is better replaced by “I know that I am alive,” which emphasizes that knowledge is a property of the operation of the physical body.

He held that scientific understanding could thus eliminate the philosophical problems of dualism, as embodied by Descartes’ maxim. Language, too, could be explained by Young’s definition of knowledge. He described it as “a recent version of the communication system that makes possible the continuation of all life.” Language is an adaptation that enables the vital flow of information.

I KNOW that I am ALIVE. Knowledge is a property of the body, and a subject no longer separated, or separable, from its context can rightly be said to have disappeared.

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IV. Shifting its shape and rearranging its privates

Colorless
Basic coloration
Mottled
Reticulated
White dorsal patch
Dark dorsal stripe
Glittering brows
Pale
Inking
Dark
Dark arms
Dark brows
Downward curls
Upward curls
Side stripes
Streaks
Dymantic spots
Bars
V's
Zebra
Dark borders
Female silver
Male silver
Papillae
and Sucker display

These are the elements of the octopus's sartorial grammar.

Search for “crazy” + “octopus” on YouTube, and you’ll find a clip of an OV that has assumed the form of a clump of seaweed. But that’s a spoiler, because if you don’t know there’s an octopus there, you just think you’re looking at seaweed until the camera operator comes too close, and the plant makes a startling switch into a bright white octopus who then darts off so quickly it appears to disappear again, as a cloud of black ink fills the video frame, signaling the end of the interaction. The impression is of a terrified, incontinent, and sublime Casper of the sea.

You can think of the octopus as one highly nuanced, asterisk-shaped muscle, plus a soft head, with no skeleton. An octopus can do bizarre things with its body, like pass through a hole the size of a coin, or vary its appearance by changing its body patterns in milliseconds through a combination of color, texture, posture and locomotion controls. It can disappear instantly into a semblance of rocks, seaweed, coral, or other animals. It can create psychedelic displays to communicate or to confound prey and predators. It can change the texture of its skin from smooth to spiky in just over two seconds. Highly textured skin looks like sand, gravel, rocks, or seaweed, and can be useful for appearing to BE sand, gravel, rocks, or seaweed when predators and camera crews come around.

An octopus changes color by contracting and relaxing radial muscles to control tens of thousands of tiny sacs of pigment in its skin. When the radial muscles are contracted, the sacs expand, and straw-yellow, orange, red-brown and black pigments spread. When the muscles are relaxed, the sacs collapse, and the amount of visible pigment is reduced. Light can then hit underlying reflecting cells, to produce interference colors—blue and green, as well as black-brown, iridescent and white. A completely wound-up octopus is pale. A completely relaxed octopus is dark, and myriad other body patterns are created through a hierarchical organization of color elements grouped into units and co-ordinated in series. The whole operation falls under control of the central nervous system.

An octopus can also adopt specific postures to communicate in a ritualized way with other octopuses. The octopus will, for example, arrange its arms in a V shape, or in a curl, pointing down or up. As for darting off, an octopus swimming is really an octopus hurtling through the sea on the thrust of the jet propulsion it has achieved by taking water into its mantle and pushing it out at once through a funnel. Octopus locomotion is highly maneuverable, but forward progress proceeds in fits and starts. Jet propulsion and passive drifting, in turns. The octopus JETS AHEAD, then floats. JETS. Floats. FAST ... then passive ... DETERMINED ... then not so much.

Some have even been known to walk. To wear a coconut shell and walk on two arms, which in this case are two legs. Neither arms nor legs. Tentacles is not the word, either ... there really ought to be a word for



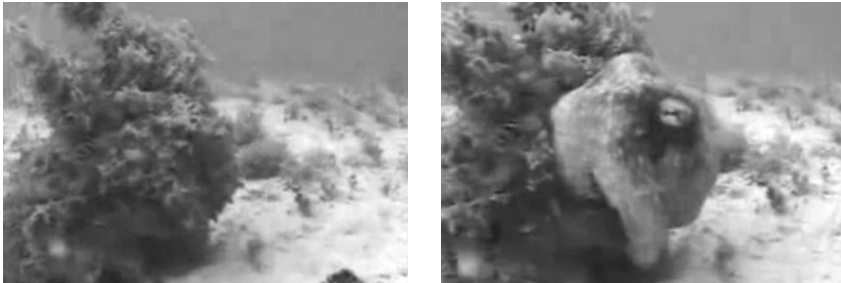
FIG. 19.12. Two octopuses that escaped from a tank with a fitted lid weighted by four large building bricks, the total weight being 19.7 kg. The weights of the two octopuses were 0.48 kg and 0.35 kg. They raised the lid but could not release their mantles and so died. (Figure kindly supplied by M. Nixon.)

accidents such as that shown in Fig. 19.12, where the octopuses had lifted the heavy lid and allowed it to fall back upon them.

There is also the possibility that these hairs serve as vibration receptors. Octopuses respond to such stimuli as shaking the tank, but the receptors responsible are probably not confined to the statocysts since the reaction continues after their removal.

Detail of page from Dr. J.Z. Young, *The Anatomy of the Nervous System of Octopus Vulgaris* (Oxford University Press, 1971)

octopus limbs that doesn't mean anything else. Thinking of an octopus as arms plus a head is way off, too. It's not that the octopus arms can't move stones and open jars like other arms, just that more octopus brain is in the octopus arms than in the octopus head. And the arm-brains are semi-autonomous.



Consecutive frames, http://www.youtube.com/watch?v=_AKGy560mSo

If you saw an octopus wearing a coconut shell and walking along the sea floor, you would suspect that it was pretending to believe that it wouldn't be noticed—knowing all the while it could be seen. You would suspect the octopus capable of irony. Or of starring in a slapstick comedy. And then, if you saw an octopus walk around while pretending to be a piece of ALGAE—as some do—you would know: the octopus has a sense of humor.

If you saw an octopus wearing a coconut shell and walking, you would see two stringy legs protruding from the bottom of a coconut, and you would think: NAKED, like a man wearing a barrel. And then you would think: NICE LEGS. An octopus in this get-up walks like a ballerina who has just taken a fall, then missed a cue after faltering again, and now has to find a way to exit the stage without making it worse. A walking octopus is awkward, but remembers being elegant, and is anyway trying to pull it together.

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V. How he or she gets from A to B

A message received is a message DECODED. Interpretation is integral to communication. The trouble is, from a perceiver's point of view, ANY object could be taken as a source of encoded information, whether intended or not. Every aspect of your present environment is made of potential information to be decoded ... but this line of thinking leads quickly into murky waters, away from the streamlined, survival-oriented program that is the brain's agenda. Let's approach this instead by supposing that communication is bi-directional, moving to and from senders and receivers. Let's also suppose that any information that has been ENcoded can be DEcoded by any recipient. Even if this decoding is incomplete and something is always lost in translation—as is certainly the case for interSPECIES communication—then, *what is the octopus trying to tell us?*

Octopus behaviors are categorized as “displays” and “anti-displays.” A display is a pattern consisting of some combination of movement, posture, color and texture change. Displays may be either “ritualized” or “unritualized.” Unritualized displays are numerous and frequent, in which information is INCIDENTALLY encoded. Ritualized displays are relatively infrequent, in which information is DELIBERATELY encoded. Every display communicates information, but ritualized displays have been adapted by the octopus *specifically to communicate something.*

A common assumption, frequently confirmed by observation, is that an animal's communications are a transparent indication of its motivations. However, this is often not the case. Signals may be DELIBERATELY misleading. They may be baffling. And cryptic. They can induce false predictions. They can be anti-displays, designed to impede communication. Octopuses are major proponents of the anti-display, and have also been observed to perform ritualized displays of aggression while turned AWAY from their supposed target of communication. Why?

Dr. Martin Moynihan, author of *Communication and Noncommunication by Cephalopods*, recommends that “Observers of animal behavior in the field should be ruthlessly simple minded and reductionist whenever possible.” It's sound advice, but inference and projection are the power

tools of human communication, and unplugging your expansionist, interpretive tendencies demands considerable discipline, even if you know you're inclined to get carried away and drill through your hand. Lacking Moynihan's discipline, one might ask whether the octopus's suppressed display of aggression is the equivalent of our punching a wall to blow off steam rather than bring on the fight. Do octopuses have second thoughts? Do they experience internal conflicts? And if so, do they express them?

The short answer is that, based on the structural analysis of octopus communication, such metacommunication is unlikely. The data regarding octopus semantics is scant, however, so answers to these questions are largely speculative.

The longer answer is that communication ABOUT communication by octopus is difficult to conceive without the equivalent of parentheses, brackets, or footnotes to indicate nesting or recursion. Going meta is generally a matter of explaining to your interlocutor, "I know that you know that I know," et cetera, but no such winking is apparent in octopus communication. In fact, what we might consider to be "octopus language" doesn't really even map onto language as WE know it, despite some significant similarities.

For starters, octopus communication is primarily VISUAL—built from the combination of sequential units of meaning in the form of postures, movements, colors and textures. However, these sequences do not seem to be equivalent to linguistic phrases, as they do not recur in regular patterns punctuated by starts, pauses and full stops. Instead, they are open-ended—even the long ones. They just go on until they don't, contrary to the vertebrate equivalent, which typically entails phrases and themes—even in the case of visual displays, like the courting rituals of some birds.

Some aspects of cephalopod communication are hierarchically organized. In a study of squid, Dr. Moynihan classified their ritualized displays into something roughly equivalent to our nouns, verbs and adjectives—but was quick to caution against overextending the analogy. He worried that our reflex tendency to anthropomorphize might obscure a true understanding of what's going on. He does, however, see symptoms of

self-awareness in some of the octopus's anti-displays.

There are two kinds of anti-display. "Baffle patterns" are, like certain political leaders, designed to be seen but misunderstood; while "cryptic patterns" are for the cognoscenti, designed to be missed by all but select observers. But the distinction is not always clear. For us human observers, of course, almost ANY octopus display is cryptic. AND baffling.

But ignoring for the moment the fact that we don't really understand their language at all, an example of a "cryptic" display is a color and texture combination that affects the direction of polarity of light reflected off an octopus's skin. While their observers—fellow octopuses and other animals with adequate equipment—would get the message, since we don't perceive the plane of polarity of light, it would bypass us entirely. Examples of "baffle" displays are "V postures," "stripes," and "streaks," which the octopus deploys in startling ways to intimidate and confuse prey or predators. These patterns do not seem to be mimetic—just inexplicably strange. Consider being confronted in waking, four-dimensional life by a sinister cartoon character who transforms from an animated house plant to a terrifying circus clown right before your eyes. Inspiring utter confusion seems a plausible enough measure of self-protection.

Octopuses appear to choose from a variety of possible "baffle" performances at random, which indicates a mechanism more sophisticated than the sort of "reflex response" humans are quick to ascribe to supposedly less intelligent species. Moynihan suggests that cephalopods performing "baffle" performances do "seem to know what they are doing," and that "perhaps they also know HOW and WHY they are doing so." From a neuroscientific point of view, awareness of intent is self-consciousness.

But octopuses grow up fast, live hard, die young. They don't have a lot of energy to waste in their brief life spans. Communication requires considerable energy and, furthermore, it can be dangerous. Visibility is vulnerability, and ritualized communications are especially conspicuous. Octopuses can't afford to play. For the most part, they're not even gregarious. Why, then, are they so ***** articulate?

The OV is an eloquent hermit, like an underwater Thoreau—only more misanthropic and prone to violence. Birds who are similarly solitary tend toward relatively limited signal systems and lose their vocabulary, but the octopus maintains a broad repertoire. Again: why?

In Moynihan's words, "It must be assumed that the advantages of existing behavior are somehow greater than the disadvantages. For those ritualized patterns which are designed to be perceived, the crucial factor would seem to be the PRECISION, and often the EMPHASIS, of the messages encoded." To confuse in a precise way is certainly baffling. But is it self-aware?

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VI. Writing oneself in ink

Octopuses ... have ... CHEMORECEPTORS.

I marveled at this word the first time I read it, feeling somewhat envious of the stupendous creature who possessed such a thing. To think: octopuses are equipped with special organs to detect chemicals in their environment! The concept was tantalizingly exotic, until it occurred to me that my own nose and mouth are, of course, chemoreceptors. But this revelation only furthered the pleasing, dissociating effect brought on by the word, which effectively made me as alien to myself as the octopus had been a moment earlier.

LIKE US, then, the OV emits and receives chemical signals. Little is known about octopus pheromones, but there is evidence that chemical expressions play a role in mating, and that some species of octopus prey can smell an octopus in their vicinity. Unlike us, though, an octopus can also emit crab-paralyzing toxin and ink. The ink is a suspension of almost pure melanin and mucus. It may anesthetize the senses. Usually, the effect is visual. It is a smokescreen, or, more often, a decoy.

The OV's ink cloud is black, but not all cephalopod ink is dark. Some species' excretions appear to humans in various hues of lavender, pink and yellow, depending on the pigment cells involved. Certain squid in the deepest deep even produce luminescent ink. Chemical displays are unique among cephalopod communiqués in that they stick around. Odors and inks are the *ne plus ultra* of open-ended transmissions. They can't be withdrawn. They carry on until they dissipate, which can be advantageous. A pair of squid approached by humans in shallow water over white sand, alarmed, finding nowhere to hide, were observed to first discharge black ink, then turn black themselves, and twirl erratically in imitation of the ink. They pretended to be their own decoys.

Cephalopods demonstrate associative connections between signals and aspects of their environments. Some even seem capable of indicating things that are remote in time and space. And they can prevaricate, lie, and talk nonsense, using symbols that are arbitrary and abstract.

They are primarily concerned with three topics: SEX, ATTACK and ESCAPE, though some conversation relates to less portentous ideas, like sociability and feeding. While the agenda for communication is limited, the range of patterns is vast: “Hundreds of different combinations can be shown, succeeding one another so rapidly that the human eye can scarcely, if at all, follow them from second to second.” All this, without phrases, sentences, or—presumably—self-awareness. The octopus, we are assured, is not a metacommunicator and is certainly not making metaphors. Octopus ink is dispersed without artful intent. It is simply a visual interjection; the supreme animal expression of being beside oneself with fear. Ink is a desperate ruse.

But what IS metaphor, and how do we KNOW whether we’ve encountered it?

Metaphor can be broadly defined as “a means of referring to one concept by using terms that are native to another, unrelated concept.” Metaphors are so pervasive in our language that we often do not even register their occurrence, as is the case with many prepositions that indicate spatial orientations—take the idea that a word is “in” language or that knowledge is “in” the brain. Or that we “enter into agreement” and “fall in love.” Similarly, we often use material metaphors to refer to immaterial actions. We “make a decision” or we “spend time,” though decisions and time are not physical substances to be made and spent.

Recalling, now, a page from Dr. Young, to say that the brain knows about metaphor is itself a metaphor. Philosophers—dualists—would call it a mistake. Knowing, they would say, is a property of mind, not brain. But recall also that the meaning of a word changes over time; our concept of what it is to know is affected by our increasing knowledge. We have recently come to think about thought as an event that occurs in a brain, like a program running in a computer.

In Young’s words, “information [in the brain] is stored by a switching system that alters the probability of future actions of neurons.” The regions where the switching occurs have been identified in the octopus brain. Is it meaningful, therefore, to say that what an octopus knows is known by these parts of its brain? And how do we determine the quality

of an octopus's knowing? Does it know imitation? Does it know confusion? If we cannot say for certain what it is to know, how can we be certain who knows what? And who doesn't? Is our language adequate to answer these questions?

Those metaphors we use repeatedly become rote, but even as they disappear from consciousness they continue to affect our manner of thinking. The veracity of a metaphor may change over time, as circumstances change. As such, to conceive of people or brains as COMPUTERS, or of noses as CHEMORECEPTORS, or of octopuses as KNOWING is potentially significant in setting horizons for thoughts we haven't yet thought.

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VII. Polysexuality and death

Your narrator is not a biologist, or a specialist of any kind. She has only seen PICTURES of octopuses—mainly drawings—and read about them in books, or watched miniature, pixelated approximations of them in low-resolution videos on the internet, which makes them as real to her as feedback from the Mars rover. Most of what I will tell you about sex and love and death among cephalopods in the paragraphs that follow will amount to draping my own projections and fears over a wire model of second-hand information.

To be fair to octopuses, I'll use the terms "sex" and "love" interchangeably in discussing their behavior. Why? ... Well, imagine an octopus studying us humans without the ability to understand our language. How would she separate those behaviors of ours which are related to reproduction and species survival from L-O-V-E? By now we know that octopuses are sophisticated communicators. If the reproductive act is considered a prototype of love among humans, why should I maintain an arbitrary class bias when assessing sex among other animals by reducing it to a strictly mechanical operation? Why do we err on the side of presuming animals don't have feelings that map to ours, rather than the other way round?

When it comes to love though, what can any of us—whether scientist or trifle—say about a phenomenon so broad and so vague that the *O.E.D.* devotes 24 columns to defining it? ... 24 columns is not a definition, it is a GROPE. Talking about love is like shining a spotlight on a shadow to get a better view of it; or like reading a phonebook to understand people. 24 columns: we can't help ourselves, even though we have an inkling of where it's all headed, in the end. Ditto: death.

This prelude of diversions and disclaimers is all to say that the love letter of condolence that follows is foredoomed. Very well. First, some basics:

- Cephalopods are either male or female
- There are no hermaphrodites
- External differences between sexes are exhibited by many species
- The word for this is "dimorphism"

– That translates as “two shape-ed”

Dimorphism takes various forms among octopuses—males and females may be of different sizes, and they may exhibit different body patterns, or males may have a “hectocotylus”—a specialized appendage through which spermatozoa are transferred to females. Males of certain species have what is referred to cryptically as a “complex hectocotylus.” It breaks off during sex and remains in the mantle of the female, where it continues flexing slowly for some time. (I have yet to come across any explanation regarding the potential benefits of this phenomenon.) As for body patterns, in some cephalopods, “glittering silver tones reflect highly ambivalent combinations of hostility and sex, and soft pastels are even more strongly sexual,” but our OV—not well-regarded for his courtship displays—lacks the capacity for such flamboyance. He exhibits little external dimorphism, other than some enlarged suckers on a couple of arms. Chemotactile cues are believed to precipitate a match instead.

According to Aristotle’s field work in *The History of Animals*,

Molluscs, such as the octopus, the sepia, and the calamary, have sexual intercourse all in the same way; that is to say, they unite at the mouth, by an interlacing of their tentacles. When, then, the octopus rests its so-called head against the ground and spreads abroad its tentacles, the other sex fits into the outspreading of these tentacles, and the two sexes then bring their suckers into mutual connexion.

Aristotle wasn’t quite right about the procedure, though his description must at least be an accurate account of how the act LOOKS, as it was based on his first-hand observation of the OV who were hanging about in the shallow waters of the Mediterranean. His rendering of the hectocotylus, on the other hand, was derived partly from hearsay. He wrote,

Some assert that the male has a kind of penis in one of his tentacles, the one in which are the largest suckers; and they further assert that the organ is tendinous in character, growing attached right up to the middle of the tentacle, and that the latter enables it to enter the nostril or funnel of the female.

The modern, scientific, and French way of framing all this is that mating occurs *à distance*. The male “stretches right arm 3 to insert the Hectocotylus into the female’s mantle cavity and then pass spermatophores into the oviducts.” In most species, he dies shortly after insemination.

SOME ASSERT that female octopuses lay eggs in quantities ranging from about ten to 700,000. The eggs are approximately 1.5 mm in diameter, and she excretes them in strings over a period of several weeks. She then attaches these strings or stalks to the roof of her den for a brooding term that may last up to five months. As the eggs hatch, she flushes the paralarvae out of the den with a jet of water. They are carried away by currents, and continue to drift with the plankton until their development is complete, about twelve weeks later. The octopus stops eating when she begins brooding, and dies, emaciated and spent, after her last egg hatches and is flushed from the den.

A sensational pop-science magazine reported not so long ago that,

RAUNCHY video footage from the depths of the Pacific Ocean has got marine biologists excited—and perplexed. For the first time, they have witnessed two deep-sea octopuses having sex—only to discover they have been watching the intimate embraces of two males of different species ... In the video, the smaller octopus—a white-coloured species unknown to science—sits on top of a larger, brown one, also unidentified. The smaller octopus rubs its sexual arm along its partner’s back then reaches under the larger male and inserts the tip of its arm into the body cavity. The smaller, white octopus’s body begins to expand and contract rapidly, a behaviour also believed to signify mating.

At the time the report was filed, octopuses of like species had been observed in same-sex encounters, but homosexual relations among octopuses in the wild or among those of different species were unheard of. Apparently dissatisfied with more obvious explanations, scientists ASSERTED:

The scarcity of octopuses down in the deep ocean makes it of paramount importance that every time a male octopus encounters another one, it must thoroughly investigate the possibilities, regardless of species or

gender. If it doesn't, the male may accidentally pass by a female of the same species—and perhaps miss a once-in-a-lifetime chance of mating.

Other, more sociable male cephalopods are concerned not with passing by, but with passing FOR and AMONG females. Certain modestly-proportioned male cuttlefish have been observed to dress up like females in order to (a) escape the wrath of more imposing males and (b) get girls à la Tony Curtis and Jack Lemmon in *Some Like it Hot*.

Large numbers of cuttlefish gather to mate on rocky reefs at Spencer Gulf in South Australia [where scientists observe] that small males often tag along with breeding pairs in the guise of females. The males' arms are usually fringed with webs, but smaller males can retract these to impersonate the females, as well as adopt the female body color and pattern. When the larger male is distracted by fending off rivals, the transvestite male reveals himself in an often successful attempt to woo a female. If the larger male returns to find his mate getting intimate with the little guy, the smaller male can rapidly don female disguise again to avert the wrath of the spurned rival.

The biologists on watch speculated that the large males and the smaller, female impersonators might be involved in an evolutionary arms race, with the larger males adapting improved means of ferreting out the transvestites and the transvestites developing ever more sophisticated techniques of disguising themselves.

Though certain baffling performances leave room for doubt, an octopus's signals and commitments are likely to be made exclusively in earnest. A long life for the OV is five years—they don't even have TIME for childhood. The young are merely miniature versions of the adults, capable of self-sustenance from the moment of hatching, when their mother flushes them from the den into the open sea. They rely upon inherited, instinctive behaviors, modified by experience during a single lifetime. An individual octopus can learn, but won't pass its knowledge to the next generation. Species learning does not accrue.

Humans live on a different scale of time. We accrue information over generations, either via speech and oral tradition, or through recorded

communication. By writing our thoughts down, we effectively extend our minds far into the future, as authors, and into the past, as readers. Call it TIME-BINDING. Or not reinventing the wheel. Unlike octopuses, we're born without adequate survival skills. We learn what we need to know to get along—motor skills, social skills, language, card tricks, philosophy—over a period of many years, and we keep building on this knowledge for our lifetime.

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VIII. Post-symbolic communication, or speaking without words

Picture in your eye's mind an octopus. A mollusk with eight sucker-bearing arms, a soft sac-like body, strong beak-like jaws, no internal shell, and two very large eyes. Gestures vacillating between diaphanous undulation and rigid, muscular aggression. Solitary. Sophisticated. Chemosensitive. Communicative. Misunderstood.

The predatory octopus, with its many limbs and alien bearing, has been used so often as a metaphor to describe ominous, obscure, and seemingly-pervasive forces that the dictionary lists a secondary definition of the word as “an organization or system perceived to have far-reaching and typically harmful effects.” This is a crab's-eye view of the octopus—a fearful, cursory regard. When reconsidered from a vantage more becoming of OUR place in the food chain, the octopus may serve instead as a model to supplement, if not supplant, our prevailing concept of communication. At least this is the perspective of Jaron Lanier, better known as the father of virtual reality.



Lanier works at the intersection of Computer Science and Neuroscience, developing software to recognize patterns to test hypotheses about how brains work. It isn't as obvious as it sounds. Computers aren't all that much like brains.

Recall that for Claude Shannon, the goal of a communication system was to transmit information from one point to another point. The message that goes in one end should come out the other end as much like the initial

message as possible. To engineer a system to transmit a message with maximum fidelity, information must first be understood as a quantity. Shannon was dealing with a very basic order of complexity—bits, not meaning—and his model of information is accordingly GRANULAR.

And it is Shannon's Information Theory that provides the conceptual framework for our modern communication technologies. The central set of conventions—the design protocol—to manage a flow of information in a computer program is STILL based in the metaphor of the telegraph. That is, computer programs assume that information is an electrical signal sent from one end of a wire to the other. Systems guided by this principle become unwieldy when tasked with a very large set of information that changes in real-time. A small glitch can cause terminal program failure.

BIOLOGICAL systems, by comparison, are both exponentially more complex and more resilient. Even though nerve impulses from each neuron in the eye must be ordered sequentially in the brain, the quantity of impulses processed simultaneously, in parallel, is enormous—and this is only a simple example. Neural processing is not yet well understood, but it is evidently a multichannel operation, and the system itself exhibits a high degree of PLASTICITY. The paths information follows as it travels through the brain, and the brain's capacity to adapt new paths in relation to its changing environment, have no place in Shannon's model. While the brain-as-computer is a dominating metaphor in common language, researchers performing simulated brain experiments have found that current software is fundamentally inadequate for modeling processes of the brain's complexity.

So the metaphor has outworn its usefulness. Why should this matter?

If we agree with Dr. Young's reply to Descartes—I KNOW that I am ALIVE—there is a constant relay between the quality of our knowledge and our potential to thrive. *A bit is not information until it is read.* Interpretation is an indivisible part of the process. In fact, I suppose it IS the process.

Lanier then thinks Shannon's "information" should be renamed "potential information." Against the protocol-based programming of contemporary

computing, he offers the model of PHENOTROPIC computing. The goal of phenotropic computing is to render systems in which *every instance of information in a system relates to its context* and which can effectively make inferences about other systems based on how they behave in a shared context. Communication transmissions in a phenotropic system MUST have a causal relationship to their environment. Instead of thinking of information as a single bit traveling from A to B, Lanier conceives of an ever-changing SURFACE from which multiple points are sampled simultaneously and continuously.

What does all this have to do with octopuses?

Dr. Young looked to Information Theory and the burgeoning field of Computer Science to provide useful metaphors for his biological models of octopus and human brains. Now, 50 years later, the situation has come full circle, and Lanier is looking to biological models like Young's to find a better metaphor for computer programs. In effect, one metaphor is being rephrased in the terms of another whose original terms of reference have since expired. Lanier's goal has been to apply the phenotropic approach to virtual reality software.

Immersive virtual reality can simulate an environment in which your perceptual processes no longer connect with your body as you think you know it. Instead, you may appear to your own eyes, ears and limbs as a monkey, or a triangle, or whatever. And when you move parts of your human body to affect what appears to be your body in a virtual reality simulation, your brain begins to adapt different patterns.

Lanier calls virtual reality a “consciousness-noticing machine.” He believes it holds the promise of a new, and fundamentally different mode of post-symbolic communication—a revelatory, LIVED experience of non-duality: *I no longer think therefore I am. I just AM, I think.* And you're correct in already thinking that his model for this is the cephalopod.

In Lanier's equation,

$$\text{Cephalopod} + \text{Childhood} = \text{Humans} + \text{Virtual Reality}$$

In other words, an octopus with the ability to time-bind by passing information from generation to generation, as humans can, would be like a human who could communicate by changing form, as octopuses do. Either scenario presupposes the development of a language with an entirely different structure than those we currently know. By reorienting the perceptual processes of our brains through virtual reality, we could experience a different relationship to our contexts ... self-aware octopuses *becoming what we wish to communicate.* Lanier calls this state “fluid concreteness.” It sounds verrry trippy.

But the concept of post-symbolic communication is difficult to parse. It begs the question: What is communication without the symbol—without the ambiguity of interpretation? If words were too specific, they would be useless. One concept is NECESSARILY used to refer to another. Yet we can and do make our meaning sufficiently clear. Or better to say, THEREFORE our meaning is made.

The point, however, is to demonstrate that new forms—even the SUGGESTION of new forms—ANTICIPATE the old ones, in much the same way that increasing our understanding about the brain or the octopus can affect, or at least cast in higher relief, our understanding of ourselves and what it is to BE¹ a self.

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1. Maybe the very idea of self-awareness will eventually be dated.