

## Appendix A, (Information and Representation)

### (The Odds Against Representation)

(This appendix is an integral part of the discussion of Chapter 1, but I felt it was too long for a footnote, and would otherwise have interrupted the flow.)

"Information", (and "representation" in whatever form), as a rationale for the evolution of the brain, just isn't a viable hypothesis. The brain, I argue, is an organ of (ontogenic) process -of response, not of "information".

#### *A Little Combinatorial Argument:*

A measure of the complexity of the reality with which an organism must deal is the organism's context of information about it. But information is grounded in context. Consider an individual (informational) sensor. It is not enough for a genetic accident simply to provide that sensor. Somehow it must furnish evolutionary advantage and differentially link that sensor to response through its functioning. To be useful as "information", (and retained under the evolutionary process), it must be usable over the range of its possibilities. It must provide *differential response* over that range.

Each sensor, (as an "informational" sensor), must be minimally binary by definition. To be useful as information, (and retained on evolutionary grounds), it must have been utilized or at least connected in both of its possible states. Two sensors -as information, it seems- would have to have been utilized in all four of their possible combined states. But is this true? No, perhaps they might have been used or connected *individually*, (and retained). But then they would not yield *combined* information-i.e. they would not be mutually relevant. Even so, each individual sensor is an evolutionary mutation and each had to be connected to two paths. The evolutionary "work" performed for the two would be 4 units!

Alternatively, suppose evolution simply proliferated sensors hugely and then sampled the combined array under a "Monte Carlo" strategy. Would this work? I think it might, but it would not be "information". It would be *response* instead! Information necessarily embodies context. When we sample a voting population, for instance, we know *what* it is we are dealing with, (i.e. the context of the sample). It is a predictable population. Organisms, or at least primitive organisms, contrarily cannot know the context of their sample beforehand. To be just a little bit cute, organisms are not capable of a "Monte Carlo" strategy. The

only comparable strategy of which they are capable would be a "Russian Roulette" strategy<sup>1</sup> -not a particularly good tactic.

The only context, (the possible sensory array states),<sup>2</sup> in which reality could have meaning *as information* for human organisms is of the magnitude: 2 to the power of  $10^7$ , the latter being Maturana's estimate of total human sensory receptors.<sup>3</sup> Taking each of the 10,000,000 human sensory cells as a minimally binary input device, their informational potential -the context within which information would be received- would be  $2^{10,000,000}$ . Converting the base, this is:

$$=10^{3,010,290}$$

This is a staggering number! The number of all the subatomic particles in the entire known universe,<sup>4</sup> multiplied by the number of seconds in the 4 billion years of evolutionary history is, by comparison, far less than  $10^{102}$ . But the latter number, contrarily, may be considered as a gross upper bound to evolutionary possibility!

### **A Simple Limiting Argument:**

#### **Maximal, (limiting), assumptions:**

- a. From the beginning of evolutionary history there were always less organisms than subatomic particles in the known universe<sup>5</sup> (i.e. less than  $10^{84}$ )<sup>6</sup>
- b. Every organism mutated once every second for this four billion years<sup>7</sup> ( 4 billion times 365 times 24 times 60 times 60 =  $4 \times 10^9 \times 3.1536000 \times 10^7 < 1.3 \times 10^{16} < 10^{17}$

---

<sup>1</sup> e.g. sticking pseudopods into flames -"Monte-Carlo-ing" its way through life!

<sup>2</sup> the set of all combinations of value input from the receptors

<sup>3</sup> Maturana, 1987, estimates that there are  $10^7$  human sensory cells.

<sup>4</sup> T-7, ( $10^{84}$ ) is far greater "than there are subatomic particles in the entire known universe"! Asimov, 1977, P.58

<sup>5</sup> Instead of trying to approximate the possible organisms at any given time, (I started with a Fibonacci series, but abandoned it to a simpler procedure), it suffices to substitute a number greater than the total number of subatomic particles in the universe -surely greater than the required number- for every term. This generates a (gross) upper limit for the series.

<sup>6</sup> Asimov, 1977

<sup>7</sup> If you won't accept this assumption of the mutations per second, multiply it by a few thousands, -or millions, -or even trillions; you are only *adding* to the final exponent -at most a

- c. Every single mutation was beneficial
- d. Not even a single (beneficial) mutation was lost
- e. All mutations were ultimately (somehow) summed into one organism

**Computation:**  $10^{84} \times 10^{17} = 10^{101}$

**Conclusion:** the number of total (beneficial) mutations for the organism named in "e" is less than

$$10^{102.8}$$

**The Argument:**

Assuming a standard bitwise, (i.e. digital), theory of information, this simple argument demonstrates a discrepancy of more than "just a few" (!) orders-of-magnitude between informational possibility and evolution's ability to incrementally embody any significant portion of it in an internal representative model. Even if every single mutation were model defining, it is a 3 millions *order-of-magnitude* discrepancy!

$$10^{102} / 10^{3,010,290} > \text{disparity} > 1 / 10^{3,000,000} !!$$

To get an idea of the scale involved here, listen to Asimov on the disparity in size between a proton and the whole universe: "We find that the number of protons it takes to fill the observable universe is  $4.6 \times 10^{124}$ ." <sup>9</sup> That is, the ratio of the volume of a proton to the volume of the whole universe is  $1 / 4.6 \times 10^{124}$  ! (disparity  $> 1 / 10^{124}$  ) But this is a lesser disparity, (much lesser), than evolution's capacity to flesh out humanity's supposed informational capacity. The

few tens. You could actually raise it to  $10^{10,188}$  times per second without affecting even the literal statement of my conclusions. I suspect that long before you got to this huge number, however, that you would be stopped by the ghosts of Planck and Heisenberg! Surely complementarity suggests that there is a lower limit to the relationship between causality, mass, space and time which can have measurable effects -i.e. "information"!

<sup>8</sup> or, alternately, to  $10^{10,290}$

<sup>9</sup> Asimov, 1977 p.226

huge difference in Asimov's striking example isn't even sufficient to so much as dent the three millions exponent.<sup>10</sup>

Why so great a gap between theory and pragmatic potential? How could "representation" be effected?

Think about simple digital models. Consider just the three "idiot lights" on the dashboard of my decrepit old truck as a primitive instance. All eight of its possible states are relevant to response and, considered as an "information model", it must account for each of them. OFF-OFF-OFF is significant -and allows me carefree driving- only in a context of possibility. In fact one of them, (the oil light), is non-functional and not "information" at all. This simple system, in consequence, does not *qualify* as a representative model. That part of it that *does* qualify as information, (insofar as it *is* "information"), requires an accounting for its context of possibility.

The hypothesis of an internal representative model as the rationale for the sensory system presumes an incremental evolutionary correlation to its context of possibility. Evolution would have had the problem of progressively correlating a model with each, (or some significant portion), of the possibilities of the sensory array -and with potential response as well.

But evolution had less than  $10^{102}$ <sup>11</sup> chances to achieve this correlation. The most optimistic correlation is  $10^{102}$  instances,<sup>12</sup> and the ratio of model correlation to possible sensory states is

$$10^{102} / 10^{3,010,298} < 1 / 10^{3,000,000} !$$

Even if the model itself were taken as an edifice of ( $10^7$ ) actual *internal* binary bits, (paralleling the sensory array), this would only regress the problem. Evolution still would have the problem of incrementally correlating alternative model states with potential response and the numbers would still stand. The odds of a "designed", or even a connected response would still be less than  $1 / 10^{3,000,000}$  -which is as close to zero as I care to consider!<sup>13</sup> It is less, (much less),

---

<sup>10</sup> Envision a celestial turreted microscope. The lowest power is only capable of resolving objects as big as the whole universe. Progressively, the next objective lens is capable of resolving objects as small as a proton. On this "God's-eye" microscope, there would have to be 24,276 objective lenses on the turret, each with an increase in resolution comparable to that between the first two!

<sup>11</sup> alternatively,  $10^{10,290}$

<sup>12</sup> alternatively,  $10^{10,290}$

<sup>13</sup> Alternatively, we would have to assume that *individual* evolutionary mutations could each (accidentally) correlate information to model at a scale of ten to the power of three millions!

than the ratio of the size of a proton to the size of the entire universe. Its *utilization* as "information" would still require an accounting for -and an incremental evolutionary correlation to- its context of possibility. Contrarily, taking my two proposed, (and grossly exaggerated), upper bounds for mutational possibility,  $10^{102}$  and  $10^{10290}$  respectively, the same informational possibility could be embodied in just 339 or 34,162 binary receptors respectively!<sup>14</sup> Why so many sensory possibilities?

The argument applies equally to the possibility of even an isomorphic parallelism of response, ("congruent structural coupling"), as Maturana and Varela have proposed moreover, (as distinguished from the case of an internal, *representative* model). That assumption still requires a correlation to sensory input! (This is the only "trigger" that anyone has postulated.) The (maximum) ratio of "designed" response, (and parallelism), to possible sensory input is less than  $1 / 10^{3,000,000}$ !

In short, we simply have too many sensors to support the "information" scenario -way too many! There are "10" -with three million zeros after it(!) - *times-too-many* sensory possibilities for evolution to have done anything with in the entire history of the universe! Conversely it is quite clear that the entire future of the universe, (assuming a finite model), would be insufficient to dent it either. Shall we talk "parsimony"? Objective reality is a *bound* to the evolution of organisms, it is not a limit which can be matched or paralleled.

Paul Churchland has argued that if each synapse is capable of just 10 distinct states, then the brain is capable of 10 to the power of one hundred trillion, ( $=10^{100,000,000,000,000}$ ), distinct states. This number is impressive and considerably larger than the one I am considering, it is true, but it does not refer to the possibility of acquisition of information, (specifically *as information*), from the environment nor to the possibility of evolutionary correlation to beneficial action -i.e. utilization. Churchland's number, therefore, only amplifies the discrepancy and the argument I have made!

It is evolutionarily plausible, certainly, to consider 10,000,000 sensory inputs as triggers of process. But it is not evolutionarily plausible to think of them as environmentally determinate -i.e. as inputs of information- as this immediately escalates the evolutionary problem exponentially -i.e. to  $2^{10,000,000}$ , (minimally)! Exponents are awesome things.

"Information" and "representation" in whatever form just isn't a viable rationale for the evolution of the brain. I argue that the brain is an organ of ontogenic process. It is an organ of response, not of "information". The function of that organ is to organize primitive biologic process; it is not to represent its

---

<sup>14</sup>  $2^{339} = 10^{102}$  and  $2^{34,162} = 10^{10,290}$

surroundings. Its job is adequate response, not knowingful information. Between knowing and adequacy is a wide gulf. Evolution demands that an organisms' performance be adequate. Nowhere in the physical or evolutionary rationale is there a place for "knowing" save by "miracle".

Objective reality is a *bound* to the evolution of organisms; it is not a limit which can be matched or paralleled.<sup>15</sup> [[View a simple graphic](#)] [[Return to Chapter 1](#)]

---

<sup>15</sup> An objection was made to this argument, (Appendix A), by a mathematician, (an anonymous referee), who invoked a "monte carlo" perspective. An extremely limited random sampling, he argued, is sufficient to sample a huge field of data. The problem I see with his argument is that it presumes a pre-existing *context* within which to orient and evaluate such a sampling. It is the preexistence of that context which allows such a sampling to be meaningful. But how did evolution acquire such a context -the context of information? It is the definition of the context itself which is exponential and to which my argument is entirely relevant.

We, as organisms, do not begin with a given, a priori context *within which* to plan and take advantage of such a "monte carlo" strategy at the level of my argument. It is the assumption of that context itself which, I argue, is *petitio principii*.