

The *A Priori* Object

A priori object properties constrain the evolution of life.

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Abstract

Charles Darwin's Theory of Evolution predicts adaptations only weakly. A more predictive evolutionary theory based in the elementary properties of objects is proposed. A set of outward gradients is expected of all objects even before they are observed. These include gradients in density, velocity, certainty of continued existence and other quantities. In the *Sparseness Adaptation Syndrome* essay we saw that humans and their ancestors must adapt to low population and resource density at frontiers.¹ The present more general *A Priori Object* theory anchors the earlier results in the properties shared by all objects *a priori*, and shows that these properties both shape the universe and constrain the evolution of life. The *A Priori Object* theory predicts for each physical gradient a corresponding average trait gradient among organisms, including humans.

Introduction

Science does not finally explain things, but rather evolves continually.

"Evolution is the best explanation for the origin of human life on Earth." This statement and others like it appear in contemporary polls of religious attitudes and shape popular debate about human origins.² The statement, however, prevents an entire class of people from responding to it decisively: scientists. Best (possible) explanation has never been a goal of rigorous science. To many scientists, affirming the statement hints that science does attempt final explanations, while denying the statement suggests that life on Earth cannot have greatly changed.

Scientific process consists of an ongoing cycle of question-answering and answer-questioning. Science is more journey than destination, and its conclusions are always provisional. A scientist may express great confidence in a provisional answer, but no real scientist makes an idol of an answer. Unfortunately the discussion of human origins is complicated by the fact that some people who try to speak for the sciences do not fully appreciate science's own evolving nature.

Against this background I attempt a fresh foray into the discussion of human origins. In this essay I advance a tentative theory that is compatible with but not strictly dependent on Darwinian evolution. Nevertheless, because of Darwin's prominence in talk about human origins and the mistaken perception that his theory poses as a final account of human origins, I open with a brief discussion of the strengths and weaknesses of Darwin's theory.

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² Look for the most recent version of this paper at <http://autismtheory.org/sparse3.pdf>

Darwin's Theory is Strong.

Darwin's theory is strong in several ways, not least in its claims: It proposes that all organisms have evolved from ancestors that differed significantly from them, and that the mechanism of this evolution is a three-part engine of trait heritability, variability and differential effect on reproductive success. The theory predicts that all observations will be consistent with a history of change by way of this three-part mechanism. Because Darwin's theory makes its strongest statements about the *past* it is a strongly retrodictive theory.

Darwin's Theory of Evolution is weakly predictive. To those who can follow Darwin's logic it is obvious that change of some kind in population traits is essentially a certainty. It's like saying that clothing fashions can be copied, can be varied, and then proliferate in proportion to the changing tastes of the buying public – with the result that popular fashions change over time. To deny Darwin's logic is to deny that some important traits are heritable, to deny heritable traits can vary in offspring, or to deny that they can affect reproductive success. It's like saying fashions can't be copied, vary, or influence clothing purchases. All these denials are absurd. As Darwin's contemporary Thomas Henry Huxley put it, "...Mr. Darwin does not so much prove that natural selection [and consequent evolution] does occur as that it must occur..."³ This fact is, however, lost on anyone who cannot follow Darwin's logic.

There are things that a stone or a dog cannot understand, and there are things that some people cannot understand. There is no shame in a limited ability to understand: There are many things I cannot understand. One strength of Darwin's theory is that it is simple enough that many people *can* understand it. On the other hand, Darwin's theory is also complex enough that many people *can not* understand it, and of these many never will. This does not stop them from voicing opinions about the matter, of course, and much discussion of human origins consists exactly of such blind opinions.

Darwin's Theory is Weak.

Having touted the strength of Darwin's logic, and perhaps singeing the pride of any unable to follow it, I now turn to the great weakness of Darwin's theory. The problem is that simple agreement with the three-part mechanism doesn't actually say or explain much about evolution. It's like explaining that the Sistine Chapel frescoes are exhaustively fashioned of brushstrokes or explaining that one robs banks because that's where the money is. These explanations miss the main point. Darwin's theory is weak because it does not actually remove much of the mystery of human origins, as we shall now see.

Darwin's theory supplies no direction to evolution beyond that what is observed must be consistent with its three-part engine. This, however, does not give evolution much if any direction. In the language of the fashion metaphor, Darwin's theory predicts that fashions will generally change with public taste, but predicts nothing about whether hemlines will rise or fall, or even whether there will be dresses. As far as Darwin's theory is concerned

an ape can as soon evolve toward becoming like a sloth or rutabaga as toward becoming like a human. In other words, as far as Darwin's theory is concerned, evolution in the direction of humans is entirely unpredictable and hence for all practical purposes a miracle. I hasten to add that this does not mean humans *are* miracles: It can just as well mean that Darwin's theory is incomplete – as we expect any proper scientific theory to be. Given the earlier description of the scientific process we may expect our understanding of human origins to be incomplete now, to remain so indefinitely, and to progress by fits and starts as we attempt *new* increasingly powerful yet always provisional theories beyond Darwin's. That is exactly the effort of this essay.

Before continuing with the new theory I must erase lingering suspicions that Darwin's theory does predict humans. I do this through a look at the mechanics of misunderstanding. The prevailing "understanding" of Darwin's theory is a misunderstanding. It consists in fashioning beguiling "Just So" stories about evolution through the addition to Darwin's theory of ad hoc postulates.⁴ Once the virtual paradigm of Darwinian evolution, industrial melanism in the Peppered Moth provides a simple example of evolutionary storytelling: "Predominantly light-colored moths evolve to become dark moths because the occasional darker moths outbreed their lighter siblings in a world freshly blackened by industrial pollution – the dark moths' color making them less visible to birds who eat them – and so the overall moth population becomes darker." (my summary)⁵ This seems only common sense, and barely in need of defense or comment.

There are at least two problems with the industrial melanism story and they take this general form:

- 1) There is no demonstration that the organism population either has the presumed-adaptive trait at the outset or has the inherent capacity to generate it anew.
- 2) There is no demonstration that the presumed-adaptive trait will lack serious ill effects on the organism.

Absent these demonstrations postulates must be added, including:

- 1) Predominantly light-colored moth populations have the genetic capacity to produce dark offspring.
- 2) The dark trait will not simultaneously render the moths fatally susceptible to other influences, for example to a hypothetical moth melanoma.

Where do such postulates come from? In the usual case they are pulled out of the air and implied rather than acknowledged. In another example bacteria evolve penicillin resistance, but they cannot do this unless⁶

- 1) they have the genetic potential to do so and
- 2) penicillin resistance brings no fatal result to the bacteria themselves.

It happens that both conditions are met by observed bacteria, but this need not have been so and the two conditions must be added as postulates to make a predictive theory. Absent their prediction penicillin resistance is as good as a miracle.

The argument that industrial melanism and penicillin resistance illustrate evolutionary mechanism relies on hidden postulates outside the purview of Darwin's theory. It's not enough to supply the wanted demonstrations in one or two cases: They must be supplied in *every* case – and each case is an *extension* of Darwin's theory, not an expression of it. Without the missing demonstrations, and given reliance on ad hoc postulates, the gears of the presumed evolutionary mechanism have no teeth. The grip of pride is strong: "Only fools need miracles," mutters the systemizing mind. Nevertheless if one can't predict anything then one outcome is as likely as the next and all are indistinguishable from miracles.

This has been the merest sketch of shortcomings in the usual evolutionary tales. It should be enough to guide a serious student, however. Please note that we have already run aground on moth wings and bacteria, and that humans are a long way from either.

We have arrived at the balanced and nuanced (I hope) position that Darwin's Theory of Evolution is strong, showing that evolution of some sort must occur, and weak in that it does not specify the direction of evolution. We are invited then to search for the apparent missing direction of evolution. In order to give proper scale to our ambition we begin by looking at global limits on prediction.

No theory can predict strongly.

The Little Dutch Boy

In an old story a little Dutch boy wanders one day along one of the dikes that holds back the sea from his native land.⁷ By the sheerest chance he passes a small but dangerous leak in the dike. Seeing the threat to his lowland nation the boy plunges his finger into the hole, stopping the flow. He remains stalwartly in place until adults find him, gratefully relieve him, and effect the necessary repairs to the dike. The boy's heroism is then sung throughout the land, for if he had not found the leak and performed his digital act the dike would have breached and the nation drowned.

The story of the Little Dutch Boy is of course fanciful, but it illustrates a phenomenon common in nature: Important events can depend on events as unpredictable as a coin toss or a boy chancing upon a hole in a dike. In the story it is only the sheerest luck that takes the little Dutch boy to the leak when it is small enough to plug, with the fate of the nation in the balance. Examples of small and unpredictable events with momentous outcomes are common in sports: A ball takes an odd hop granting a team the winning score; a player just barely makes a tackle, blocking a game-changing open-field run, and so on. It is true that the stronger team usually wins, but it does not always, and in any case what is most interesting is the actual play of the game.

The history of life on Earth is filled with events of consequence precipitated by events as small and unpredictable as any in sports. The whim of a meteor's path erases all big animals on Earth in a virtual instant. Continents collide and drift apart. Volcanoes bring global winters and new lands. A landslide buries an ecosystem or a hurricane wipes it clean. A tree falls and a tiny species is no more. At every scale the important depends on the unpredictable, and varied forms of life perish or thrive accordingly. There are averages to be sure but important features always escape these blurry averages. To predict the course of evolution in robust detail is to predict the hops of balls, the vagaries of winds and seas, and the private life of meteors. To boast too loudly of a theory's power, then, is to invite humility at the hands of chance. Unless one denies the importance of the unpredictable, or of anything depending on the unpredictable, one's theories will be imperfect prophets. No theory of evolution can be very strongly predictive. Even where asteroids, seas and winds have all been tamed, important but unpredictable events will arise and be indistinguishable from miracles.

We see that our predictive aims must be modest. In fact my primary goal in this essay is simply to contribute to an ongoing cycle of question-answering and answer-questioning. The hunger for prediction evokes one ancient if not purely scientific question: How much fire will the universe grant us for the benefit of all beings? The very question ripples with hubris. Who would presume to grasp at universal fire or to know what benefits all beings? Nevertheless, as we try to add predictive power to our theories and to give teeth to our logical mechanisms we seek something more potent than any fire. Having seen that our predictive aims must be limited, though, a good place to begin our search for prediction is in limits themselves. From limits on prediction, then, we turn to limits on life. Are there *limits* to the ways life can unfold and do these limits give us any power to predict?

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**A modest theory of evolution, based in limits on observation, is undertaken.**

### ***The Search for Global Limits***

If something cannot happen then we may predict that it won't, and to see what can't happen is to learn something about what can. A naive student's search for limits might turn up something like this: "Highly developed life cannot lack a nose to support its spectacles, so we can confidently predict the evolution of noses." A more sophisticated student might offer, "Life must obey limits posed by thermodynamics and quantum mechanics." This latter is fine, and worth pursuing, but it overlooks the fact that these physical limits were themselves inferred from observations of the universe. We shall therefore first examine limits to observation itself.

Let us begin with the basic act of deciding whether or not something, say a stone or a cat, exists. Here, then, we encounter a limit: The existence of an entity cannot be more certain elsewhere than where-and-when it is directly observed. Stated positively, the existence of an entity is more certain as it is directly observed than it is elsewhere. As I directly

observe the cat on the lawn I am more confident that it exists than I am when it disappears behind a bush where a cat dismantler may lurk. Similarly, I am more confident that the cat on the lawn exists when I observe it now than I am of its existence yesterday, when it may not yet have been created in a laboratory, or tomorrow, when it may be dead. What is so for cats is so for dogs, stones, and even the most abstract ideas: My confidence in their existence is at a maximum as I observe them directly.

It may be that we live in a waking dream, and that even the cat on the lawn is a ghost. That is entirely possible: Once in a dream I pinched myself to check whether I was dreaming and falsely concluded that I was not. Since that time I draw no harsh line between physics and dreaming, and simply note that dream cats and non-dream cats hold to the same limit: I am more confident of their existence as I directly observe them, whether theirs is a "real" or a dream existence. This limit on observation is so basic that it seems a plausible place to start a search for predictive rigor. It has the added merit of not hiding the messiness of actual physics behind equations induced from observations in the first place.

### *The Certainty Gradient*

Does a cat or stone exist? Never more so than *as* it is directly observed. Notice that this apportionments existing entities into two approximate regions or directions: the directly observed more-certainly-existing portion, and the less-certainly-existing (or more certainly non-existing) portion elsewhere. In other words, in all directions of space, time, quality – along any dimension whatsoever – an entity exists with less certainty elsewhere than as it is directly observed as well as where it is directly observed to be absent. This is so whether the entity is singular like a stone or collective like a handful of sand. It is equally so for a cat and for its litter of kittens. It is so for every living organism and population on Earth. This limit thus defines a **Certainty Gradient: The certainty/probability of the continued existence of an entity drops radially outward past some point in all directions.** An everyday object may be substantially contained in a sufficiently large sphere. The Certainty Gradient is a fundamental limit of the universe.

### *The Density Gradient*

The Certainty Gradient applies to entities of all kinds, including dreams as well as tangible things. However, it is the tangible things – what we call *objects* – that are of most interest here because the stars in life's unfolding – the living things themselves and their various groups and parts – are all tangible things. What applies to *any* entity applies to any tangible thing, which is to say to any object. This said, where an object most certainly exists we may say that it is *dense*, and where it is not as likely to exist, *sparse*. The Certainty Gradient thus can be recast in less general but more immediately useful form as a **Density Gradient: The density of an object drops radially outward past some point.** A particular object's density *may* rise outward – locally – but it *must* decline outward eventually. This is so at many scales surrounding the scale of everyday objects, up to and beyond the scale of galaxies. It is also so whether the density is of parts, events, features or stuff: An object cannot have parts, features or events where it does not exist.

Even in crystals surface parts lack outer neighbors and so exist in relative sparseness. If it's an everyday object it has a Density Gradient. The Density Gradient is the first of many that correlate with the Certainty Gradient, ultimately limiting evolutionary possibilities.

Let's see if the resulting Density Gradient is as obvious in practice as its derivation suggests it must be. Does the density of a stone or cat drop radially outward at some point? Moving outward from within the body of a cat one encounters a fuzzy zone of mixed cat and air – its fur – and an undeniable drop in cat density. Even if the cat has no fur and has a skin made of steel the outermost atoms of steel exist in relative sparseness for want of outer neighbors. Every rock has an abrupt but outwardly-declining density gradient.

One can try to make trouble for the Density Gradient by throwing at it examples like a bubble in steel or a tornado, but these too have little presence or influence at sufficient range. Go ahead: Throw strange things at the definition to your heart's content – any tangible thing you can contain in a sufficiently large bag as you can an organism or a population – and see if you can dodge the Density Gradient. Bear in mind that proposed counterexamples must avoid extremes of scale because one cannot certainly observe the outermost limits of the universe, or extremely small particles, and this in itself limits observable existence.

The correlated gradients apply for objects of all kinds, whether they are connected objects or not. In collective objects like populations the Density Gradient appears as an expected outward decline in population density. It is worth stressing that the outward decline in population density is expected *a priori*, that is, prior to any observation of the population: Surface sparseness is simply a property of objects. Contrived counterexamples only confirm the rule that most concerns us here: **All organisms and populations throughout history have and have had Density Gradients.**

### ***The Velocity Gradient***

Suppose two featureless objects move about with respect to each other. Relative to the dense center of each object the other object then has a non-zero velocity and so there is a velocity gradient rising outward from each object's dense region. (The momentary velocities in this scenario may be inward, outward or orbital.) Now suppose those two objects and others also moving about are taken to be the *parts* of a larger object. If each part of the object defines an observational frame of reference within the larger object and the *a priori* expectation is of a Density Gradient within the large object then the predominating frame of reference within the large object is supplied by its densest regions. As a result there is expected within objects a **Velocity Gradient: The velocity of moving parts is expected to rise outward in an object.** The Velocity Gradient extends outward to objects that are not part of the central reference object.

The Velocity Gradient can be seen in many ways, for example:

- Where there is great uncertainty of continued existence there is great uncertainty of position and time, with a resulting great range of velocities in outer object regions where continued existence is most uncertain.
- For any interval of time the greatest velocity of parts within an object as measured by actual movement between points must occur across the largest dimensions of the object.
- Central parts of an object *may* move, but surface parts passing the threshold of correlation with the object *must* move.
- If an object is most identified with those of its parts that remain dense and persistent in many frames of reference, then those parts must move relatively little with respect to each other as long as the object exists.

### *Implications for Physics*

The *a priori* properties of objects yield a number of expectations about the physical universe.

The Certainty Gradient has its origin in the nature of observation. With everyday objects it is possible to observe that they proceed from relative certainty of existence where they are to relative certainty of non-existence where they are not. In the case of the physical universe as a whole, however, it proceeds from relative certainty of existence where we are but it does not proceed outward to relative certainty of non-existence. At extreme distance we cannot observe whether the universe continues to exist or not: There is an **Observability Gradient**.

Here Relativity and Observability potentially collide: If the physical existence of a thing strongly depends on our ability to observe it then we on Earth are at the center of an actual universal Density Gradient. On the other hand if as Relativity suggests an observer looking into the sky anywhere in the universe encounters the same Observability Gradient then either we must accept the actual existence of things we can *never* see – meaning objects remote observers must be able to see in order to observe the same universal Density Gradient – or Relativity is violated. In either case, though, the *a priori* properties of objects lead us to expect that *we* shall observe universal Density and Velocity Gradients, and indeed we do.

Because the certainty of an object's existence is always greatest in the present, it follows that **the past must always appear to favor the creation of objects, and the future their destruction**. Aging and impermanence are inevitable. However, the Certainty Gradient puts no limit on the *amount* of time an object may sustain itself through mechanisms of repair and copying.

A second expectation is of *generalized inertia*: Because everyday objects are much smaller than the space and time surrounding them (where they are substantially nonexistent) the most probable place to find part of an everyday object is near another of



its parts – in both space and time and with nearness determined by the object's scale. Thus a mountain is likely to persist as a mountain, whereas a lightning bolt that has persisted for only moments is as yet expected to persist for only moments. If there were no generalized inertia mountains often would change suddenly in major ways. Although observations can alter expectations, inertia is expected *a priori* – prior to observation – in any of an object's characteristics. Novel behaviors are possible in spite of inertia, of course: They are simply less probable. Generalized inertia appears later in the form of *adaptive inertia*.

The Certainty Gradient and others described below represent *a priori* expectation for all objects. In other words, the gradients reflect *actual average behavior* of objects even in the absence of detailed observation, or of any observation at all.

Atoms are internally sparse. Thus density declines not only as one moves outward from an object to larger scales, but also to some extent as one probes an object at finer scales. In general there are limits on the fine-ness of scale at which objects can be observed. This suggests that some or all of the gradients detailed above and in coming pages may apply microscopically as well. The behavior of the gradients at small scales merits close study.

In quantum entanglement one can effectively "toss a coin" in certain ways and have the outcome register instantaneously in a remote corner of the universe. This remote influence at arbitrary range at first seems to give objects potentially unlimited extent. However, any actual remote location is at a finite distance, and the coin-tossing setup and entanglement verification depends on range-limited and fallible infrastructure, as well as on uncertain storytelling in its interpretation. The result is intact Certainty and Density Gradients.

Aside: I may be far out of my depth in suggesting the following – if so I apologize. The *a priori* properties of objects appear to *require* that we observe a universal velocity gradient when we look into the sky. This means that the *a priori* properties of objects virtually mandate that the universe appear to be expanding as if from a Big Bang and that we *must* observe Doppler red-shifting of remote galaxies. The question then is, "Was there a Big Bang, or is this simply the way things must appear as long as we are held in the straight-jacket of basic object properties?" In any case the *a priori* properties of objects and the observed macroscopic structure of the universe appear to be deeply connected. If gravity itself is a manifestation of generalized inertia then this may open a path to anchoring gravitation and quantum phenomena in *a priori* object properties and underlying limits to observation.

### ***Further Gradients and Gradient Correlation***

Various basic physical gradients correlate with the Certainty Gradient. The Density and Velocity Gradients we have already seen and others I'll describe presently. I call this alignment of gradients, and their effects, *Gradient Correlation*.

Where an object does not exist there can be no local correlates of its existence because there is nothing there to correlate *to*. Thus there is in objects a **Local Correlate or**

**Causal Gradient: There is expected *a priori* an outward decline in local correlates or causes of an object's existence.** Given that the probability of existence declines outward, all causes must appear on average to favor the destruction of outward-moving parts, and the sustenance of inward-moving parts. The Causal Gradient also entails a **Risk or Danger Gradient: There is expected *a priori* an outward rise in existence-threatening risk faced by an object.**

Where there is great certainty there is little information to be gained through further observation. In everyday objects the Certainty Gradient ranges from relative certainty of existence to relative certainty of non-existence. Uncertainty is at a maximum midway. Thus there is in everyday objects an **Information Shell: Object-correlated information is expected to rise to a maximum midway down an object's Certainty Gradient, and to decline from there outward.** (Given that the certainty of the universe's continued existence may not decline outwardly to zero, the universe as a whole may have a simple Information Gradient whereby past some point the information per local object continues to rise outward without declining as in an everyday object.)

Where the probability of existence is high parts tend to be stable and where low, short-lived and so newer on the whole. Thus in objects an **Information Stability Gradient proceeds outward from stable to novel information.**

We now return briefly to the subject of Darwinian Evolution.

### ***Darwin Revisited***

To repeat, Charles Darwin's Theory of Evolution can be framed in a single sentence: Organism traits are heritable, variable, and differently affect reproductive success, so that descent with modification and species evolution cannot fail to occur. The relative success of some variations as compared to others is called *natural selection*.<sup>8</sup> Darwin's theory provides that change across generations occurs by way of the three-part engine and also tells that organisms need not resemble their ancestors – that, for example, human ancestors may look more like apes than humans. However, we have noted that for all its elegance Darwin's Theory is almost completely non-predictive. It is one thing to say that humans descend by increments from apes, and another to say that evolution tends in the direction from ape to human. The three-part engine tells nothing of direction in evolution: It is a rudderless ship.<sup>9</sup> This much we have already seen.

Darwin's theory stretches uncomfortably between requiring change to be so rapid that it might as well be miraculous and that change be so gradual there are not generations enough to effect it. The theory supplies little reason that myriad small trait variations should be statistically dependent in a way that makes large changes plausible, or even that any promising variation has no simultaneous ill effect. Without a prior measure of fitness the popular formulation of Darwin's theory as *survival of the fittest* is a hollow tautology. The result is that persons who do not object to their species being miraculously fashioned from apes rather than clay have nothing to fear from Darwin's theory, for that is how little light Darwin's theory sheds on the direction of life's unfolding. Into this

explanatory void venture the *A Priori Object* theory of this essay and the *Autocatalytic Text* theory of the *Dragon Puzzle Story*.<sup>10</sup>

The correlated physical gradients of the present *A Priori Object* theory mesh neatly with Darwin's three-part engine of evolution, but the gradient effects run deeper than this and in a way that addresses weaknesses of Darwin's theory. Briefly put, **organisms are adapted to the physical gradients expected of all objects**, and adaptation to the physical gradients precedes the operation of Darwin's engine for the simple reason that adaptation itself precedes it, as now detailed.

### ***Defining Adaptation***

How do we tell that an organism is adapted to its circumstances? Initial answers to this question are likely to take the form of teleological stories like this: "A mackerel has gills suiting it to undersea life. Gills show that a mackerel is adapted to life in the sea. Roots show that an oak is adapted to like on land." A more rigorous reply to the question follows.

An organism that perishes instantly in a particular circumstance is not adapted to that circumstance, whereas an organism that, itself or in kind, persists in a particular circumstance is adapted to it. An oak perishes almost instantly in flaming lava and so is not adapted to life there. Mackerel persisting for generations in the sea are adapted to life there. The case intermediate between longevity and instant death proves instructive. An oak in sea water and a mackerel on land do not perish instantly. They are not as poorly adapted to life in those circumstances as is an oak in lava. Regardless of any teleological stories a fish out of water and an oak at sea are adapted to their lives there for precisely as long as they survive. An organism that persists in a circumstance for a time is adapted to the circumstance *for that time*. **Adaptation has a time scale and existence in a circumstance proves adaptation to it.**

Note that adaptation is defined here independently of Darwin's Theory of Evolution. Darwin's theory suggests *how* adaptations arise: The present definition, and *A-Priori-Object Theory* itself, is more concerned with the *fact* of adaptation than with its underlying mechanism. The point here is that adaptation exists regardless of whether a Darwinian mechanism fully accounts for it, and that persistence is a defining feature of adaptation.

The fact that adaptations have a time scale gives them a form of generalized inertia – or what may be termed *adaptive inertia*: It is the *a priori* expectation that enduring adaptations change slowly, whereas recent adaptations change with higher probability in the short term.

### ***Natural Selection and the A-Priori Object***

The bodies of organisms are objects, and populations are collective objects. Hence correlated physical gradients are expected of them as of any stone. Gradient Correlation constrains natural selection and relieves the tautology of *survival of the fittest* by

providing *a priori* determinants of organism fitness. A constraint affects natural selection when it influences organism survival and reproductive success over the course of many generations. The correlated physical gradients have existed *as long as there have been objects*, and are expected even before properties like mass and temperature. Because they always exist prior to natural selection, and effectively constrain it, it is unlikely that they have failed to guide natural selection.

A-Priori-Object Theory is compatible with Darwin's Theory of Evolution but does not rely on it. ***A priori* object properties limit evolutionary possibilities whether or not natural selection is the means by which this occurs.**

We now explore general adaptations to the correlated physical gradients.

### ***Trait Gradients***

An organism generally appears not as an undifferentiated mass but as a collection of properties and behaviors – of *traits*. To say that an organism is adapted to a circumstance is thus to say that its collection of traits is adapted to that circumstance: The persistence of an organism in a circumstance proves the adaptation to that circumstance not only of the organism but of its collected traits. The correlated physical gradients are a basic part of any organism's circumstances, and the existence of the organism amid the inescapable gradients implies adaptation of its traits to those gradients: **For each physical gradient a gradient of organism traits is expected** prior to observation, and as with the physical gradients **the trait gradients and their corresponding poles are expected to correlate.** I now describe some of those trait gradients.

Like any object a population of organisms exhibits a density gradient, and so in any population some organisms live in regions of sparse population and others in dense. Even in a colony of closely-packed organisms symmetry is broken: Those on the surface lack outer neighbors and so live in dramatic sparseness relative to their interior companions. *An organism is fitter to survive in a sparse region when its traits allow thriving at relative distance from others of its kind*, in an environment dominated less by kindred society than by things or dissimilar organisms. In other words, in sparse regions what may be called *loner* traits and traits conferring *natural-* or *object-world savviness* are adaptive. *This is the a priori expectation for organisms of any kind – and at any era or scale.* The converse holds, too: An organism is fitter to survive in a region of dense population when its traits allow thriving near kin. Thus in dense regions *social, gregarious* and *cooperative* traits are adaptive. In sum, **correlated with the Density Gradient in any population is expected a gradient of organism traits ranging from cooperative, gregarious, social-world savvy organisms in dense regions to loner, object- or natural-world-savvy organisms in sparse ones.**

An organism may *become* adapted to its circumstances, for example through natural selection, but an organism's existence at a particular spot on a gradient also shows that it *is* adapted to that spot as long as it persists there.

The Velocity Gradient is evident among organisms as a gradient of organism mobility and is probably most obvious in a population expanding into surrounding territory: Newly inhabited territory is necessarily first entered by moving organisms, with the fastest-moving organisms at the fore. As elaborated in the first chapter, the process here is rather like chromatography – and in the early stages of life's evolution may literally have *been* chromatography – in which a muddy mix of substances separates into a spectrum of species arrayed according to speed of movement, with the fastest leading. It is also like the splash of a wave on a shore, and may, too, literally have involved this. Populations flow and ebb. When the direction of chromatography is reversed or a wave recedes fast-advancing parts become fast-receding parts. The expectation of the Velocity Gradient is that whether in advance or retreat the most mobile organisms are likely to be found in a population's sparse regions – near its external and internal frontiers.

Although the influence of the Velocity Gradient may be most obvious at the frontiers of an expanding population, *the gradients exist and are correlated at a wide range of scales, including the scale of density fluctuations* within a population. Thus they limit evolutionary possibilities even in a population with well-contained frontiers.

Organisms disposed to move a lot may be called mobile or restless. Muscles and wanderlust exemplify specific traits favoring restlessness. By contrast, organisms disposed to remain relatively stationary may be called sedentary or tenacious. Roots of plants exemplify a specific tenacity-favoring trait. In sum, **corresponding to the Velocity Gradient in any population is expected a gradient of traits ranging from sedentary or tenacious interior organisms to mobile or restless outer organisms.**

The local causes of an organism's existence include nutrients, with various forms of energy prime among them. The Local-Correlate Gradient appears significantly among organisms as a **Nutrient Gradient: In any population an outward decline in the prevalence of nutrients is expected *a priori*.** A thought experiment in Chapter 1 confirms the existence of this gradient. Dense population in itself supplies evidence of nutrients: No such *a priori* inference is possible where there is no population. The *a priori* expectation is that inner organisms are relatively nutrient-rich and outer organisms nutrient-hungry. Nutrients are needed to sustain population density, for example to reproduce, and energy is needed to move. The Nutrient Gradient leads to an expectation of a trait gradient extending from organisms preferentially using plentiful nutrients to reproduce, to organisms efficiently using scarce nutrients to move.

**When an organism receives fewer and fewer nutrients it does not simply become less and less alive: At some point it dies.** Even seeds and spores perish. This **Nutrient Threshold Effect** limits evolutionary possibilities in regions of low nutrient density. Environmental fluctuations like droughts and snowstorms can abruptly produce large areas of low nutrient density. Because of the Nutrient Threshold Effect such an area may contain nutrients sufficient to sustain one organism but not two. *Here cooperation cannot succeed: Survival is mutually exclusive.* In such a grim place the organism whose traits incline it to prevent a neighbor from eating, and to grab the available nutrients, thus killing the neighbor, is the only organism whose traits will persist there. This

phenomenon is familiar from the Sparse Box thought experiment in Part I of the *Sparseness Adaptation Syndrome*.<sup>1</sup> At the low end of the Nutrient Gradient circumstances tremendously favor competition, aggression, and even violence, murder and cannibalism, which supplies nutrients as well as eliminating competition. Traits favoring murderous competition are further consistent with population sparseness for the stark reason that killing organisms reduces their population density.

Cooperation can succeed in very sparse regions only as long as supply lines tenuously render the regions more nutrient-rich, and the more remote the region the more tenuous the supply line. Recall that inner organisms are expected to be relatively cooperative. Inner organisms may have their competitive moments, but these in general pale beside what occurs at the grim end of a nutrient gradient. In conclusion, there is a **Competition Gradient: Proceeding outward in a population there is expected a gradient from cooperation to competition extending even to extreme violence**. A corresponding trait gradient is expected.

The Information Stability Gradient for its parts leads to the expectation of a trait gradient ranging from inner organisms adapted to store stable information to outer organisms adapted to acquire and manage novel information. The greatest storage capacity and greatest novel information rate (bandwidth) may be expected to arise respectively just inside and just outside the information maximum midway down the Certainty Gradient. In order to survive in an environment filled with novelty an organism must be adaptable and even innovative.

Outer novelty-facing organisms also face something deadly: Risk. The Certainty Gradient provides the *a priori* expectation that the probability of existence declines outward in a population. In other words, there is a **Risk or Danger Gradient: Proceeding outward in a population there is expected a rise in life-threatening risk faced by organisms**. This gradient applies to risks from all sources. The risk gradient can be sensed from the simple observation that if one proceeds in any direction on space or time one eventually encounters a region where continued existence is unlikely. The Risk Gradient itself limits evolutionary possibilities and leads to the *a priori* expectation of a trait gradient extending outward from danger-avoiding to danger-facing organisms. Because of the correlated Competition Gradient, in regions of low nutrient density not the least risk arises from an organism's own kind.

In sum, **corresponding to the Information Stability and Risk Gradients is expected a gradient of traits extending outward from conservative storers of stable information to risk-facing acquirers of novel information**.

Because the physical gradients correlate, corresponding trait gradients are also expected to correlate. In any population of organisms the *a priori* expectation is that there will arise, correlated with the Certainty, Density, Velocity and other physical gradients a

### Gradient of Correlated Traits

extending

| FROM                           | TO                                         |
|--------------------------------|--------------------------------------------|
| sedentary/tenacious            | mobile/restless                            |
| cooperative                    | competitive/violent                        |
| gregarious                     | loner                                      |
| social-world savvy             | object- /nature- savvy                     |
| stable-information-<br>storing | novel-information-<br>acquiring/innovative |
| danger-avoiding                | danger-facing                              |
| fast reproducers               | slow reproducers                           |

(This is a partial list, and the terms are relative.)

This terse table has been hard-won. It is a prize, however, because it is the simple consequence of evolutionary possibilities constrained by the mere fact that organisms and populations are objects, and because it thus represents *a priori* expectation for all populations at all scales and eras.

We are now in a position to apply the Gradient of Correlated Traits to problems in brain evolution. For present purposes we shall assume the prior existence of a population of simple reproducing organisms with some sort of genome.

#### ***Nutrient-Information Exchange and Gender***

Outer organisms in a population – particularly an expanding population – gain information about surviving novel risks. Risks can move – indeed that is the expectation of the Velocity Gradient. Danger-shy inner organisms have much to gain from information about how to survive possibly approaching risks. The very existence of an organism at the frontiers speaks eloquently of its risk-surviving traits. Some of these traits can be of distinct value to inner organisms.

Inner organisms have much to gain from risk-related information but are rich in potential energy and other nutrients. Outer organisms are hungry for the energy and nutrients sparse in outer areas, but they are rich in risk-related information. *The conditions for symbiosis thus exist.* These circumstances favor inner and outer organisms that exchange nutrients and novel information. Outer organisms face risk and supply information about how to survive it: Inner organisms supply energy and other nutrients while storing risk-surviving information. Thus **Nutrient-Information Exchange** and Energy-Information Exchange in particular are expected *a priori* to mark the development of organisms and brains.

Because within a species inner organisms reproduce the traits of surviving outer organisms, as well as their own, their offspring form a spectrum of Inner and Outer types. Inner organisms can thus implicitly supply energy to outer organisms by relieving outer organisms of the energy cost and motion impairment attendant on reproduction. **When inner organisms produce outer-type offspring, outer organisms – already slow reproducers – can entirely cease to reproduce.** In this way Nutrient-Information Exchange favors the origin of gender among organisms. Non-reproducing but information-supplying organisms are typically called *male*, and reproducing, information-accepting organisms *female*. Nutrient-Information Exchange is not the only mechanism that can sustain gender, but it is an important one and particularly so in any population facing a notable Risk Gradient.

Because male and female organisms meet to pass information, gender is a relatively local effect of Gradient Correlation. However, mixed *groups* of males and females can live in either sparse or dense regions, so topological effects also occur on a larger scale, as now detailed.

### ***The Competitor Condensation Cycle***

In a nutrient-rich area a small decline in nutrient level may produce a small drop in organism population. By contrast, because of the Nutrient Threshold Effect, at the nutrient-poor frontiers a small decline in nutrient level can send a large area across this threshold, rendering the area uninhabitable. The few mobile and competitive organisms living in such a wasteland are then, regardless of gender, faced with a choice: Move inward – up the Nutrient Gradient – or die. Obviously, under such circumstances evolution favors those outer organisms that overcome their loner tendencies and employ their mobility to head back toward denser population. Because of trait correlation, as these ravenous frontier organisms retreat they encounter organisms progressively less competitive than they are. The competitive can be violent but it need not be: One population may decimate another simply by gathering available nutrients more rapidly.

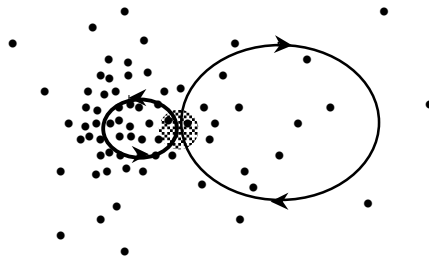
The cooperative traits of inner organisms can provide some defense, but times of severe nutrient decline favor the wave of mobile, competitive organisms retreating from the frontier. This is **Competitor Condensation**. Times of great nutrient increase conversely favor rapidly reproducing organisms, leading to **Cooperator Expansion**. Very rapid population growth can precipitate nutrient crisis as well as encroach on loner frontier organisms, and thus itself trigger Competitor Condensation.

Nutrient levels constantly fluctuate: A cycle of alternating Cooperator Expansion and Competitor Condensation is an expected feature of organism and brain development. Population density in these cycles is likely to have a sawtooth shape because of a fundamental **Growth-Death Asymmetry**: It is generally possible to die much more quickly than it is to grow to maturity.



## *The Hybrid Engine*

Inevitably some organisms return inward from the frontier and inner organisms expand outward. The two varieties meet and interbreed. Competitor Condensation and Cooperator Expansion accelerate this process. The hybrid offspring then scatter according to the mix of inner and outer traits each has inherited. The overall effect is the creation of a global *Hybrid Engine* that mixes inner and outer traits in new combinations. Emerging hybrids immediately encounter correlated gradients and so the Hybrid Engine keeps turning. This helps account for the stability of the phenomenon of gender in spite of hybridization.



The Hybrid Engine enables robust hybrids – offspring that can thrive in either outer or inner conditions as circumstances require. In this sense mixing is the lifeblood of a species. However, hybrid vigor could not result if there were not disparate types to mix, and in any case hybrids are unlikely to show the peaks of specialized ability found in relative non-hybrids. Thus even the robust hybrids do not constitute a "master race" within a species. **Within a species the only master race is the species as a whole, and that is no master race at all.** The Hybrid Engine also makes pure distinct races unlikely: It makes hybrids of all.

## *Rapid Speciation*

From the Information Stability Gradient it is expected that proceeding from one object to another nearby there is little gain in novel information: Novel information tends to be more remote. In other words, neighboring objects tend to be more similar than widely separated ones. The Information Stability Gradient is thus also a **Similarity Gradient: Proceeding outward through any object there is expected a decline in the similarity of its parts, as compared to central parts.** This gradient is obvious for rocks and rivers, and it is obvious for most organism populations: Because of the nearness of parents and offspring organisms tend to live near relatives. Organisms sufficiently dissimilar cannot jointly produce viable offspring.

From the preceding, the outer part of a population is expected to be a forge of novel, even radically innovative traits. This novelty can arise through such mechanisms as stress-induced mutation, fragile chromosomes, ostracism of mutants, rapid recombination, and inbreeding. Novel, even bizarre, organisms retreating from the frontier during Competitor Condensation encounter others not only less competitive than they are: Because of the

Information Gradient they encounter organisms less and less similar to them. During a severe nutrient crisis, such as often occurs during geologically significant events, a *catastrophic instability results*: The wave of condensing competitors crashing back from the frontier destroys the outer layer of still rather-competitive cousins and then easily cuts a swath of destruction inward through progressively less competitive and less similar organisms. By the time the wave stops the retreating frontier organisms may find themselves in contact with cousins so dissimilar that they can no longer jointly produce viable offspring. Speciation has occurred. The constraint of evolutionary possibilities by Gradient Correlation thus leads to an **expectation of rapid speciation with extinction of intermediate forms, as is commonly observed in the fossil record.**

Catastrophic condensation can also occur when two arms of a parent population meet and one of the arms is more competitive at its frontier: Then there is no wall of competitive cousins to overcome and one arm can condense through the other. If the two arms have become separated from the parent population then they are essentially tribes and their collision produces what is, effectively, *war*.

If the condensing frontier organisms are initially so competitive as to be somewhat cannibalistic, then Competitor Condensation becomes **Predator Condensation** and a **food chain** is the result: The modern division of plant and animal kingdoms may be the echo of an ancient Predator Condensation.

### ***Predictions***

A strong scientific theory makes predictions about measurable quantities. We saw in the opening discussion of the Little Dutch Boy that it is not possible to make an exhaustively predictive theory of evolution. However, it is possible to make a theory more predictive Darwin's, and the *A Priori Object* theory does just that. In addition to the predictions already given in the *Sparseness Adaptation Syndrome* essay the *A Priori Object* theory makes these predictions: <sup>1</sup>

- The traits listed in the *Gradient of Correlated Traits* table will be found by any obvious metrics to correlate in many if not all populations of organisms.
- Every member of a species is a hybrid of inner and outer types. The genes responsible for survival in lush and dense versus sparse conditions can be found to a first approximation by placing representative organisms in lush/dense or sparse conditions respectively and measuring which genes are activated. Inner and outer conditions can be arranged by constraining nutrient levels and average distance to neighbors. The *A Priori Object* theory predicts that among the hybrids constituting a particular species some will have more dense-adapted genes and some more sparse-adapted genes – and that these genes will be found disproportionately in dense and sparse areas respectively.
- When the positions of an inner and an outer member of a species are swapped they will persist for a shorter time on average than do neighbors swapped with others at the same degree of sparseness. This test can be run on offspring in order to control for learned adaptations.

- Outer organisms in a population will be found to move about more relative to local nutrients than do inner organisms.
- A clone population placed into a fresh environment will in time differentiate into the spectrum of types expected in the *Gradient of Correlated Traits* table, with evidence of an active Hybrid Engine in operation.

There are other predictions but these should suffice to test the theory. The predictions extend to hominids and hominins as they do to other organisms. Please conduct any experiments with vast respect for the organisms involved. It is important to remember that these predictions regard the average behavior of organisms and that exceptions may only prove a rule. The range of some species may have such sharp, stable boundaries and the Hybrid Engine have been so long in operation within them that most of the species' members have genes allowing them to rapidly adapt to either inner or outer conditions: The measured inner/outer differences in these cases may be small but quite possibly observable nevertheless.

### ***Conclusion***

This concludes a sketch of the *A Priori* Object theory. It proposes that properties shared by all objects before they are observed both shape the universe and constrain the evolution of life. The theory makes stronger predictions about the average courses of life's unfolding than does Darwin's Theory of Evolution. The theory is riddled with flaws but perhaps some of them can be mended. If the theory's predictions are not born out then whatever confounds them probably is important in the history of life.

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