Journal of Education and Literature
Vol. 3, No. 1, 2015, 36-46

Yardsticks and Light Years: Teaching Extreme Measures

Harold Toliver[1]

Abstract

Philosophy in one its roles joins common experience and science in labeling, measuring, connecting, and evaluating. In anything concerning natural history since the 1920s its references have had to acknowledge extremes in space, time, heat, and size beyond anything previously suspected. Problems in representation come where the gap between common sense and science widens. Measurements are especially problematic at the building block level where observation and testing affect the object. Even within the normal sensory range, nothing in systematic math or science adequately represents disorder and fine gradations among instances, a problem faced some time ago in taxonomy and species identification. Defined systems like plane geometry have limited application to the irregularities of topography, celestial debris, and galactic clusters. The grids they superimpose make orientation possible, however, as longitude and latitude allows global positioning without regard to topographical irregularities.

Keywords: Discourse, Measurements, Standard Model, Metonymy, Myth, Pedagogy

1. Introduction

The best and the worst thing early people did was invent language and numbers. Throw in images and you have most of what we use for placing, defining, and misrepresenting things. I say worst because of the ease of intentional and unintentional misrepresentation and the indoctrination in myths that follows from it. That may not be all bad, and it is certainly nothing new. At some point lost in time mythic beings started hurling lightning and bringing plagues, floods, and drought and started providing beliefs in common to solidify and unify ethnic groups and nations. As historians of consciousness and language such as Merlin Donald (1991 and 2001), Steven Pinker (1994), Steven Mithen (2006), Derek Bickerton (1990), Terrence W. Deacon (1997), Daniel C. Dennett (1991), Ray Jackend off (2002), and Harvey V. Sarles (1985) point out, the capacity to project actual and imagined things in symbols and in grammatical constructions didn't come all at once. By the time of settlements and city states, after probably about 40-30,000 years of language use, populations banded together for their collective good and ill, their structured social orders depending on codes of conduct, literature, myth, and multiple means of teaching.

As to what science is and its discourse, it is a more relatively recent phenomenon, but that hasn't prevented it from gaining weight like a baby whale. Philosophers as well as scientists and ordinary people weigh in on it, relatively recently in Richard Rorty (1991), Robin Dunbar(1995), W. V. Quine (1992), Hilary Putnam (1988, 1999), W. H. Newton-Smith (1981), Lorraine Daston, and Peter Galison (2010). The what's out there question is a subject with a long history dating back to the pre Socratics, Plato, and Aristotle and nicely summarized by dates and schools by John Losee (2001). The swerve into ontology and epistemology gathered force under the new empiricism of the 17th century in Hobbes, Hume, Locke, and Descartes before flowering in 19th and 20th century realists and pragmatists. Not only what reality is but how to present it are such basic issues that they continue to draw voluminous commentary. Any answer in the earlier days of the new empiricism that considered fossil study and the lengthening history was hard on the assumed cosmos and the priority humans claimed in the universe. Myths, creeds, and doctrines had to

[1]Ph.D. University of Washington,

be rethought along with how to present to an often disbelieving public what had come to be known in numbers, distances, speeds, and ages.

The methods of science and the education of students are obviously related, but for purposes of convenience we can keep them apart, as much of the commentary on science has. Relatively recent examples quite rightly emphasize that no one method characterizes all branches of science and no method of presentation serves all levels and audiences. For my purposes, cognitive linguistics, the history of language, and most of anthropology can be set aside. We need to keep in mind too that despite far-out theories and measurements, it remains true as Robin Dunbar (1995) observes, that science “is a ‘natural’ approach to the physical world” (77), though it is equally true, as he concedes to Lewis Wolpert’s emphasis on unnatural science, that it is counterintuitive in its handling of extremes.

As empiricists and realists in the Aristotelian tradition insist, something is out there even if we may not be able always to think it or represent it. An episode or object gets transformed in our reception of it and again in the models we draw or the words and images we use. Subject and mode of presenting inevitably impinge on the object. That isn’t always an unconscious process. It is designed and often involves fakery. Photo shopping a visual image or clipping and editing sound tracks and tapes can be hard to detect. Intent isn’t always determinable in the final product. That is partly why philosophy concerned with ontology tries to get beyond representation and in some cases makes hybrid subjective and objective presentations into a new ontology (Carusi and Sissel). Whether a presentation addresses a lay audience, eighth graders, or experts, and whether a regional or global audience, is another newly important complication in the dissemination. Another cadre of commentators has turned its attention to that increasingly international dissemination, an offshoot of discourse analysis that goes as basic as James Paul Gee’s introduction (2014) and gets as specialized as Greg Myers, “Discourse Studies of Scientific Popularization: Questioning the Boundaries,” Perez- Llantada, Carmen’ Scientific Discourse and the Rhetoric of Globalization (2012), and such journals as Public Understanding of Science and Science as Culture.

The voluminous commentary on discourse of the past few decades hasn’t been much concerned with such hybrids as historical novels, cosmologies that were hypothetical but believed to be true, hyperbole, politically slanted news, and intentionally fraudulent representations. That relative lack of interest in the generic distinction between intended truth and contrivances, sometimes cultural myths and sometimes fakery, leaves a gap in such otherwise comprehensive accounts of science communication as Jane Gregory’s and Steve Miller’s Science in Public (1998), Alan G. Gross’ and Joseph E. Harmon’s Science from Sight To Insight (2014), the work of Alan Irwin, Brian Wynne, historical accounts of cosmic imagery in John D. Barrow, histories of ideas, in George Lakoff, Mark Johnson on “metaphors we live by,” rhetoric in Herbert W. Simons, visual presentation in Luc Pauwels and scholars of science presentation gathered under “visuals,” not to mention specialists in cognition and hermeneutics. Concerning the transformations that take place in the mental processing of reality, it leaves the relations of fact to belief in limbo along with the bizarre psychology of minds that believe in mutually exclusive world views.

Belief in obvious contrivances and myths isn’t a concern of anthropological and social science based commentaries, though it has been in literary criticism and theory, some of the best practitioners of which such as Northrop Frye (1982), Kenneth Burke (1970), and Harold Bloom (1990, 2005) have been biblical critics, as were predecessors in the wake of Darwin. Cross citation between fiction and non fiction is surprisingly rare in most branches of discourse commentary of the kinds I’ve named. In terms of academic institutions they leave a gap between the humanities and the social, biological, and hard sciences. In strictly factual presentation the artful and inventive elements make for another kind of hybrid necessitated by the impossibility of reproducing reality in any medium however truth- seeking and ingenious. The means of labeling and organizing has never caught up even to what falls within the sensory range let alone the vastly extended spectrum from quantum to cosmos. Getting representations to match what is there, or someone thinks is there, has never been easy. Signs, symbols, numbers, and images have systematic relations that aren’t exactly matched to natural laws and the proliferation of heterogeneous and often chaotic phenomena. That fundamental and intractable discrepancy, together with the basic distinction between truth and error, needs to be more prominent in theories of signification.

Without paying attention to the thinking apparatus as studies in cognitive neuroscience and psychology do, we can't expect to assess the gap between presentations and things. It is after all the brain that converts episodic sensations into semantic memory equipped with names for classes of things and into music, images, models, and graphs. We make the conversions from episodic to semantic memory so automatically that we scarcely realize we are doing it, yet that conversion is a veritable miracle. We see the object, think maple tree, and overlook the fact that nothing made of cells could perform that trick until probably about 50-40,000 years ago. With the citation might come qualifiers such as clothed in fall color and perhaps a passive link such as is or an active link such as came clothed in . . . . As with any single object, so with the rest of the cosmos. Thanks to the agility and invention of the thinking apparatus, what's out there has taken on all the forms the history of literature, myth, science, and philosophy have given it.

Long before the shattering of the atom and the extension of telescopic vision to far galaxies, the quantitative minded devised measurements for nearly everything within sensory range, the heat value of kinds of wood when burned, the running speed of cheetahs. Partial chaos isn't an oxymoron but a recognition that both confusion and calculations come in degrees. Order and disorder keep close company. Visible objects are seldom perfectly symmetrical or geometric. The cosmos as a whole is more a confusion than most of the concepts applied to it acknowledge. That the great chain of being and the 18^{th} century clock-like mechanism were off the mark was due to the lack of instruments of sufficient penetration to see that the cosmos was neither and to a natural preference for order over disorder.

That most of the constants in physics and astronomy were discovered comparatively recently tells us what science and philosophy lacked prior to their discovery.

2. Degrees of Deviation

Categorical names are tricky because nature doesn't come classified. Incessant change in phenomena and nearly infinite gradations among sentient and non sentient things bearing the same name make exactness in designations impossible. In most classifications before the 17^{th} century, names and concepts were applied within a world view that assumed a creator who had made everything to suit mankind. Thus animals and plants were named and treated under that rubric, a story ably told by Keith Thomas (1983). Not all errors and problems disappear when knowledge and intentions shift in the direction of Linnaeus and the attempt to name species and genus according to observable characteristics. The basic problem is that names are fixed. Nothing in nature is.

But set aside evolutionary movement for a moment and take gradations, some of them variants in contemporary instances. Cognitive, metaphysical, biological, logical, and philosophical studies all have a problem with the discrepancy between almost infinitely variable phenomena and fixed-category nomenclature. The grid of longitudinal and latitudinal lines we impose on a global map isn't answerable to the lopsidedness of the sphere and its geographic irregularities. Ocean currents flow, mountains rise, and canyons erode in complete indifference to grid location. When is a fish not a fish? 'Much of the time' is the appropriate answer. The fossil record has many kinds of fishness from things that swim in the ocean and have gills to amphibians that left the water and began exchanging fins for limbs, an extended process recently the subject of a televised series called "Your Inner Fish." 'Fish' with lungs and gills are among the in-between forms. Similar gradations make attempts to separate Australopithecus from Homo as difficult as separating land crawling tetra pods from amphibians. That would be even more the case if the fossil record were better. Rather than one missing link, each discovery of an in-between form adds another small gap that might or might not ever be plugged.

Moreover–to reintroduce motion–as Stephen Jay Gould points out, any two branches of a parent kind can change at quite different rates. One that has changed rapidly such as the rhino loses lingering fishness more decisively than one that has changed slowly, like the coelanth, the oldest lobe- finned fish. One saving feature is that with some larger animals we can identify individual variants and name one of them Mrs. Robinson and another Joe Dimaggio. Even then, the names don't catch moment-by-moment changes. The infants Miss Egbert (Mrs. Robinson's hereby assigned maiden name) and little Joe had almost no resemblance to the adults. Using salient features to distinguish a type helps but that isn't foolproof either, since what is to be considered prominent has to be chosen from among several distinguishing features.

The number of gradations and lack of decisive differences among them is part of a more general problem having to do with what lies beyond the range of unassisted perception or is numerous beyond calculation. As Gould remarks in the ambitious summing up of his career in The Structure of Evolution, "Among nature's vastly different realms of time, from the femtosecond of some atomic phenomena to the aeons of stellar and geological time, we really grasp, in a visceral sense, only a small span from the seconds of our incidents to the decades of our lives. . . . We experience enormous difficulty in trying to bring these alien scales into the guts of our understanding" (674). Those who take in more than a small fraction of the extremes do so mainly by abstractions and mathematics or by samples and specimens in which one stands for many. The first eliminates details. The second eliminates the differences each instance has compared to the others. Both are lump sum designations.

Means of representation encounter that discrepancy up and down the scalar spectrum. How does a two dimensional hologram transcribe three (or in M theory, eleven) dimensions? Does an abstraction actually represent something concrete, or does the brain use it to cross over to blurred, multiple impressions of objects it has lumped together? Words like messy, irregular, and chaos don't enumerate components. They are umbrella terms. Broken glass and scattered lumber from a hurricane are in a disarray next to impossible to chart, though wreckage detectives can piece together what force it was that tossed them about.

Discrepancies between nomenclature and scattered things are comparatively minor compared to gross error. Gradations don't completely undermine measurements and names. Degrees of heat tell us something reasonably exact even if the numbers can't tick off every variant of molecular motion. Unbreakable minimums such as particles and moments save us from the Zeno paradoxes in which infinitely divisible time and distance prevent any motion whatever. (Every halved distance could otherwise be halved again, and then again, and so on ad infinitum.) Specialists who calculate exact measurements have broken mass, charge, distance, energy, force, and density down into minimal units assigned category names. Errors inevitably come with estimates, some worse than others, and the difference between bizarre error and brilliant deduction isn't always obvious. Quackery and genius are near cousins. Martin Gardner (1952) recites from the self-proclaimed genius Alfred Lawson, speaking of himself in the third person, "in comparison to Lawson's Law of Penetrability and Zig-Zag-and-Swirl movement, Newton's law of gravitation is but a primer lesson, and the lessons of Copernicus and Galileo are infinitesimal grains of knowledge" (69). Notions almost that giddy have been trashed only to return later fully vindicated.

Most areas of study face similar difficulties in deciding which if any proposed innovations are promising. Some matters have to be settled before others fall into place as what were once thought to be nebulas had to be recognized as galaxies before the universe could extend to distances beyond the Milky Way. How isotopes decay had to be settled before isotope half lives could be used to date rock. Measurements of lead amounts, easily contaminated, weren't managed with enough accuracy to date the solar system by means of meteorites until the later 1950s. Not only are some errors minor, they can also be useful. Without Ptolemy's errors, probably no Copernicus, and without Copernican anomalies, possibly no Galileo or Newton. Newton wanted absolutes, and so Einstein with the help of his math instructor Hermann Minkowski (1864-1909) provided relativity.

Much more serious are miscalculations on a grand scale of the kind that place the planet at the center of the universe and make mankind its master. That point of view dominated medicine, theology, social orders, and most other fields and frequently along with it held monarchy to be a natural form of government in force throughout the animal kingdom. Indeed kingdom and its attending hierarchy were the primary concept of rule not just among animals but among minerals, plants, and the heavens with their God and ranks of angels. I'll choose just one such miscalculation for illustration and not otherwise dwell on what can now be more easily avoided. Ways of thinking that assumed a purposeful design prevailed if not necessarily a kingdom or hierarchy and were hard put to explain deformities without also presuming malignant figures to account for confusion, extreme of heat and cold, and other perturbations. Milton illustrates one of the more ambitious attempts to reconcile what exists in plainsight with a supreme power guided by infallible wisdom. I'll illustrate from him partly because in myreading Paradise Lost is as much about discourse as it is about disobedience. God's appointment of his son as the Word, as a communicative link, initiates history. An offended Satan organizes a rebellion and as the father of lies assumes the role of misrepresentation. Without some such second innovation, not only disorder but much language would lack a source. No skullduggery, slyness, or innuendo. The counter word is also responsible for perturbation, pain, mortality, and the reintroduction of chaos. Without it we wouldn't recognize the world weknow.

The gunpowder and canon Satan and company invent throw the loyal angels into confusion and make them in effect angel-flock rubble. The first discharge of the canon Milton presents as a mock parallel to divine pronouncements that have been gathering the angelic host into a coordinated hymnal and dance troupe ecstatic at the perception of whatever part of godhead the declaration has revealed to them. Their habitual choral joy gives way to consternation: "By thousands, Angel on Arch-angel roll'd" (6.594). To that travesty Satan adds derision, the origin of epic taunts in Milton's chronology and again an upended version of hymnal praise:

O Friends, why come not on these Victors proud? Erewhile they fierce were coming, and when wee, To entertain them fair with open Front And Breast, (what could we more?) Propounded terms Of composition, straight they chang'd thir minds, Flew off, and into strange vagaries fell, As they would dance, yet for a dance they seem'd Somewhat extravagant and wild, perhaps For joy of offer'd peace. (6.609-617)

The rebellion spreads to the first man and woman and through them to their offspring. By means of God's wrath it goes still further in infecting earth's creatures, disturbing the planet's topography and climate.

That version of how confusion came to be wasn't strictly speaking a Hebrew or Christian invention, nor was the moralizing of the cosmos. Both had been around for many centuries before the authors of Genesis rethought them. Milton's war in Heaven is more Hesiod and Homer than biblical. The satanic host's scattering of angel bodies forecasts the battlefields of the epic tradition, which paradoxically makes Paradise Lost a forerunner of dynastic battlefields and Milton in effect a step ahead of his classical competition. That rewriting of history is typical of misrepresentations that have prevailed in a good many cultures, often side-by-side with attempts to follow where common sense and science lead. In the context of that and other geocentric misconceptions, the proper placement of the planet and mankind in the scalar spectrum determined by observation and rationality came as a revolution. It emphasized exact measurements, theses and axioms based on testing, and eventually the sizing and numbering of much of the universe under natural laws detached from the observer and often working against the well being of life forms.

3. Setting Standards

Estimates of extremes are based on conventional sizes and distances. These aren't entirely arbitrary but mostly so, the earliest known sources being too long ago and too anonymous to say for sure how they came about. In any case, uniform weights and measures based on the human sensory range were invented early, and it is these that we use to gauge extremes beyond that range. We multiply them in such quantities as the distance light travels in a vacuum, the "best answer" for which (from "B Rad8908" online) is 670,616,629.2 miles per hour or 186,282.397 miles per second. We calculate speeds, powers, and distances carefully when safety depends on it, including in manuals for drivers how far a car travels in a second at 30 mph and what a safe trailing distance is at different speeds. Intricacy bordering on chaos we can see in fern leaf edges, heads of cauliflower, and tempestuous seas, good examples of regularity disturbed and made complex. A head of cauliflower isspherical from a few feet away. From up close it is full of canyons. From closer still, the bumps and cavities are composed of cells.

Taxonomy ran into such problems long before Aristotle. Take virtually any observation, let's say of the muffled black spots and bewhiskered cheeks of a bobcat (felix rufus) disappearing into the chaparral. What goes into its classification? Pedantry lies just around the corner in any attempt to answer such questions, and so I'll be brief. Sensory perception heads the list and precedes getting scientific and technical with DNA and species history. These now figure in textbook taxonomy and identification. As the biologist and taxonomist Ernst Mayr remarks, genus is less certain than species (281). Establishing an evolutionary sequence for a species or a genus is easier than settling on one for a still higher classification. An individual bobcat is short lived and specific. Its species is ancient, its genus more ancient still, and so on through family, order, class, phylum, kingdom, and domain .

Measurement of isotope decay paces evolutionary change, but dating is only the chronological side of it. A species only rarely leaves fossil traces that are found and examined. Did the change that produced the current bobcat proceed as Darwin believed through what Gould calls the "relentless accumulation of tiny changes through immense time" (Structure, 94)? Or by spurts after intervals of stability, as in the punctuated equilibrium of Gould and Niles Eldredge? Either way, it changed incrementally and by inexact DNA replication. Natural selection and genetic mutation can work as slowly as tortoises or as rapidly as changes in bacteria and the beaks of Galapagos finches. The pace of the change depends on the isolation of breeding grounds, changes in environment, population numbers, and reproduction rate. We should fear bacteria more than lions because they quickly develop immunities to our counter attacks and keep on coming.

Those who are especially industrious retreat to the Metazoan phyla of Cambrian body plans and arrange life forms in basic divisions as laid out in the teamwork of geology and evolutionary biology. One small tip of the branch of nucleated cell life led to animals, a diminutive tip of which branched off into mammals, a minuscule twig of which became Homo sapiens in the neighborhood of 200,000 years ago, an uncertain figure because of variants in intelligence, musculature, and size. Comprehensiveness necessarily sacrifices detail. The scientific method is more exact and far reaching than identification by sight but not so far reaching or exact as to master all the differences from one specimen to another, especially not all the way back to the first single cells to stir with life. Discarding is as essential to intelligibility as forgetting is to mental functioning. Even mathematics accommodates approximation in signs like < (greater than) and > (less than), :<: and ;:, greater than or equal to and less than or equal to. That is typical of labeling, as in social matters stereotyping and profiling eliminate variants. Indeed, in the sensory realm we make most judgments on the fly and have no choice but to forget moment by moment trivia. Scientists do the same but with more rationalized criteria andinternational agreement on them.

4. Fortunate Forgetting

In using one example to represent many or to substitute one name for another, part-for- whole representation (metonymy or synecdoche) strikes a compromise between remaining grounded in fact and skimming past detail. Particular instances are inscribed in undramatic rocks and trees, in redundant animals, in stream beds cut through rock, in ice-age scratches left on mountains. Episodic memory records filtered contact with that specificity, which the brain often processes into recognition, and sometimes mistakes a bush in the shadows for a bear. Remote regions of the scalar spectrum may come attached to the instance if we look closely and think again. Take a walk or a drive nearly anywhere and details fill the senses. Even on a warm day, a walk through the Ledges outside Akron, Ohio is a walk through ice ages felt in the cool air coming off the rock. A stroll along a beach with cliffs and offshore rock formations can launch a similar mental voyage through the ages. Evidence of ancient catastrophic change lies in the stressed, folded, crunched layers of color-coded rock.

Consider the language and the math of eons and periods as a system. The periods are extended, the statements and charts compact. Amphibians and reptiles had their turn for 300 million years before dinosaurs and flying reptiles got in their 175 million, and these we treat in lump sum as kinds gone missing, compressed into a few lines and an inch or two of chart space. The classifications cover a multitude of in-between examples and relations among adjoining or contemporary kinds. In that context the creature that calls itself wise is a rank newcomer on foot on the savanna, encountering and interbreeding with Neanderthals, on horse or camelback, and eventually kicking up dust in motorized vehicles, again with innumerable variants. The branches of learning that anthropology, history, literature, and religion organize came about just a few thousand years ago, some of the sciences and supporting philosophy a few hundred. Quanta and DNA put in their respective appearances only decades ago. All this can be compressed into a representation we take in at a glance.

Selecting specimens to serve as part-for-whole representatives is the most common way to simplify such stories. In my living room I have an approximately 360 million year-old set of orthoceras fossils embedded in a marble matrix. To the eye they look every bit as contemporary as the artifacts that keep them company, and in a sense they are. We habitually foreshorten time as a vital part of detail suppression. These particular fossils bring something with them of the era that spawned cephalopods in whorled chambers, but under artful arrangement they have become like diorama mockups in museums. Waiting to be quarried, polished, and displayed in a gem show, the fossils lay under terrain that lurched and drifted randomly before pausing under present-day Morocco. By the time I acquired them, craftsmen had placed them in an aesthetic, economic, and interpretive framework that included jewelry and tourist trinkets. In order to follow traces as far back as such samples go, we depart momentarily from the present, suppressing its particulars. The flexible brain with its semantic classifications and associative powers can manage that well enough by skipping the in-between. Much like positioning one thing in relation to a specific other thing, we project our thoughts to destinations, momentarily obliterating everything not of the momentary perception.

We often combine scientific with folk taxonomy, one based on species lineage, the other abbreviating the names. That again isn't to say that we must include the official nomenclature, but getting our bearings does require pulling back now and then to take stock, and doing so takes us into the names and numbers provided by specialists. In the American West where less of the geological record is paved over or farmed than in other parts of the lower forty eight, reciprocity between the near and the distant sits more directly before us than in most places. No wonder the geologist friend and consultant of John McPhee in Assembling California (p. 48), Eldridge Moores, finds that the stretch between human and geologic time produce schizophrenia. When Charles Fergus, looking at galaxy M31 on a dark night, asks his mind to register the relevant time and space, it balks (The Wingless Crow, 21). Making scalar adjustments has a way of causing that to happen.

We can adjust well enough to a certain range of speeds and sweeps of time and space. The speeds include acceleration by technological means, as in fast forwarding. Television advertisers have discovered that images can flash onto a screen at a rapid pace without confusing viewers. Until they were outlawed, subliminal cuts registered on the brain without even reaching consciousness. Those who make commercials have learned to tell entire life stories in 15 seconds. In the weaponry department, missiles can intercept a moving target at a combined closing speed of 15,000 MPH and strike not just the offending target but a precise spot on it. That is comparable, a spokesman once remarked, to getting a hole in one with a golf ball struck in Los Angeles and landing in a moving small opening in New York City. Under the influence of newsprint, cinema, and television, fads that once lasted a generation now enter and leave the stage quickly if not in cybernetic fractions of seconds. The vernacular picks up and drops jargon in the flash of a split infinitive.

Zooming in and retreating are effective ways to adjust scales in science programs that can see the planet as a pale blue dot in the distance, approach to satellite altitude, and descend under control into the realm of microbes. Tied to a mammalian body whose circadian rhythms developed over epochs, the human brain in working at such warp speeds and changing perspectives leaves not only details but emotions behind. The plot of Oedipus Rex told in a few sentences doesn't raise pity and fear. Adjusting to variable tempos and distances is an art form as well as a mental exercise. Adjusting to what can't be detected by the senses is harder. The word virtual has risen to unusual prominence in the last few decades, because we now have almost as much exposure to simulated as to actual things. People with smart phones walk real streets lost among virtual ones.

5. Buildup and Breakdown

Cycles occur in everything composed of parts including atoms, many of them inexact in that the broken and separated parts of a composite don't usually return to anything similar, or if they do, not on schedule. The minerals of decayed trees may go into grass on its way to herbivore protein or into a robin by way of a worm. Some of the spans are mind-stretching in duration, like the formation of second generation stars and planets. Others are irregular and unpredictable. We approach these about like a tailor keeping up with a runner to take his measurements. Abroad in the cosmos, clouds of dust and gas are even now being gravity-

compressed into new spheres. The stages of heated assembly and of cooling are predicated on size, gravitational compression, and fuel, which can be approximated but not timed exactly. The word chaos fits some of this irregularity, being as Ian Percival tells us (Hall, 12) persistent instability. Semi-chaos obeys some laws. The evolution of stars is governed not only by mass but by an equilibrium or disequilibrium between thermal pressure and gravity. Terms like helium flash and runaway fusion indicate the violence of the phases. With colliding objects such things merely happen, albeit under the laws of physics and chemistry. With intelligent organisms, some motions are planned, though multiple intersections create a confused overall context of crowds.

Some degree of confusion characterizes every scalar level including the lowest, where quantum physics has its indeterminacy principle and kinds of particles in the standard model are so numerous that even physicists as exceptional at explaining them as Lederman and Hill (2013) need pages of diagrams and use a nomenclature as odd as the left and right muon (the same muon alternating), spin and half spin, particles and waves in the same bits, cyclotrons, synchrotons, linacs, SCRFs (supper colliding radiofrequency cavities), D-zero, neutral ð$^{0'}$s, an $E = mc^2$ formula rewritten as the $E^2 = m^2 c^4$ (198), red, yellow, and blue up and down quarks, and much more. The traffic among these species in the particle zoo would probably resemble a freeway scramble in an ice storm if we could see it. That's if the particles aren't few as some alternative physics suspects and their variations in behavior owed to the frequency, amplitude, and speed of waves. Or if they aren't strings that writhe and twist. Matter and energy do have order and measurable timing, however, or else dealing with them wouldn't be science.

Equations put some configurations in mathematical terms and graphs, but not much of that capacity or its extensive nomenclature makes its way into the public domain. Nor need it do so to represent natural history basics. Computer-generated configurations in chaos theory have brought an expanded vocabulary for perturbations and ways to measure them even if they can't keep up with the scatter of things. For the purposes of myth and error correction, the prominence of irregularity need only be acknowledged philosophically, not charted in detail. A prominent tendency in the history of ideas is to set too much irregularity aside in the interests of coherence. Mandelbrot and Julia sets, Lorenz strange attractors, fractal geometry, the Taylor-Couette system, and the predator-prey system (Hall, 96) are part of the correction, which is to classical physics about what Kafka is to Jane Austin. Where the Pythagorean cosmos and Euclidean- influenced geometry preferred regularity and symmetry, modern schemes for nonlinear phenomena are open to a good many order/disorder gradients.

We normally use folk idiom for a given day's events and their visible range, but scientific measurements and terminology are catching up to what everyone knows from experience. Outside of art, construction, and mechanics, not many things are free of irregularity. In ancient myths, irregularity was usually attributed to divine reactions to something prophets and priests considered objectionable. Distance would have made a good goddess assigned to keep it going. As the Julie Gold song says, it is from a distance that harmony echoes through the land and no guns, bombs, disease, or hunger disturb the peace. We can be thankful that the inverse ratio of strength to distance is true of more than gravity. If rays and charges travel by waves rather than particles, waves too must diminish in force over distance. Light, gravity, and electromagnetic influences all do. If they didn't, life would be even more precarious than it is. Earth happens to be the right distance from the sun to avoid being frozen or roasted and distant enough from gamma-ray bursts and supernova explosions to avoid being torched.

6. Sizing Up and Placing Objects on a Horizon and In a Field

Magnifying the image of an object on the far edge of vision brings that much nearer while putting the rest momentarily on hold, in sight but not in focus at the moment. By alternating focal objects with survey, we can take limited particulars into account without sacrificing the field. The scientific parallel to that puts given subjects in an inclusive context, as anthropology places mankind in a primate background and if it wants can include the entire evolutionary tree. Astronomers concentrating on a given planet for the moment need pay no attention to the rest of the solar system, but they know what it and the galaxy imply about it. Setting the position an object occupies in a surveyed field is partly what is meant by definition.

Unless it was the Greek turn toward rationality and its philosophy, math, and historiography, no change in the history of ideas quite matches the discovery of the extended field of natural history. In alternating close and far and in selecting in between fields, we are in effect putting deduction and induction in reciprocity. Playing scales does that comprehensively while at the same time making us aware of the notches on the measuring instruments. Leon Lederman and Christopher Hill (2013) explain the startup of the outermost context in these terms: “The universe emerged from a plasma of the elementary constituents of matter: quarks, leptons, gauge bosons, and perhaps many other hitherto undiscovered particles furiously swarming about at extreme temperatures and pressures in an embryonic warped and twisted space and time”(217). The plasma had to cool before the strong and weak forces could start pulling hydrogen atoms together, with electrons the last particles to join them. A slight excess of matter over antimatter left over from their mutual annihilation allowed larger composites to start collecting under electromagnetism and gravity.

From that stage onward, protostars began to form under heat that powered the nuclear fission/fusion process. Under the cohesive power of the four forces they became full-fledged stars, and these in turn became “the parents of all the later heavy elements, the planets, and the solar systems to come” (217). We don’t ordinarily consider molecules integral objects, but technically speaking anything above particles is– atoms, isotopes, cells, chromosomes, arms, and legs. As a theory with that kind of scope, the standard model is still a work in progress, and in fact didn’t acquire the cosmic inflationary episode until a lecture by Alan Guth in 1979, but this “scientific version of ‘genesis’” has proved out in tests. In fragmentary and condensed forms, it has captured the interest of a portion of the educated public. Most acts of placement use a lesser concept of an appropriate field rather than a sweeping inclusive horizon, as a state belongs first to a region, then to a nation, and finally to a continent, which belongs . . . and so on. An address gives name, house number, street, state, and sometimes nation. That may sound too basic to warrant attention, but finding what the binding forces and relations are at each level of inclusion as required much ingenuity over a long period of time.

When we place decay and debris in any such field we are identifying stages of breakdown or incomplete rebuilding, as for instance on an extremely large scale the Carina nebula, NGC 3372, one of the grandest mixtures of star clusters and chaos within telescopic range. Natural processes put disintegration and decay into the field as inevitably as they do cohesion and buildup. In whatever state it is in currently, rubble follows the same cause and effect logic as stars and planets and can likewise last for billions of years. It bears mentioning again also that the visible universe as a whole has no configuration or orderly relation of parts. That makes the largest conceivable horizon a jumble in terms spatial configuration. The laws that work locally, however, also work universally. Super galaxy clusters are its largest combinations, and they defeat attempts to apply anything like the trigonometry circle with its y and x diameter lines, its angles, and its radians. Astronomers can gauge distances and estimate numbers, but the relations are too abundant and complex to be calculated in total. In effect they remain an unfocussed background to organized systems–in other words an overall welter.

The kinds of composition are numerous. Because such composites as riffles and wind and things bristly and smooth have recurrent features, they too can be labeled if not easily measured. A waterfall drops a certain volume a certain distance, but gradations from plunging drops to mist, blown by a wind, defy calculation. Sciences can single out this or that element to quantify, gallons per second, for instance, and place the rest in the background. That's as it should be of course. We've no need to know the number of droplets per second, the moisture content of air coming into and leaving contact with the water, gradations of temperature on the fringes on a hot day and a cold day. Some measurements we take because we've a reason to; others are prompted by curiosity or the prominence of the phenomenon. Practically everything that exists goes without measurement yet has a size, place, speed, density, and heat that ingenuity might put in comparative terms.

The best philosophy and science can do is single out certain things for comparison and location and polarize one against another or against batches of related items. Making the visible universe a conceptual background keeps the scalar spectrum in view as a reminder of the relative place of this and that. The total timeline and the spatial sweep of the visible universe are always there whether or not we make use of them, and they do now stand in correction of former estimates.

References

Barrow, John D. Cosmic Imagery: Key Images in the History of Science. New York: W. W. Norton, 2008.

Barrow, John D. Theories of Everything: The Quest for Ultimate Explanation. Oxford: Oxford University press, 1991.

Bickerton, Derek. Language and Species. Chicago: University of Chicago Press, 1990.

Bloom, Harold. The Book of J. David Rosenberg, trans. New York: Random House, 1990.

Bloom, Harold. Jesus and Yahweh: The Names Divine. New York: Penguin Group, 2005.

Burke, Kenneth. The Rhetoric of Religion: Studies in Logology. Berkeley: University ofCalifornia Press, 1970.

Carusi, Annamaria and Aud Sissel. "Toward a New Ontology of Scientific Vision," Representations in Scientific Practice Revisited. Massachusetts Institute of Technology, 2014.Daston, Lorraine, Michael Lynch, Steve Woolgar, "Reflections" [on representation].Representation in Scientific Practice Revisited. Massachusetts Institute of Technology, 2014.

Daston, Lorraine and Peter Galison. Objectivity. New York: Zone Books, 2010.

Deacon, Terrence W. The Symbolic Species: The Co-evolution of Language and the Brain. New York: W. W. Norton & Company.

Dennett, Daniel C. Consciousness Explained. Boston: Little, Brown and Company, 1991. 995.

Donald, Merlin. A Mind So Rare: The Evolution of Human Consciousness. New York: W. W. Norton & Company, 2001.

Donald, Merlin. Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition. Cambridge: Harvard University Press, 1991.

Dunbar, Robin. The Trouble with Science. Cambridge, Mass.: Harvard University Press, 1995.

Frye, Northrop. The Great Code: The Bible and Literature. New York: Harcourt Brace Jovanovich,1982.

Gee, James Paul. An Introduction to Discourse Analysis, 4th ed. New York: Routledge, 2014 (1999).

Gould, Stephen Jay. The Structure of Evolutionary Theory. Cambridge, Massachusetts: Harvard University press, 2002.

Gross, Alan G. and Joseph E. Harmon. Science from Sight to Insight: How Scientists Illustrate Meaning. Chicago: University of Chicago Press, 2014.

Gross, Alan G. and William M. Keith. Rhetorical Hermeneutics: Invention and Interpretation in the Age of Science. Albany: State University of New York Press, 1997.

Irwin, Alan and Brian Wynne, eds. Misunderstanding Science? The Public Reconstruction of Science and Technology. Cambridge: Cambridge University Press, 1996.

Jackendoff, Ray. Foundations of Language: Brain, Meaning, Grammar, Evolution.Oxford: Oxford University Press, 2002.

Lakoff, George and Mark Johnson. Metaphors We Live By. Chicago: University of Chicago Press, 2003.

Lederman, Leon M. And Christopher T. Hill. Symmetry and the Beautiful Universe. Amherst, New York: Prometheus Books, 2004.

Losee, John. A Historical Introduction to the Philosophy of Science. Oxford: Oxford University Press, 2001.

McPhee, John. Assembling California. New York: Noonday Press, 1993.

Milton, John. Complete Poems and Major Prose, ed. Merritt Y. Hughes. New York: Macmillan, 1957.

Mithen, Steven. The Singing Neanderthals: The Origins of Music, Language, Mind, and Body. Cambridge: Harvard University Press, 2006.

Myers, Greg. (2003). "Discourse Studies of Scientific popularization: Questioning the Boundaries," Discourse Studies 5 (2): 265-279.

Newton-Smith, W. H. The Rationality of Science. London: Routledge, 1981.

Pauwels, Luc, ed. Visual Cultures of Science: Rethinking Representational Practices in Knowledge Building and Science Communication. Hanover, N. H.: Dartmouth College Press, 2006.

Percival, Ian. "Chaos: a science for the real world," in Nina Hall, Exploring Chaos: A Guide to the New Science of Disorder. New York: Norton, 1991.

Perez-Llantada, Carmen. Scientific Discourse and the Rhetoric of Globalization: The Impact of Culture and Language. New York: Continuum International Publishing Group, 2012.

Pinker, Steven. The Language Instinct: How the Mind Creates Language. New York: William Morrow and Company, 1994.

Putnam, Hilary. Representation and Reality. Cambridge, Mass.: MIT Press, 1988.

Putnam, Hilary. The Threefold Cord: Mind, Body, and World. New York: Columbia University Press, 1999.

Quine, W. V. The Pursuit of Truth. Cambridge, Mass.: Harvard University Press, 1992.

Rorty, Richard. Objectivity, Relativism, and Truth. Cambridge: Cambridge University Press, 1991.

Sarles, Harvey B. Language and Human Nature: Toward a Grammar of Interaction and Discourse. Minneapolis: University of Minnesota Press, 1985.

Simons, Herbert W., ed. The Rhetorical Turn: Invention and Persuasion in the Conduct of Inquiry. Chicago: University of Chicago Press, 1990.

Thomas, Keith. Man and the Natural World: A History of the Modern Sensibility. New York: Random House, 1983.

Wolpert, Lewis. The Unnatural Nature of Science. Cambridge, Mass.: Harvard University Press, 1992.