A FORAY INTO THE WORLDS OF ANIMALS AND HUMANS

Jakob von Uexküll

A FORAY INTO THE WORLDS OF ANIMALS AND HUMANS

WITH *A THEORY OF MEANING*

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Introduction by Dorion Sagan

Afterword by Geoffrey Winthrop-Young

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INTRODUCTION UMWELT AFTER UEXKÜLL

Dorion Sagan

ALTHOUGH LIFE BOTH TRANSFORMS MATTER and processes information, the two are not proportional: the touch of a button may ignite a hydrogen bomb, while the combined military efforts of Orwellian nations will fail to make a little girl smile. Thus life is not just about matter and how it immediately interacts with itself but also how that matter interacts in interconnected systems that include organisms in their separately perceiving worlds—worlds that are necessarily incomplete, even for scientists and philosophers who, like their objects of study, form only a tiny part of the giant, perhaps infinite universe they observe. Nonetheless, information and matter-energy are definitely connected: for example, as I was jogging just now, hearing my own breathing, I was reminded to share the crucial fact that the major metabolism that sustains us perceiving animals is the redox gradient,[1] which powers the flow of electrons between the hydrogen-rich carbon compounds of our food and the oxygen we take in from the atmosphere, a chemical difference which itself reminded me, in one of life's circumlocutionary moments, of its own existence.

Once upon a time, says Nietzsche, in a cosmos glittering forth innumerable solar systems, there was a star "on which clever animals invented knowledge [however] . . . After nature had drawn a few breaths the star grew cold, and the clever animals had to die." Their knowledge did not preserve their lifeform or lead to its longevity but only gave its "owner and producer . . . [a feeling of great] importance, as if the world pivoted around it. But if we could communicate with the mosquito [some

translations give 'gnat'], then we would learn that it floats through the air with the same self-importance, feeling within itself the flying center of the world. There is nothing in nature so despicable or insignificant that it cannot immediately be blown up like a bag by a slight breath of this power of knowledge; and just as every porter wants an admirer, the proudest human being, the philosopher, thinks that he sees the eyes of the universe telescopically focused from all sides on his actions and thoughts."[2] How strange that our cleverness (which might be described as the linguistic, thought-based power to find—and forge—connections), which after all we possess only as a crutch to make up for our physical weakness, for we would have died without it, should lead us to consider ourselves masters of the universe. "[L]anguage is a thing:" writes Blanchot, "it is a written thing, a bit of bark, a sliver of rock, a fragment of clay in which the reality of the earth continues to exist."[3] But language is a thing with peculiar properties. Within a given animal's perceptual life-world, which the Estonian-born biologist Jakob von Uexküll (1864–1944) referred to as its *Umwelt*, signifying things trigger chains of events, sometimes spelling the difference between life and death. Consider the signifying honeybee. When bee scouts come back to a hive, before they do their famous figure-eight waggle dance, which tells their hivemates of the distance and location of resources needed by the group, they spit the water, pollen, or nectar they've collected into the faces of the other bees waiting at the entrance of the hive. What they spit to their fellows is essentially a sign of itself, but their dance says where and how far. Moreover, if the message is of something the hive needs, the bee will be the center of attention. In a hive starved for pollen, a scout bee may be welcomed enthusiastically by its fellows, and may do the famous waggle dance up to 257 times, for as long as half an hour.[4] But if it is later in the day, and the hive is cool, water is not needed and the ignored bearer of the information of the water source will tend to crawl about languidly. Even at the

insect level such resource-related signifying—bringing good news or relaying useless messages—may coincide with feelings of depression or elation. Indeed the bee returning with pollen and the message of its whereabouts may even enjoy the sort of intersubjective bliss reserved in human beings primarily for matinee idols and rock stars.

The notion of a distinct perceptual universe for honeybees and other animals is Uexküllian. Uexküll sees organisms' perceptions, communications, and purposeful behaviors as part of the purpose and sensations of a nature that is not limited to human beings. Uexküll's conviction that nonhuman perceptions must be accounted for in any biology worthy of the name, combined with his specific speculations about the actual nature of the inner worlds of such nonhuman beings, is a welcome tonic against the view that nonhumans are machine-like and senseless. Uexküll also insists that natural selection is inadequate to explain the orientation of present features and behaviors toward future ends—purposefulness. Uexküll may be right. Natural selection is an editor, not a creator. The whittling away of relatively nonfunctional forms by their perishing and leaving no offspring (that is, by natural selection) would seem to provide an incomplete explanation. Uexküll's postulation of a human-like consciousness orchestrating natural purposes from a vantage point outside of time and space will seem bizarrely Kantian or too creationistic for most modern readers. Worse still, Uexküll's talk of a "master plan" may sound outright Nazi—although this may be partly the result of translation.[6] If the real world of human toes, parasitic wasps, and penguin wings suggests more a cosmic hack than an all-powerful creator, the history of Faustian eugenics at the time Uexküll was writing renews the question of where Uexküll, in his view of life as a unified entity, thought purposeful life was going. And yet Uexküll's exposition of purpose and perception, of cycles and signaling, of the relationship of part to whole attends to precisely those subjects that have been neglected in

the development of biology after Darwin. Perception and functionality pervade living things, and ignoring them, while convenient, is not scientific. Thus Uexküll's careful inventory of such phenomena is to our lasting benefit. Uexküll's examples remain fresh and interesting to modern theorists coming back to construct a broader, more evidence-based biology—a biology that embraces the reality of purpose and perception without jumping to creationist conclusions.

Uexküll is among the first cybernetic biologists, ethologists, and theoretical biologists, as well as being a forerunner to biosemiotics, and a neo-Kantian philosopher.[6] The scientist most cited by Heidegger, Uexküll and his Institute studied the differences of human and other animals' perceptual worlds. The nature of the alleged gulf between humans and (other) animals of course has ethical implications, because it helps determine how we treat them, and was a problem that absorbed Derrida during his dying days. Uexküll's analyses are important to Deleuze and Guattari, among other philosophers. In literature he influences Rainer Maria Rilke and Thomas Mann, in ecology Arne Næss, and in systems theory Ludwig von Bertalanffy.[7] Uexküll's example-rich discourse of life perceived by various species is relevant to epistemology; it expands phenomenology; and it integrates the primary data of perceptual experience into behavioral psychology. Uexküll's notion of the Umwelt and his work in general was popularized and developed by Thomas Sebeok, who spoke of a "semiotic web"—our understanding of our world being not just instinctive, or made up, but an intriguing mix, a spiderlike web partially of our own social and personal construction, whose strands, like those of a spider, while they may be invisible, can have real-world effects. Sebeok calls Uexküll a "cryptosemiotician," semiotics—the study of signs—being, according to John Deely, "perhaps the most international and important intellectual movement since the taking root of science in the modern sense in the seventeenth century."[8]

Scientific innovator though he be, Uexküll, while not explicitly anti-evolutionist, disparages Darwinism. He dismisses the notion that natural selection can account for the character of life he considers most important: the interlinked purposeful harmonies of perceiving organisms. The existence of rudimentary organs is "wishful thinking."[9] Uexküll compares functional features to a handle on a cup of coffee, which is clearly made for holding. He calls our attention to angler fish with lures built into their heads that attract smaller fish which, approaching, are literally sucked in by a whirlpool when the angler suddenly opens its mouth. He points out butterflies whose wing-placed eyespots startle sparrows because to them the spots look like a "cat's eyes." He makes much of beetle larvae that dig escape tunnels in hardening, maturing pea plants, so that when they metamorphose their future forms, about which they know nothing, can eat their way out of the rigidified vegetable matter, which would otherwise become their green coffins.[10]

Organisms in their life-worlds recognize not only sensory inputs, but also functional tones, the use they need to make of certain stimuli if they are to do what they need to survive. The hermit crab has developed a long tail to grab snail shells to use as a temporary home. "This fitting-in cannot be interpreted as a gradual adapt[at]ion through any modifications of anatomy. However, as soon as one gives up such fruitless endeavors and merely ascertains that the hermit crab has developed a tail as a prehensile organ to grasp snail shells, not as a swimming organ, as other long-tailed crabs have, the hermit crab's tail is no more enigmatic than is the rudder-tail of the crayfish."[11]

But of course evolution implies evolution of function, with new purposes coming into being. Consider the surprising result that the life spans of animals such as rats increase not only, as is well known, if they eat less, but can also increase if they don't *smell* food. Houseflies exposed to the odor of yeast paste are deprived of longevity at approximately 40 percent the rate of their calorically restricted brethren. The smell of

food, although vanishingly tiny compared to what it signifies, functions as a molecular sign. An evolutionary explanation is that the smell of food is an indicator of dense populations. Foregoing feeding and dying sooner under such circumstances would tend to preserve resources and allow rodent populations to be refreshed with stronger, more youthful members. The fitting in, the matching of food giving away its presence by an "olfactory sign" (the food in effect being a sign of itself[12]) to increased rodent senescence, is beyond individual rat consciousness but selected for by the superior robustness of populations whose members interpreted excess food as a biosign. Such meaning-making, or semiosis, evolves between organisms and their environments, among organisms of the same species and across species, and within individual organisms such as humans attempting to understand the symptoms of their bodies. Signs are read in a language older than words. An embarrassed person's face flushes, showing something about his relationship to the group. That men produce more sperm if they believe their spouses are cheating reflects not a conscious but an unconscious semiosis, at the level of the body. An itch signifies the possible presence of an insect, which evolutionarily was often enough fatal due to adventitious inoculations of pathogens during the blood sucking of insects. Emotions and feelings carry meaning at a prelinguistic or preverbal level in ways illuminated by a consideration of evolutionary history.

While all organisms may have minor goals, such preparations for the future as that of a beetle larva, along with "our personal Umwelts, are part of an all-embracing master plan."[13] Yet one need not adhere to the idea of a master plan—so consonant with German philosophy (e.g., G. W. F. Hegel's writings), Nazi ideology, and monotheism—to recognize the pervasiveness of purposeful activity in biology. More than once in his corpus Uexküll mentions Noah's Ark (e.g., "we have seen them leave the ark of Noah in pairs").[14] Invoking "transensual, timeless" knowledge that allows organisms without human foresight to

act in ways that match present action to future needs, he genuflects to a musician-like "composer" of awareness who is "aware" and can "shape future life-requirements," with a "master's hand":[15] it is clear that he has not completely abandoned traditional monotheistic ideas of design, although this may be more a reaction to the perceived inadequacy of Darwinism to explain function than an unqualified embrace of creationism. Uexküll wheels out musical metaphors. Organisms are instruments in a sort of celestial music show of which we hear only strains.

Thus, Uexküll is divided: on the one hand he reserves in his neo-Kantianism a transcendental dimension beyond space and time that seems quite anachronistic in terms of modern science, and yet on the other he catalogs details of animal behavior deducing the reality of their perceptual life-worlds in a manner more naturalistic than that of behaviorists, mechanists, and materialists who treat the inner worlds of animals (for *functional* reasons of scientific investigation!) as if they don't exist. A systemic view, which gives some causal agency to the whole over the parts, is not only consonant with modern thoughts of emergence, systems biology, and thermodynamics, but vindicates Uexküll's dogged persistence against natural selection as a sufficient explanation for the extremely nuanced, functionally oriented life-forms covering our planet. One need not embrace a transcendental master plan or nature moving toward a unified single goal (e.g., God, or the end of history) to see purposeful activity deeply embedded in living things, and emerging often in diverse, unpredictable ways.

Pre-Uexküllian ignorance of animal Umwelten should be seen in terms of the history and methodology of science: focusing on one aspect of the environment, as science does to isolate objects for study, presents an abstracted, truncated version of the elements under study that eventually comes back to haunt those who overgeneralized on the basis of an incomplete sample. For example, Max Delbrück's decision to investigate life's molecular mechanism by studying bacteriophages (bacterial

viruses that do not have their own metabolism, making them easier to study) helped lead to an overemphasis on genes as the all-explanatory secret of life.[16] So, too, particle physics discovered the necessity of including the observer, her apparatus, and measurements to fully account for observed behavior. And in thermodynamics, the initial simplified studies of matter and energy in thermally sealed systems were prematurely extrapolated to suggest that all natural systems inevitably become more disordered, even though most systems in the universe, including those of life, are not isolated in experimental boxes but open to material and energy transfer.

The phenomenon might be described as the return of the scientifically repressed: what is excluded for the sake of experimental simplicity eventually shows itself to be relevant after all. Behaviorism, explaining animals in terms only of their external behavior, is a logical development of the expeditious exclusion of the dimension of living perception, methodologically bracketed by a church-savvy Descartes, and swept under the rug by a Faustian science drunk on the dream of an all-encompassing materialistic monism.[17] With Uexküll the inner real comes back in the realization that not only do we sense and feel, but so do other sentient organisms; and that our interactions and signaling perceptions have consequences beyond the deterministic oversimplifications of a modern science that has bracketed all causes that are not immediate and mechanical.

"The process by which the subject is progressively differentiated from cell-quality, through the melody of an organ to the symphony of organism, stands in direct contrast to all mechanical processes, which consist of the action of one object upon another."[18] Here Uexküll remarks the ineffectiveness of immediate cause and effect to explain the long-range development of organisms. Uexküll doesn't see, for example, how natural selection can explain the growth of an acorn into an oak, or an egg into a hen, because, "Only when cause and effect coincide in time and place can one speak of a causal connection."

Despite his musico-creationistic vocabulary, his seeming lack of understanding of how natural selection can radically alter function and eliminate the nonfunctional, as well as his death (1944) prior to the massive advances in chemical understanding of effective causation at the level of replicating genes in the 1950s, Uexküll's emphasis on the need to better integrate functionality into biology is, I believe, correct.

Although functionality can certainly change (think, for example, of using car ashtrays to store change), the functional characteristics of organisms have been illuminated in recent years by nonequilibrium thermodynamics. This science provides the backdrop for life's origin and evolution, and for its overall character of being highly functional and goal-oriented. Perhaps it is best to give at the outset what I consider to be one of the best examples of the misreading of teleology—purpose—in biology, which I hereby christen "Turing Gaia." First it is crucial to realize that there is a huge taboo against a teleological understanding of organisms and/or their organs being genuinely "for" something—except, of course, for surviving, which is not an explanation in terms of immediate cause and effect, but is allowable because natural selection in the past gives the impression of present, to use an Uexküll term, harmony. The reason for the antiteleological bias is obvious enough: purpose smacks of God's plan, religion, and design, anathema to scientists. But "Turing Gaia" shows that what looks like purpose and in fact may be purposeful need not have *either* a creationist *or* a Darwinian explanation. Gaia is shorthand for the realization that in the biosphere major environmental variables such as global mean temperature, reactive atmospheric gas composition, and ocean salinity are regulated over multimillion-year time spans. Indeed, Earth's surface resembles a giant organism, whose surface regularities and complex biochemistry look engineered, behave purposefully, and would never be predicted on the basis of chance alone.

But the environmental regulation has a natural thermo-

dynamic explanation. When sensing organisms react by growing or not growing within certain ranges, for example of temperature, this will lead to global environment regulation. The simplest computer model to show how this works is the Daisyworld model.[19] Growing and absorbing heat when conditions are cool (but not too cool) patches of black daisies (say) heat things up. Then, when they get too hot, they stop growing, leading to planetary thermoregulation. White daisies do the same, working in reverse. The real Earth multiplies uncounted variations on this theme of open systems growing and not growing within constraints in such a way that regulation and intelligent-seeming behaviors occur. There is no mysticism, just the growth of organisms within a certain temperature range or other conditions.

Nonetheless, such planetary regulatory behavior could not be understood by hard-core Darwinians because they could not see how organisms could arrive at a "secret consensus" (Ford Doolittle), or regulate as a single being without natural selection having acted at a planetary level, implying an astronomical environment littered with dead or less functional planetary individuals (Richard Dawkins). In short, fear of teleology as nonscientific leads scientists to accept true purpose only at the level of evolved structures or human consciousness. But growing at such and such a temperature, and not at another, leads directly to planetary regulatory behavior that looks so purposeful it was dismissed as impossible evidence of consciousness, teleology, and intent. The behavior is also implicitly semiotic, as temperatures are interpreted as signs. The reason I call this example Turing Gaia is that Alan Turing defined a conscious computer as one that would be able to consistently persuade humans that it had a genuine inner self, a cyber-Umwelt. As hard-core Darwinians mistook for conscious foresight simple thermodynamic behavior modeled on a computer, growth within constraints has in effect passed the Turing Test. Simple behaviors can easily appear purposeful and conscious.

There is indeed a functional tone to the whole of life. But

it probably owes far less to Uexküll's transcendental celestial counterpoint than it does to the vicissitudes of energy flow in complex systems. Uexküll's focus on perceptions that lead to actions has a thermodynamic context because complex systems (such as daisies) appear only under certain conditions, which they implicitly recognize as signs. They do not appear when those physical conditions, which again act as signs, are not present.

Uexküll may not have liked Darwinism's Englishness, its truncation to a bare-bones mechanical view of a broader German *Naturphilosophie*. Uexküll argues the British popularizer of Darwinism Herbert Spencer "made a basic error" when he put forth "'survival of the fittest'" rather than "survival of the normal" to "support the theory of progress in the evolution of living beings."[20] As for many German scientists, Uexküll's thought grew out of Kant, who argued there was no direct apprehension of things in themselves. We bring our own categories—for Kant, time, space, and causality—to the world we appear to observe directly. Ironically, this emphasis on mental construction and the impossibility of a true objectivity may have helped make Uexküll be more objective, thinking about the categories under which other animals perceived the world.

Defying the rise of biological reductionism epitomized by natural selection as an explanatory principle, Uexküll emphasized the influence of the whole: whereas, he says, "When a dog runs, the animal moves its feet, i.e., the harmony of the footsteps is centrally controlled. But in the case of a starfish we say: 'When a starfish moves, the legs move the animal.' That is, the harmony of the movement is in the legs themselves. It is like an orchestra that can play without a conductor."[21] The starfish's legs take the starfish along, whereas you decide where you want your feet to go.

Uexküll's view here is holistic, anticipating systems biology and cybernetics. Ironically, considering the ascendance of

Gaia science (or "Earth systems science" as it has been appropriated in geology departments) as "geophysiology," Uexküll identified physiology as the life science challenged by its focus only on parts, whereas biology proper was for him the life science of the whole. (However, Uexküll tended to focus more on individuals than ecosystems.) The scientific trend against which Uexküll was reacting, of explaining everything in terms of local cause and effect, stimulus and response, the material interaction of connected parts, he identified with physiology: "In the introduction to his first book about the experimental biology of water animals, Uexküll distinguished between physiology, which organizes the knowledge about organic systems on the basis of causality, and biology, which does it on the basis of purposefulness (*Zweckmessigkeit*)."[22]

Uexküll pushed for a biology that would systematically account for the perceiving beings that had been left out in the rush to explain living "things" (as we sometimes say) as effectively and scientifically as Newton had explained celestial motions by mechanics. The law of natural selection does not explain the inner world of animals—our original and enduring encounter with reality—with anything like the accuracy that the laws of motion explain the external behaviors of plants. Cartesian philosophy dismissed the inner world of animals (let alone plants and microbes[23]), treating them, conveniently enough, as soulless, unfeeling machines. Behaviorism in psychology, such as Pavlov's experiments on dogs, investigated animals as mechanisms without attending to their inner processes. Uexküll's work, however, integrated inner experience. Take the Umwelt of "man's best friend," the dog. How do dogs perceive? Uexküll shows us the difference in the Umwelten of the shy dog and the "spirited" dog, urinating away, marking his territory. Whereas Chekhov writes of a dog sniffing all the corners of a room and, from the dog's viewpoint, of the unquestioned superiority of human beings, and Nietzsche talks about a dog coming up to the philosopher as if to ask a question, but

then forgetting the question, Uexküll more closely enters the question of what it is like to be a dog.

Pavlov's experiments showed dogs could be made to salivate in expectation of food at the ding of a bell, and by extension at a spoken word such as "food"—but that doesn't mean they understand the meaning of the word. Contrariwise, as Uexküll points out, referencing the work of a colleague, that dogs trained to sit on a special chair at the command "Chair!" will look for something else to sit on if the call is repeated but the chair removed. This suggests that dogs use signs, which can be used to convey a notion of a "sitting-quality," and Uexküll adds that, while linguistics is beyond him, making a "biological science" of it is the "right path"—although it may be that "true" (human-style) language, which includes a childhood ability to learn grammar, and a cultural ability to play in a semiotic space that can virally spread new and discard old words as well as other abstract signs, depends on the ability to realign neuronal models with external models, and thus that it starts with brains and not, as Uexküll's son Thure von Uexküll suggests, with the "living cell" as the "'semiotic atom.'"[24] The superiority of certain modeling tasks human beings have thanks to our neuron-packed cerebral cortices should not be confused with either a complete perspective or a lack of complex sensory processing in nonhuman beings. Novelist, painter, and biological theorist Samuel Butler, in his *Note-Books* (derived from his habit of carrying one with him and making notes whenever an idea struck him), points out the anthropocentrism of the very notion of language. Doing the etymological analysis, he shows that language, the word, comes from the French *langue*, meaning "tongue." But, Butler points out, when a dog looks at you, then looks at a door, then looks at you in anticipation, he is also talking, not with his tongue but with his eyes—and this Butler, a clever wordsmith, deigns to call "eyeage."

Compared to that of dogs, the human Umwelt is superabundant in signs but poor in smells, the genes for which, in-

deed, have been disappearing in our lineage. A dog is hungry, he eats, he is no longer hungry. The desire to replenish, to do something to continue or fortify the systems we call living, is linked to their circular state, the cycle linking perception to action that Uexküll calls *Funktionskreis* ("functional circle").[25] Because the living being is not a finished state but a continuous process that must replenish and keep integrated its parts, and ultimately reproduce before they fall into disrepair, succumbing to the wear and tear formalized in the second law of thermodynamics, there is, given awareness, a continuous sense of anticipation of one thing leading to the next, as well as surprise, disappointment, fear, and so on when they don't. Julius Fraser, who has made a professional study of time, takes a cue from Uexküll to argue that time neither flows nor should be understood in terms of eternity but rather reflects certain basic, sometimes animal-less, Umwelten.[26] The experience of time, space, and language probably differs from species to species. Wittgenstein rhetorically asks why we would say a dog is afraid his master will beat him but not that a dog is afraid his master will beat him tomorrow? Wittgenstein also says that if a lion could speak we would not understand him—a comment that no doubt cannot be not (mis)understood.

Semiosis, meaning-making, comes from the Greek word *semeion*, as does the word "sign"—"something that suggests the presence or existence of some other fact, condition, or quality," as defined by the 2006 edition of the *American Heritage Dictionary*.[27] For Derrida, writing is "general"; "Il n'y a pas de hors-texte": there is no outside of the text.[28] For Heidegger "man is not only a living creature who possesses language along with other capacities. Rather, language is the house of Being in which man ek-sists by dwelling, in that he belongs to the truth of Being, guarding it."[29] From this pan-linguistic, post-structuralist standpoint, everything would seem to have a semiotic component. Even the orthodox thought that there is a realm to which language does not extend is necessarily expressed in language.

When Derrida died, he had already been selected by Blanchot to read the latter's eulogy, as Blanchot trusted no one else to do it right. But apparently the eulogy, delivered among the family, came across as awkward and boring, and thus Derrida made sure to write his own eulogy, which his son delivered graveside. The key passage, as related by Avital Ronell in Manhattan shortly after the philosopher's death, reads: "Know that, wherever I am now, I am smiling."[30] Which "undecidably" (to use a Derridean adverb) signifies both a spiritual passage into the (fictional) afterlife and a presentiment of the scene in which the departed eulogy writer smilingly composed his doubly meaningful lines. Relatedly, I had earlier heard from a professor at De Paul University in Chicago that Derrida was accused in Kansas of practicing willful obscurantism by a pointing fellow, who said words to the effect, "We know what you're up to—you're like the one in the movie, *The Wizard of Oz*!"

"*Ou*?" replied Derrida in his French accent, "zhe dawg?"

Some would argue that dogs don't have language because, while they use signs, they don't know they're using them—they have no relationship to the symbolic realm as such, let alone living, as we do, in language. In discussing the Umwelt of *Canis familiaris*—the "dawg"—Uexküll contrasts the relative barrenness of a room, whose chairs to sit on and plates indicating potential food are meaningful in the canine world, but whose scholarly books and writing desks are all but irrelevant. (Of course for puppies and teething toddlers, almost anything can be endowed with a lovely "chewing tone.") Yet the dog is not stupid. It has in its mind an idea, a "search image" of the stick it is looking for before it finds it. (Even an earthworm has a search image, says Uexküll, and knows, by smell, which end of a leaf fragment to pull on to bring it to its burrow.[31]) And certain impediments for some humans, such as the curb of a sidewalk for a blind man, a dog navigates without a second thought. So, too, as dog whistles attest, the ears of a canine perk up at the sound of ultrasounds we miss. With regard to

language, as Uexküll points out in a letter, some languages are innate, making it possible for pheasant chicks to be raised by turkey hens, whose warning cries they respond to, but not to ordinary hens, whose alarm call they don't understand.[32]

The capacity to learn new associations varies. Nonetheless, even if brains are necessary to process language proper, organisms in their bodies as well as their behavior show clear evidence of finely honed functionality. An air bladder used for stabilizing fish evolves into gills, with a function that comes to be even more crucial. Penguins cannot fly, but their fat wings help them steer on ice and swim in icy waters. The heart may have other functions, but one is clearly to circulate the blood. As Salthe and Fuhrman point out, the genitals and breasts have a function that rightly belongs not to the present but to the next generation, to keep going the basic functionality and form of a system whose parts, if they were not reproduced in new models, would perish of thermodynamic disrepair.[33] The whole organism, along with and as its integrated parts, functions to deplete energy gradients. Gleaning this functionality may have misled Uexküll to espouse his musical creationism. Less sophisticated creationists also use the neglect of the obvious evidence of purpose in anglo-American evolutionism to dismiss the entire evolutionary enterprise. Unfortunately, evolutionary biologists as authoritative and as ideologically opposed as Richard Dawkins and Stephen Jay Gould both portray a largely random biological world devoid of purpose, direction, or progress. However, these traits exist and are demonstrably thermodynamical adjuncts of the development of complex systems effectively and naturally depleting energy sources, rather than necessarily implying the awkward thesis of humanoid design. Not just the functionality of organs and behaviors that Uexküll catalogued (and are indeed partially the result of natural selection), but many clearly nonrandom trends mark the evolutionary process: increasing number of taxa, amount of energy use, energy storage, memory storage and access, area colonized, number of individuals, ef-

ficiency of energy use as indexed by respiration efficiency in representative samples of more recently evolved taxa as we move forward in time[34] and, despite clades that have experienced decreases in brain-to-body ratios, a secular increase (albeit with setbacks during mass extinctions) toward increasing intelligence, semiotic transfer and data processing capacities, ability to represent past and predict future states, number of chemical elements involved in biological processes, and maximum energy levels achieved are among the abilities life has progressively augmented. These progressive tendencies are of a piece with the purposeful behavior of even simple energy systems, which have as their natural end-state equilibrium, but which may undergo quite complex processes "to" move toward achieving that state. Even nonliving systems use up available energy, cycling matter and growing until their natural teleological task is finished.

Because of a new wave of mechanical understanding of living things based on molecular biology and replicating DNA and RNA, Uexküll's emphasis on the importance of integrating purpose, function, and nonrandom directionality is if anything more germane now than when first he enunciated it. Genetic determinism does not tell us how, if I tell you to close your eyes and think of a pink tree, you can do that, any more than it tells us how you can understand that you are alive in a world that exists. And yet Darwin was himself Uexküllian in the berth he gave to the inner worlds of animals.[35] Both Darwin's *The Expression of the Emotions in Man and Animals* and his *The Descent of Man and Selection in Relation to Sex* discussed the inner worlds of organisms, some, such as choices by females in selecting mates whose traits would thereby persist, affecting evolution. Should not Uexküll's insights, such as his emphasis that we perceive things like bells not only in terms of their colors and sounds but most importantly (ignoring such features) in terms of the more primordial question what they are for, be integrated into our evolutionary view?[36]

Although Uexküll seems to have retreated toward an out-

moded idealism and creationism, in comparing the wholeness and functionality of organisms to the wholeness of instruments in an orchestra, he in a way leapfrogs to an older understanding of the word organism, *organon*, Greek for instrument. For Uexküll we organisms are not cosmically random. Uexküll's Umwelt music might strike the modern listener as quaint or romantic but it reminds us to see life in terms of wholeness, perception, and purpose. Far from being impeded by the development of complex systems, our activities along with those of other complex systems expand the natural end-directed processes of energy to be used up and spread implicit in the second law. Life has also hit upon many ways to moderate its use of available energy, which has allowed it to last far longer than nonliving complex systems that deplete energy.

Life on Earth has been transforming the energy of the sun for almost four billion years now. Complex systems, though they grow their own complexity, more effectively export heat to their surroundings. And this natural finalism or teleology coordinates with life's detection, sensation, and perceptual modeling abilities. It has a perceptual connection. By metabolizing and spreading organisms produce entropy, mostly as heat, keeping themselves relatively cool in the process. The biosphere in general, and complex ecosystems (such as rainforests) in particular, measurably reduce the energy gradient between the 5700 kelvin sun and 2.7 kelvin space.[37] (0 kelvin is absolute zero, the theoretical temperature of absolute atomic stillness.) Nonequilibrium thermodynamics thus deconstructs the line between life and nonlife, much as Darwinism deconstructs the barrier between humans and other organisms by showing our behavioral, morphological, and biochemical continuity to other organisms.

We can thus suggest life is a natural thermodynamic process with a natural "plan," the same coordinated tendency of matter to join and cycle to bring about equilibrium seen in nonliving complex systems. Complex systems showing har-

mony, wholeness, and a subservience of the parts to the whole, which have the natural function of producing molecular chaos (thermodynamic entropy) as they grow, are not confined to life. They include Belousov-Zhabotinsky reactions and other chemical clocks, manmade Taylor vortices that "remember" their past states, whirlpools such as hurricanes and typhoons that grow as they reduce air pressure gradients, and Bénard convection cells that actively reduce temperature gradients. These systems, like the daisies of Daisyworld, grow only under certain conditions, making them effectively semiotic.[38] Living beings enhance this thermodynamic process by reproducing. They "relight the candle"—life as life persists as a thermodynamically favored, implicitly teleological process that uses genetic replication. As stable vehicles of degradation, our kind sustains and expands natural processes of entropy production and gradient destruction.[39]

From a nonequilibrium thermodynamic our ceaseless striving has no metaphysical significance in terms of good and evil or ultimate meaning, but just reflects our being caught up in a more efficacious, but constantly threatened, process of gradient reduction by complex systems. Although we may semiotically separate ourselves from the process, whilst we live such striving is part of a function-oriented systemic process that occurs unconsciously and underconsciously, and includes learning, such that the directed goals toward which animals strive—say a baby squirrel trying to climb a cement wall to reach its mother, or a six-year-old trying to stay on a bike—can retreat from conscious effort to subliminal mastery. Some anciently evolved behaviors, such as breathing, occur automatically but remain open to conscious intervention. It is as if consciousness is a limited ability that takes hold uncertainly in uncertain situations.

Uexküll's humble ("This little monograph does not claim to point the way to a new science . . .") *Foray into the Worlds of Animals and Humans* is a bit of a conundrum. On the one

hand, we have an intrepid philosophical act of observation, intuition, and deduction of the perceptual worlds of other species. Shamanically, he'll tell us what it's like to be a blind, deaf tick waiting in darkness for the all-important whiff of butyric acid, prior to a drop from the top of a blade of a grass, hopefully onto a warm, blood-filled animal. He tells us what it means to be a scallop, or what flowers look like to bees in a spring meadow. On the other hand, he is simply saying that other animals perceive, that they too have worlds, and trying to figure out what those worlds are like. Thus at one and the same time Uexküll is a kind of biologist-shaman attempting to cross the Rubicon to nonhuman minds, and a humble naturalist closely observing and recording his fellow living beings.

Not only for us but for every living being, the world may seem perplexing but also somehow complete. Uexküll's vision entails what I've called "Procrustean perception"—after the Greek robber who cut people's legs off to fit them in bed: so, too, evolutionary expediency forces us (unless we are mad or drugged) to conceive of this world as whole despite being formed from data fragments.[40] For example, you only have eyes in front of your head yet your conception of the space around you is not marked by a huge gap corresponding to the back of your head. Incomplete beings, we are "Procrustean" in that, although we take in only tiny parts of an immensity whose totality we cannot possibly perceive, we nevertheless cannot help but fill in the blanks, constructing a whole we then take to be real. This premature completeness allows organisms to be fooled by signs, the parts and sensations they take for wholes. Uexküll shows us the sea urchin extending its spines to the stimulus of passing ship and cloud, which the sea creature misinterprets as a potentially deadly predator fish. He intuits the plight of the fly, its vision unable to resolve the strangling strands of the spider's web, or the jackdaw fooled by a cat carrying a rag. Even the world of the blind, deaf tick, sensing mammals by the slight amount of butyric acid[41] their bodies give off, is uncovered by Uexküll's shamanic Umwelt vaulting.

Uexküll's vision reminds me of the Net of Indra in Indian Mahayana and Chinese Huayan Buddhism. Indra's net is an infinite web with a dewdrop-like eye glimmering in the middle of each compartment. Each jeweled eye contains all the others and their reflections. Similarly, each of us contains a view, albeit particularized, of the entire world. As Leibnizian monads, we do not have windows, direct access into the sensory flow of others, though there are examples in fiction, such as Mr. Spock's Vulcan "mind meld" in *Star Trek*. Fiction itself, creating characters with whom we can identify, creates at least the illusion of experiencing foreign sensoria. In Tibetan Buddhism, *lojong* is the art of putting yourself in another's shoes. Thus while assuming the sensorium of other organisms has long been claimed in shamanic circles, and has been explored in fiction, for example in Carlos Castaneda's Don Juan books, in John Varley's "Overdrawn at the Memory Bank," where the protagonist is "doppeled" into a wild baboon, Gregor Samsa the cockroach in Kafka's *The Metamorphosis*, and of a variety of animals inhabited by gods in Ovid's *Metamorphoses*, such explorations, such "embodiments" remain rare in the scientific literature. It is as if after Descartes, who famously compared the cries of animals to the squeaking of parts in an unfeeling machine, any imputation of complex awareness or humanlike consciousness in nonhuman entities might take away the license of researchers to tinker with suffering nonhuman bodies. In Disney cartoons animals must be clothed like humans and talk like humans before we accept them as sufficiently human to take them seriously—which even then we don't because they're only cartoons.

In addition to Uexküll's stick-searching dogs, hypothesis-generating scientists, and starfish-avoiding scallops, there are an estimated ten to thirty million extant species: water scorpions with built-in fathometers sensing hydrostatic pressure gradients, plants with gravity sensors, algae perceiving barium sulfate and calcium ions, fish that gauge the amplitude and frequency of turbulent waters with dipole electrostatic field

generator-and-sensors, magnetosensitive bacteria, homing pigeons and polarized light-detecting bees whose peregrinations are not impeded by clouds, male silkworm moths sensing sexually mature females miles away, and deep-sea fish with luminous lures attached to their heads that attract each other as well as provide bait to dupe their prey into an ugly mouth. Luminous algae in the waves and moss in the woods have inspired poets and the tellers of ghost stories. Fireflies recognize each other's flashes, and some species use specific mating patterns for one species to lure males of another. Once, in the woods, a firefly appeared to mistake the tip of my cigarette for an attractive conspecific.

Procrustean perception assures mistakes on the basis of preconceptions and signs. In Poe's story "The Sphinx," a frighteningly bizarre hairy giant animal with tusks and a skull marking on its great back is confirmed seen, the second time prowling the woods beyond a scholar's window as the perceiver risks revealing the possible hallucination of a private Umwelt. The scholar, reading from a book, solves the mystery: the beast turns out to be nothing but a death's-head moth, *Acherontia atropos*, on the glass of the window but mistakenly thought to be farther away.

Although we have learned to augment our senses with technological instruments from infrared cameras to X-ray telescopes, the naked human eye sees only visible light, a relatively small region of the electromagnetic spectrum consisting of light waves from 400 to 700 nanometers. Photosynthetic bacteria and their descendants such as algae and plants, as well as most animals, also sense this same range of wavelengths, which comes to us as all the colors of the rainbow ranging from the shortest wavelengths, purple, to the longest, red. Many pollinating insects detect flowering plants through signs invisible to those who cannot see in the ultraviolet range below 400 nanometers in wavelength. At the other end of the spectrum, pit vipers such as rattlesnakes detect infrared radiation (heat)

too subtle for us to notice. Bats determine the size, location, density, and movement of prey such as fruit flies 100 feet away in a pitch-black cave by use of sonar, emitting through their mouths and nostrils ultrasound vibrating at frequencies of some 100,000 cycles per second, about five times what we can hear. Dolphins echolocate in the water by making click sounds, and humpback whales sing to each other in songs that completely change over a five-year period, using some of the same rules human composers do. The metabolically advanced, quorum-sensing, gas-exchanging bacteria grow and trade genes globally, not unlike a more-than-human, genetic version of the information-expanding Internet.[42]

If we grant that language is a group-evolved phenomenon that records signs older than and more time-tested than any individual human, we must boggle at the bewildering possibilities of potential biocommunication systems of an estimated extant ten to thirty million species, trading signs with each other and across species boundaries. As Nietzsche intimates, it begins to look increasingly ridiculous for us to indulge our delusions of possessing a radical cleverness, some sort of ur-Umwelt that would separate us as if by an "abyss" (as Heidegger puts it) from other animals. How, for instance, do we stack up against blue whales, whose brains are far bigger than ours, and who (at least until recently, with the constant roar of ship engines) communicate with each other across the oceans over thousands of miles? For any punk rock or heavy metal fans out there, consider this. The threshold of pain to the human ear is 120 to 130 decibels. A jet engine is about 140 decibels. Concert music, at its loudest, is 150 decibels. Blue whales, comparatively, belt out their vocals at 188 decibels. Their communications are time-delayed because of water. They may, in their giant Umwelten, have fabulous multisensory pictures of major portions of the ocean, images that, even if we had direct access to them, we couldn't process, because our brains are too small. They may experience time in an extended way compared to

our sense of time, even as their native ocean-imaging abilities likely far surpass our own.

Together the biospheric network of interacting, sensing, proto- or fully semiotic organisms, many if not all of which have their own Umwelten, maintain the complexity and regulate the environmental conditions of Earth's biosphere away from chemical and thermodynamic equilibrium. Contrary to creationist beliefs and neovitalist "negentropic" scientific models, organisms are perfectly natural within the energetic context of producing entropy in accord with thermodynamics' inviolate second law, which says that energy will move from a concentrated to a spread-out state, becoming unavailable for work over time. Semiosis, insofar as it recognizes regions of energy flow and material substrates to go, is integral to life's process. As James Clerk Maxwell (in the *Encyclopaedia Britannica*, 1878) pointed out, the potential energy of reactive particles in a mixture depends on intelligence to be tapped: "Dissipated energy is energy which we cannot lay hold of and direct at pleasure, such as the energy of the confused agitation of molecules which we call heat. Now, confusion, like the correlative term order, is not a property of material things in themselves, but only in relation to the mind which perceives them. . . . It is only to a being in the intermediate stage, who can lay hold of some forms of energy while others elude his grasp, that energy appears to be passing inevitably from the available to the dissipated state."[43]

Maxwell's Demon was an attempt to get rid of the third interpretive third party, by replacing it with a physical differentiator that could create gradients and therefore, through the operation of a pure intelligence-sensation, reverse the dissipation of energy. This would, however, effectively be the production of a perpetual motion machine, and has been deemed impossible, not just theoretically but practically, in the U.S. Patent Office's refusal to accept applications for them. However, the thought experiment was quite instructive, helping lead to

the recognition that a differentiating machine can process information. No machine or organism, however, can restore gradients from scratch; all require external inputs of high-quality energy. In retrospect, we can recognize life as a sort of reverse perpetual motion machine, a Maxwellian Angel that uses information to build itself up as it dissipates gradients—until it runs out of resources. Humanity is a most impressive but necessarily stable example of this natural semiosis. Maxwell, who linked electricity and magnetism, shows here a link between matter and mind.

Animals who identify the particularly colored, scented flowers, fruit, or fungi upon which they need to feed breed and succeed relative to those who make mistakes in identifying food sources. The ability to detect concealment and camouflage, as well as to sense fine differences in colors, such as the color orange associated with vitamin A, brought about a natural increase in sensibilities, a fine-tuning of Umwelten within the thermo-evolutionary space. This space provides the backdrop for the beloved Byzantine textual practices of literary critics, hermeneuticists, and scholastic intelligences. The keen-eyed wolf, the bacteria swimming toward sweetness and light (in order to degrade sugars and make energetic use of high-quality electromagnetic energy), the hard teeth of the australopithecine ancestor used for grinding and crunching, crushing and slicing vegetable tissue in mastication prior to digestion—these and other obviously semiotic, purposeful activities must be seen in their thermodynamic context.

Uexküll's scientific formulation of the Umwelt can and should be developed within an evolutionary-semiotic context. As Uexküll suggests in the final section of his essay, where he discusses the worldviews of the astronomer, the chemist, and the physicist, science also has its Umwelten. Forming scientific pictures of the universe with the aid of instruments and the cross-checking and peer reviews of scientists, despite political and corporate corruption of scientists, can be seen as the

development of a metahuman neural network adding another powerful eye to the evolving Net of Indra. Uexküll's pioneering investigations focus our attention on the perceptions of nonhuman others, some of whose perspectives, as profound as they are alien, we will probably never understand, nor get the chance to, given the present epoch of human-generated mass extinction.

In the opinion of Deely, Uexküll's work, while not fully developed, provides an opening onto the most important revolution in intellectual history since the origin of science.[44] Uexküll gives the lie to the idea of scientific objectivity divorced from the perspectival, perceptual subjectivity of the observers themselves and the signs they use. The idea of an independently existing external reality divorced from minds occurs only within minds.[45] Following an illustrious intellectual history that does not shirk medieval jaunts through scholastic ontology or religious philosophy, Deely argues the world is intelligible. We have, you might say, a sense of being: just as the primary datum of the sense of vision is light, and hearing sound, so the human instrument receives, via the intellect, the basic knowledge that the universe exists. We are alive and know we are alive, whatever that may mean. Following Heidegger (who calls animals "benumbed"[46]) to a certain extent, Deely however doubts that this knowledge of the world as world exists for animals, who are semiotically underdeveloped compared to us. According to Deely, while animals may and do communicate, they do not have language as such, which he defines not just as the ability to use signs (like Butler's dog, signaling with his eyes), but understanding of those real, but nonetheless invisible, linguistically constructed relations among signified things.

For Charles Sanders Peirce, whom Deely recognizes as the founder of semiotics, "firstness" refers to existence, "secondness" to contiguity of relations therein, with "thirdness" and the possibility of semiosis occurring only with an interpretant reacting to the sign. A third "party" in other words is nec-

essary to make sense and recognize the relations of one thing to another. The mute interaction of one thing with another opens the possibility of signification, especially in the living, where material complexity and thermodynamic lag ensures that the appearance of one substance will follow another. The simplest and best example of this is food, as it "represents" the attended-to substrate on which an organism's continued livelihood depends. Its "meaning" is simple enough—continued survival itself, along with the continued ability to recognize that upon which the organism, originally or originarily a bacterium, depends. The example of such a bacterium swimming up a sugar gradient shows the basic semiotic operation, which is also a purposive and cybernetic act, and how it differs in living things. As the bacterium swims toward its source of increasing nutriment, it recognizes, implicitly or with the tiny awareness and limited purposefulness that Samuel Butler imputed to even the smallest beings, the signs that it must follow to ensure its survival. If it fails to be aware of the chemical and energetic concentrations upon which it depends, it may perish. If it successfully "hermeneuticizes," following the tracks of the material signs upon which its continuous thermodynamic degradation depends, it will tend to leave more semiotically adept ancestors than its less sensitive, less aware (or aware-acting) brethren. The living being is thus aware of the signs of its own continued being and thus contrarily its own potential demise. Here we may locate a segue between signification and primitive sensations, such as hunger and thirst, as well as proto-emotions such as depressed activity due to lack of stored energy, and fear of death, which may exist in Umwelten in some manner nearly from the beginning.[47]

Perhaps the most influential philosopher of the twentieth century, Martin Heidegger, speaks of being-toward-death as proper to *Dasein* (literally "being there"), his version of the human perceptual world, our Umwelt that we tend to raise up over those of other species, just as we tend to put our own con-

cerns, and those of our loved ones, and our nation, over those of other people, races, and countries. Philosophers vary in the extent to which they would separate the Umwelt Heidegger calls Dasein from those of other animals. In Deely's terms we engage in anthroposemiosis, which is distinct from zoosemiosis although it is a part thereof. An internet interlocutor, responding on a blog hosted by the novelist-philosopher "Kvond," defends this long-standing philosophical tradition that erects a special place for our species, against the blog's host, who begs to differ, quoting Spinoza to the effect that humanity is not so separate but rather constitutes a "kingdom within a kingdom":

> It seems to me that for both Bains and Deely, and the authors on whom Deely relies (notably Aquinas, Scotus, Poinsot and Peirce), all mental action is, as you say, transspecific (though not panpsychic). All beings capable of even the lowest level of sensation are characterizable as cognitive, noetic, mental, or what have you. Rational, intellectual, semiotic mentality is a special kind of mentality, but it is not a division autonomous from the sphere of the mental generally. Rather, it is a division that occurs within the mental sphere. Why is this division crucial? Because it explains what is most distinctive of human beings. All animals employ signs, but only humans are aware of the nature of signs as triadic relations (cf. Poinsot, Maritain and Peirce). All animals are semiosic, but only human animals are semiotic. Semioticity is a property that one either has or does not have, much like being pregnant. Does this privilege human beings? Yes and no. If you consider the world of culture, art, the sciences, etc. to be privileges, then we are privileged through our semiotic capacities to be able to participate and enjoy in these aspects of "world" that these capacities have enabled. However, this is not to say that animals are not privileged in other ways. As even Heidegger is willing to say, "this does not mean that [nonhuman] life represents

> something inferior or some kind of lower level in comparison with human Dasein. On the contrary, life is a domain which possesses a wealth of openness with which the human world may have nothing to compare.[48]

Uexküll himself writes that the first principle of Umwelt theory is that "all animal subjects, from the simplest to the most complex, are inserted into their environments to the same degree of perfection. The simple animal has a simple environment; the multiform animal has an environment just as richly articulated as it is."[49] Heidegger's notion, that "*the* [*sic*—italics added] animal" (again: we are animals) is "poor in world"—while also maintaining that other species are not on "some kind of lower level"—seems an example of what Theodor Adorno calls Heidegger's "peasant cunning."[50] Derrida, the closest and most respectful reader of Heidegger, nonetheless reviles his claim of an "abyss" between the human and the animal, calling it "violent and awkward."[51]

Academic hairsplitting is a common enough phenomenon to merit the derogatory idiom, but is also simultaneously indicative of humanity's semiotic strength. The categories into which we divide things, based on the relations Deely would credit us with realizing exist in contradistinction to the benighted animal world, do not always work in our favor. Earth seen from space sports none of the color-coded boundaries among nations we see on the typical map of the world. Nature does not weep over academia's fractious territorialisms, nor take pleasure in the university's attempts at interdisciplinary cross-fertilizations. Our strength at connecting one thing to another, arbitrarily, by inventing signs, such as the color schemes displayed by countries on their flags, may well be our special strength, our Nietzschean cleverness, the key of thought which opens our Umwelt. But it is a strength based on a kind of lie, the power of invention that we then take to be real, forgetting the history of our associations, the connections forged by

thought. Chemistry and physics and biology, the human and social and sciences proper, are all already always abstracted from nature's wholeness, which haunts typological thought like the plump belly of the Buddha sitting serenely in silent meditation. We have ignored the viewpoints of other beings, which like our own reflect the whole, for the sake of our simplified, goal-directed analyses. Our metastasizing terminologies may or may not have real-world effects. Our gift of making signs and sense, and partial and postmodern forms of (non)sense is, as Nietzsche reminds us, not an unqualified encomium, but the only way we've found to spread, as a relative weakling primate, across all the continents and seven seas. Although it has inspired amazing things, it has also wreaked major havoc, both to our own species, to other beautiful animals and arguably to the global biosystem, whose present stage of development was required for human evolution but may, because of human activities, be coming to an end.[52]

Humanity's technical intelligent civilization is extremely adept at energy extraction, but that does not mean it has staying power. The most confounding quality of our "intelligence" is its lack of wisdom: we use our know-how to plunder as quickly and greedily as possible, cheating each other, hoarding luxuries, organizing corporations on the basis of quarterly reports, and in general acting like Jonathan Swift's Yahoos, whose most memorable trait was to defecate impressively from treetops. Life as an Umwelt-studded system is some 3.5 billion years old. Whether we can survive within it, let alone at our current and growing levels of energy depletion, is another story. The two primary activities in which living beings are involved are gradient reduction and survival. Semiotic cleverness may be exceedingly good at the first task but ultimately fail at the second.

The opposite of Heidegger's abyss is Alan Watts's claim that all organisms think they're human. To deconstruct the would-be yawning gulf between the human and the nonhu-

man requires sensitizing ourselves not only to the evolutionary continuity between humans and other organisms, not only appreciating the ecological contiguity of life forms on a connected biosphere, but also remarking the mind-like processes observable in far-from-human systems, including nonliving systems, to which we have (as indeed we have toward each other) no direct phenomenological access. In Alan Turing's test of computer consciousness, a program that persuades us by its behavior that it is self-aware must be considered aware. I thus believe your foreign Umwelt is real because you persuade me as such. The alternative is solipsism. I can imagine, but not directly know, what it's like to be you.

In *Do Androids Dream of Electric Sheep?*, Philip K. Dick plays in multiple ways with this quixotic notion of the imputed Umwelt. Rachael Rosen, his (character's) beautiful single-malt–drinking love interest, is an android whose fabricators at the Rosen Association have implanted artificial memories in her that make her initially think she's human. Real animals are a symbol of status, ecologically rare, and replaced by very lifelike flesh-and-blood replicas. Rick Deckard (a partial homonymic anagram of the author's name, Dick) is a bounty hunter with an electric sheep and a depressed wife. He is charged with hunting down escaped Nexus-6 robots. Deckard is told by the self-serving Rosen Association that Rachael is actually a real human but schizoid, meaning that his initial test of her status calls into question the testing protocol to distinguish androids from humans. The Voight-Kampff tests differentiating between real humans and the ersatz fugitives (their escape implying free will) Deckard must "retire" paradoxically measure not only involuntary eye movement and blushing, but the level of emotions in responses to questions about harming animals. Thus Rachael Rosen, an android who believes otherwise, has a real Umwelt in which she comes to realize she is not authentic, whereas her heartless corporate keepers, lying and conniving, scheme to elude the empathy testing protocol that would identify bona fide

beings with the right to exist. Rachael confesses she feels empathy for a fellow android of her make, and that she loves Deckard. Later she kills the real goat he had purchased while he, in the radioactive Oregon desert, finds a toad thought to be extinct. Exhausted, he brings the toad home to his wife, who finds it is also electronic–thus defying French biologist Jean Rostand's couplet: "Theories pass. The Frog remains."[53]

While Heidegger points to the abyss between human and animal Umwelten, and Deely separates physiosemiosis from zoosemiosis from anthroposemiosis, Derrida is busy deconstructing the figures of speech that allow us to show how one thing differs from another.[54] In "The Flowers of Rhetoric" section of the piece "White Mythology" in *Margins of Philosophy*, he does this in part by introducing the word "heliotrope." A trope is a figure of speech, etymologically deriving from the Greek tropos, "to turn." The heliotrope has three main meanings, first, of a type of flower, second, of a stone (bloodstone), and third a color, ranging from pale violet to a deeper reddish-purple color. Beyond specific flower, rock, and color, however, the word means any plant that turns toward the sun. Etymologically and literally, if not by extension, a heliotrope is that which turns sunward. It thus becomes a kind of metatrope for polysemy in general and also for a semiosis or metasemiosis beyond discrete meaning that refers to a physical process involving the sun. Here one can probably detect, although Derrida eschews talk of "influence" (perhaps it is his desert cunning), the influence of that great theorizer of a solar influence behind, beyond, and creating the condition of meaning, Georges Bataille. In 1929 Bataille read Soviet geochemist Vladimir Vernadsky's *La Biosphère*, a book in which the activity of life on Earth is discussed as a unified transformation of solar energies, manifesting, for example, in the power of living beings, as birds and human munitions, to defy the determinism of gravity by taking to the skies. Indeed, while Vernadsky described living matter (he avoided the term "life") as a kind

of moving mineral, and Lovelock described Earth's surface as a planet-sized organism, both break down, as does Derrida from a completely different direction, the would-be ironclad (heliotrope-colored) distinction between life and nonlife.

Such deconstructions no doubt reflect a moment in the evolutionary trajectory of which we are a part. As we grow, and our knowledge increases, and life begins to impinge upon the cosmic environment from which it derives and to which it has always necessarily been connected, our understanding of ourselves not as divine isolates, but part of an interconnected natural thermodynamic system, increases. We may as well speak of technosemiosis or paranthroposemiosis when speaking of humanity in its technological phase as a growing telecommunicating mass whose Umwelt connects us at the speed of light to once-remote regions of the world, and through satellite telemetry and the Hubble Telescope to a Gaian and astronomic Umwelt whose bubble, to use Uexküll's term, extends beyond this sphere 27,000 miles in circumference billions of years backwards in time to the microwave radiation left over from the Big Bang, and forwards to speculative physicists' visions of coopting the energy of galaxies for the purposes of life.

In the meantime, less grandiosely, it is worth pointing out that there is something almost spookily semiotic about nonliving complex thermodynamically driven processes. They need not even be complex. Close to equilibrium situations, such as hot air in an imperfectly sealed container, will appear to "figure out" how best to equilibrate[55]—reduce the gradient, spread the energy—"in order to" (preanimate teleology) achieve the temporary end state of gradient reduction implicit in extended versions of the second law. As Fraser says, "the poltergeists of yesterday are the creaking steps of today."[56] The creaky stairs, no less than directed gusts of wind (perhaps appearing with ghostly miens due to a light tracking of dust) in Victorian houses, especially poorly insulated ones equilibrating as the sun goes down at night, may well—especially in conjunction with

human tendencies to personify—be a large part of the physical explanation behind historical reports of ghosts. As Uexküll presciently stressed, biology must take full account of the real processes of purposiveness observant biologists have catalogued in the growth and behavior of living forms. Ironically, however, identification of mind-like processes indicative in us and Rachael Rosen and others of genuine semiosis seems also to exist in the natural teleology of thermodynamic processes to which few would be willing to grant an Umwelt. If it is too late to say with Plato that the celestial spheres move in perfectly circular orbits of their own volition, it is too early to say definitively who, or what, does and does not have an Umwelt.