Patterns of Form and Behavior: a Brief Introduction

how Platonic Space in-forms evolved, engineered, and hybrid embodied minds

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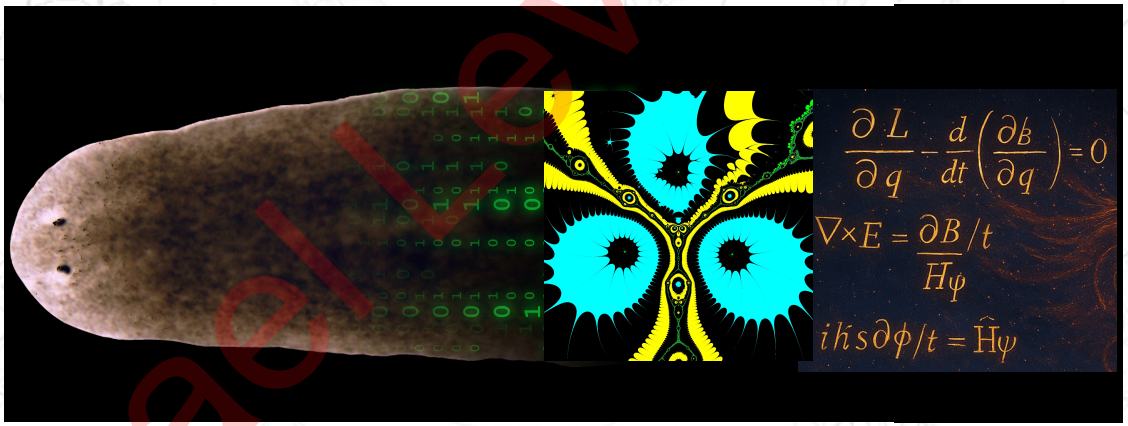

Levin, M. (2025), **Ingressing Minds: Causal Patterns Beyond Genetics and Environment in Natural, Synthetic, and Hybrid Embodiments**, *PsyArXiv*, doi: 10.31234/osf.io/5g2xj_v3

https://osf.io/preprints/psyarxiv/5g2xj_v3

ALLEN DISCOVERY CENTER at Tufts University

Computer-designed Organisms

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Outline:

- Generalize “patterns” = forms of anatomy, physiology, and behavior
- Morphogenesis = homeostatic process *toward* a specific outcome (beyond open-loop complexity and emergence)
- Where do the specific goals come from? (beyond selection and specificity of environment + genetics)
- Platonic space = structured space of patterns that in-forms biology and physics (physicalism is insufficient; causation and explanation)
- Even very simple interfaces get some of the magic (algorithms, and chimeras)
- Research program: study the space, and the mapping

Outline:

- Generalize “patterns” = forms of anatomy, physiology, and behavior

  Proposal for unification, erasing boundaries between disciplines

- Morphogenesis = homeostatic process *toward* a specific outcome (beyond open-loop complexity and emergence)

  Provide experimental evidence of homeodynamic, goal-directed capabilities

- Where do the specific goals come from? (beyond selection and specificity of environment + genetics)

  Provide novel model systems whose properties can’t be pinned on selection

- Platonic space = structured space of patterns that in-forms biology and physics (physicalism is insufficient; causation and explanation)

  Metaphysical position: optimism, not random “regularities”

- Even very simple interfaces get some of the magic (algorithms, and chimeras)

  Provide experimental evidence of minimal systems exhibiting unexpected competencies

- Research program: study the space, and the mapping

  Under way!

Some Key points:

- Strong opinions, loosely held
- "Platonic space" does not mean I'm defending Plato's views

Just piggybacking on the dualism of mathematics in general.

- Controversial extensions of the Mathematical Platonism

Platonic space is home to more than low-agency mathematical objects

Thoughts vs. thinkers (we are patterns, patterns are not passive attractors etc.)

- Preformationism - let's discuss

Explanations, where specific patterns "come from"

- Causality, interactionism

Time, entailment, determination, "because"

- It's woo!

Only in the sense that [staring with set theory (or logic)
and *finding out* the specific value of *e* etc.] is woo
(it is; the biggest woo of all; I have nothing wilder than this to add)

“What breathes fire into the equations?”
Hawking had it backwards

Physics = the behavior of systems constrained by Patterns

"I think that modern physics has definitely decided in favor of Plato. The smallest units of matter are not physical objects in the ordinary sense; they are forms, ideas which can be expressed unambiguously only in mathematical language."

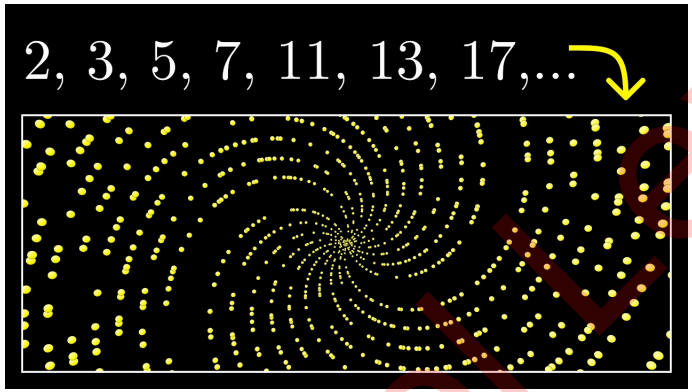
- Werner Heisenberg

"Biology is the study of the larger organisms, whereas physics is the study of the smaller organisms,”

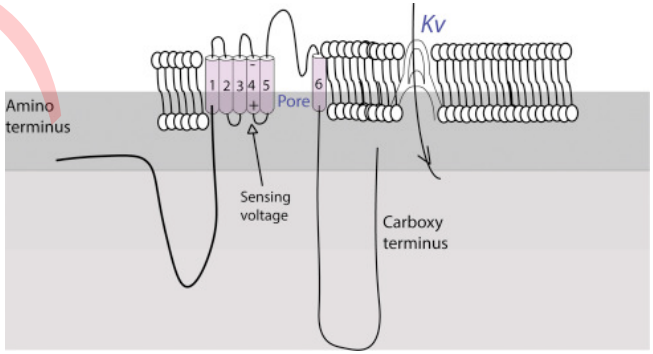
- Alfred North Whitehead

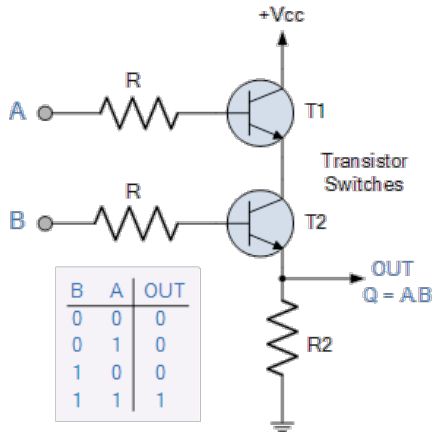
Biology = the behavior of systems elevated by (i.e., which exploit) Patterns

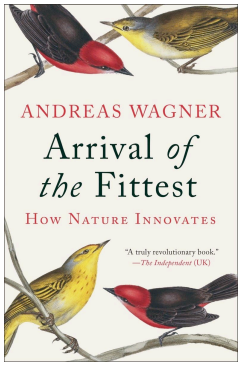
Causality,
Explanations:
Math -> Biology



Biology Exploits Free (Cheap) Lunches







Whence specific goals and competencies if not Selection (history)?!

Evolution exploits free lunches: shapes, behaviors, properties of networks, features of computation, numbers, etc.

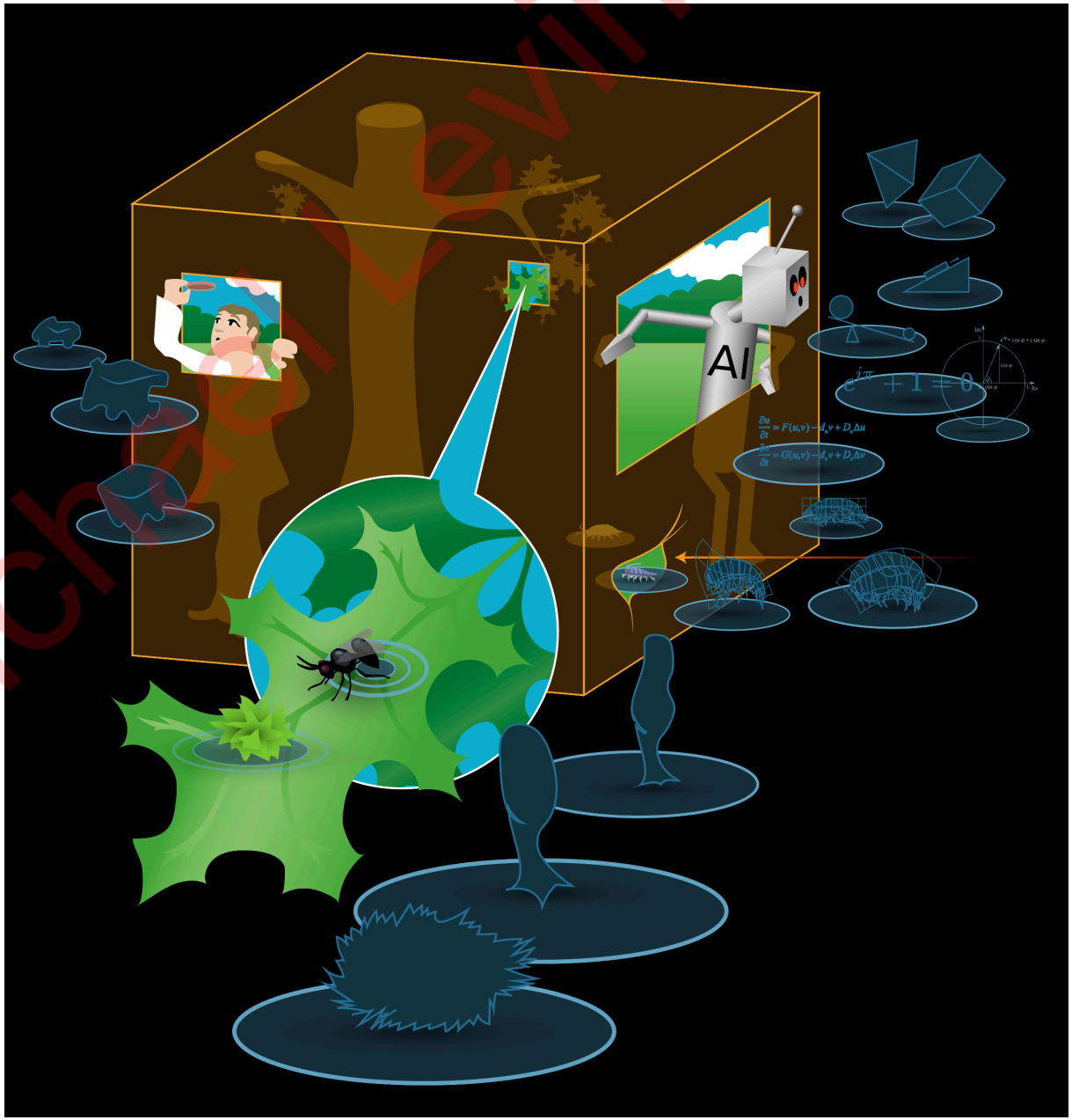
Option 1: there is a random set of amazing "facts that hold" and we will call it "emergence" and be surprised each time

Sparse Ontology -> mysterianism

Option 2: there is an ordered, non-physical latent space of patterns which can be studied systematically

Optimism -> research agenda

Synmorpho beings and minimal algorithms as vehicles for exploring Platonic latent space!



A Very Simple Argument

1. There are specific facts of mathematics, let's call them "patterns" (a.k.a., forms). Examples: value of e, Feigenbaum's constant, facts of number theory and topology, symmetry of SU(2), amplituhedron, etc.

2. There are many specifics which are surprising, and forced on you, once you choose some basic assumptions (very few – just logic, apparently) –> you "get more out than you put in". Start with set theory and get the specific value of *e*.

3. for some such patterns P,
- there are aspects of physics and biology that are *explained* by recourse to the specifics of P. If you ask "why" long enough, you end up in the Mathematics department.
- in contrast, there is no aspect of the physical world (physical events/laws), and no amount of history (biological selection), that explain/set the properties of P
- if P's facts were different, biology and physics would be different.
- it doesn't work in the reverse: there is nothing you can change in the physical world to make P be different.
    - therefore, causality flows from these forms to the physical world (not in the temporal sense).
    - therefore, these facts play important instructive roles. They cannot be ignored if you want to understand and tame evolution, bioengineering, etc.

4. Therefore
- physicalism is a non-viable theory: there are facts that are simply not "in" the physical world in any useful sense of "physics". Pythagoras knew this already. Let's call the space of possible properties of P's "the Platonic Space".

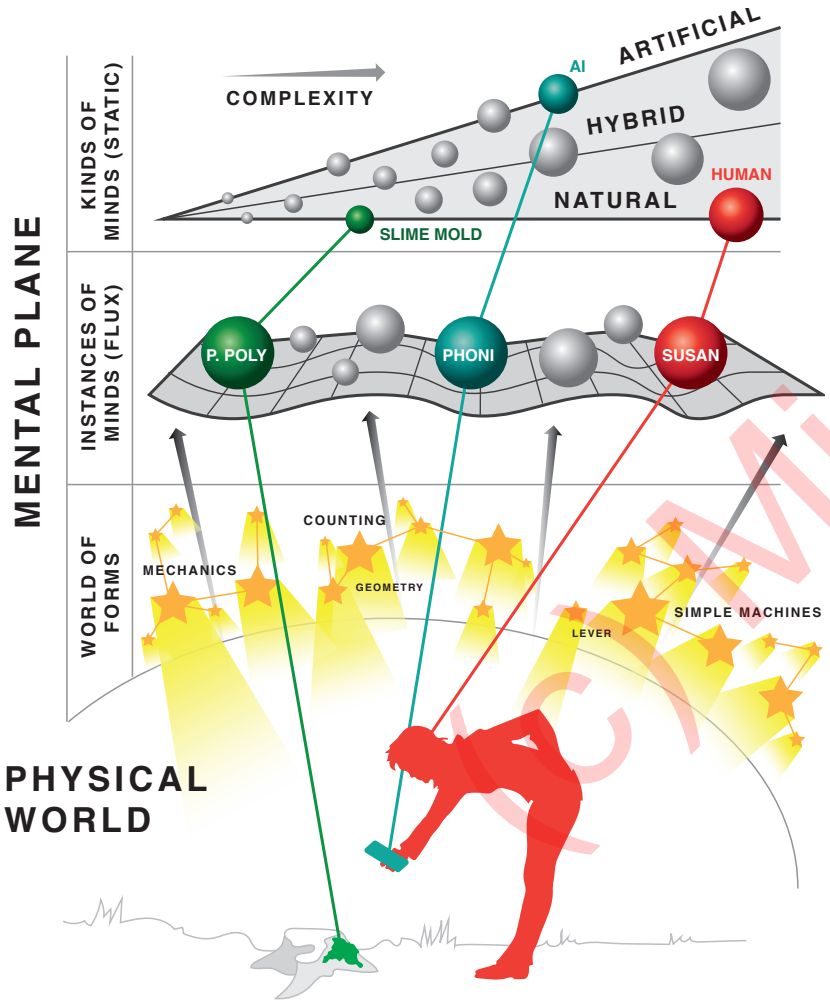
5. Optional hypotheses: (optimistic metaphysical claim)
- P is drawn from a distribution that's not a random collection but a structured space
- therefore, we have a research program: map the space, understand relationship between interface and which P it channels.

5. Skeptical position: we cannot assume that low-agency models of math encompass all the residents of this Space. Some may be better described by behavioral science tools.
- therefore, some of the patterns that ingress into physics and biology may be "kinds of minds".
- therefore, Dualism is viable. We already knew it was true in physics and biology; this suggests it's also relevant in cognitive science.

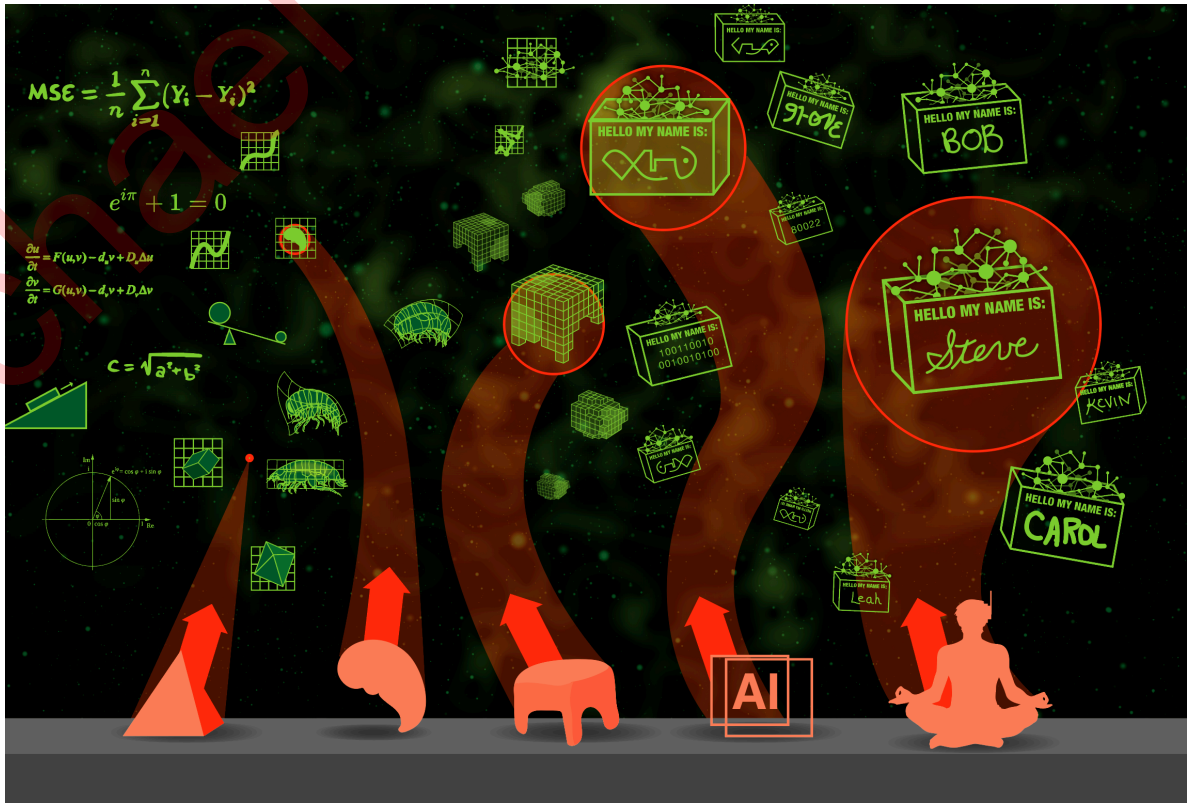
7. Skeptical position: we cannot assume that biological materials, evolutionary search, etc. have any monopoly on hosting those patterns.
- therefore, perhaps algorithms/robots should be searched for surprising ingressions that are not just complexity or unpredictability, but well-understood cognitive competencies.

Beyond Low Agency (?) Mathematical Truths - Behavioral Patterns (a.k.a., minds)

Math = the behavioral science of a specific layer of the Platonic Space
(those forms that are amenable to certain classes of precise formal models)

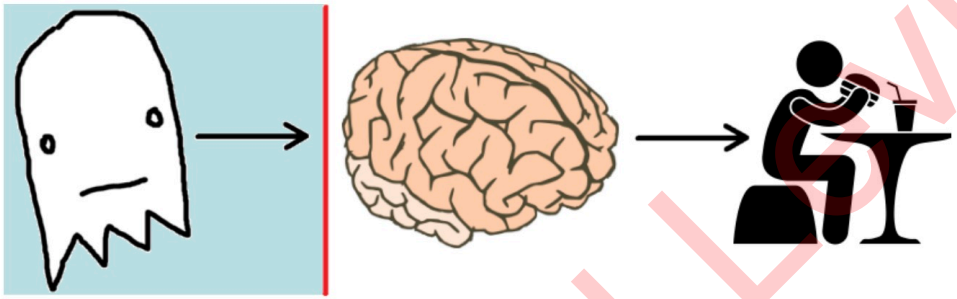


What else inhabits it?



But isn't Interactionism Dead?

But if the mental state is non-physical, how does it transfer over into the physical world and cause things to happen?



How does the non-physical mental state (left) **cross over into the physical world** (over the red line) and cause changes in my brain and in my behaviour?

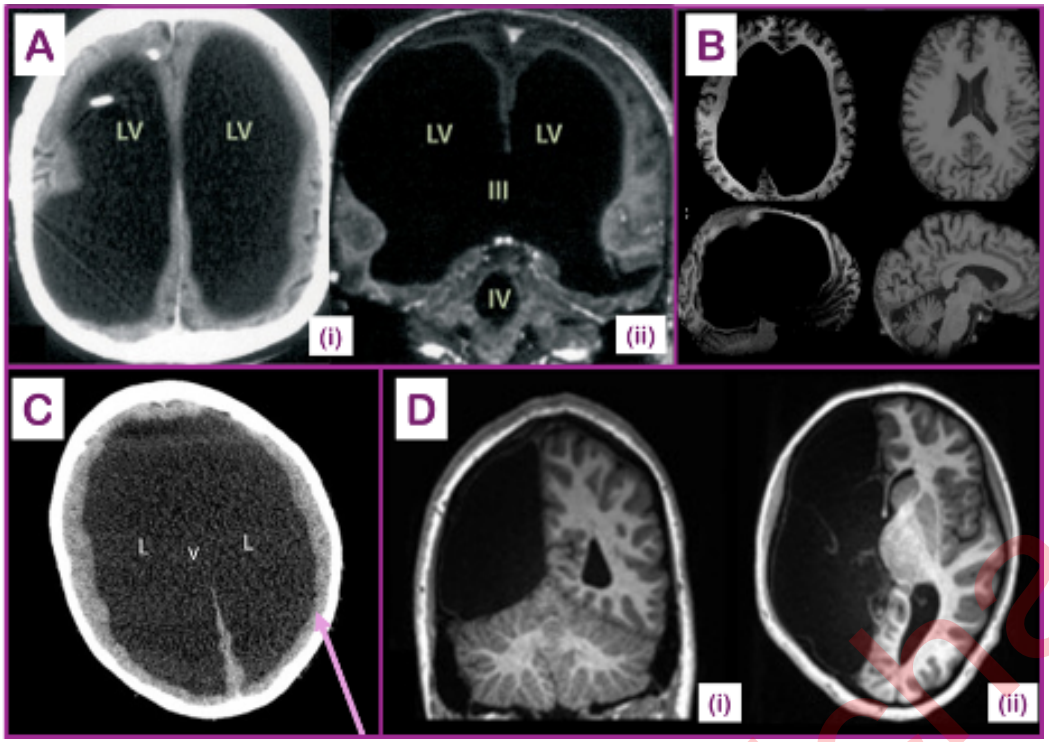
https://philosophyalevel.com/aqa-philosophy-revision-notes/dualism/

physicalism was already dead in Newton's universe because it was haunted by the laws of mathematics. No QM needed.

the explanation, the *reason* (driver) for facts of particle physics, and aspects of biology (Cicada timing, On Growth and Form, etc.) are facts of mathematics. Epiphenomenalism is as hopeless for math as for mind.

math :: physics = mind::body

The Brain as Thin Client, Biology as Interface



Minimal brain structure

or function (Savant syndrome)

cases of high performance!

Mind & Matter **23**(1), 13-69 doi: 10.5376/mm2025.13

Cases of Unconventional Information Flow Across the Mind-Body Interface

Figure 2. Select cases of reductions in brain matter with normal function. **[A]** Image from (Feuillet *et al.* 2007) showing a white collared worker case of extreme hydrocephalus**;** he led a normal life as a civil servant, who possessed an average IQ of 75. During his neurological assessment at age 44, his (i) CT scan and (ii) T1 weighted MRI scans with contrast showed extreme ventricular enlargement**.** LV indicates lateral ventricle, III and IV indicate the third and fourth ventricles, respectively. **[B]** Image from (Alders *et al.* 2018), showing the case of a 60-year-old with a bad mood with massive ventriculomegaly and severely reduced cerebral mantle and corpus callosum, that went largely unnoticed. The left column is T1 weighted MRI images taken in the transverse, coronal, and sagittal planes of the patient. The right column represents T1 weighted MRI scans of a healthy control. **[C]** Image from (Persad *et al.* 2021), imaging of a Canadian living a normal, independent life with massive hydrocephaly. MRI scan taken from the axial view (plane parallel to the ground) at the level of the lateral ventricles (arrow points to extremely thin layer of cortical mantle, LV stands for Lateral Ventricle). **[D]** Image from (Asaridou *et al.* 2020), showing the T1 Weighted MRI scans of a child born without left hemisphere (i) taken in the coronal plane, (ii) taken in the axial plane. The child had normal cognitive development and language skills despite hemihydranencephaly of the left hemisphere and near-absence of the corpus callosum. All images re-used with permission.

Humility Warning: neither digital nor biochemical "machines" are only what our formal models say they are

nothing **is** a TM, not even a TM

Magritte

- Minds are not fully defined by our models of them, neither for their limitations nor for their competencies.
- Partly because our models (CS, physics, biology) are models of the front end only.

Summary:

- Patterns of form (in 3D space, and in other spaces = behavior) are ubiquitous
- They serve as goals for minimal agents' problem-solving competencies
- Genetics + emergence is insufficient; emergence itself is mysterian and limiting
- Novel forms, which can't be pinned on history of selection, require new models

Hypotheses, Speculations, and Implications:

- Patterns exist which are not determined by history or facts of physics; like facts about mathematical objects.
- Physical objects (simple machines, cells, embryos, cyborgs, swarms, robots, etc.) are pointers into a space of these patterns - interfaces through which non-physical influences ingress into the physical world
- Evolution exploits these free lunches massively, and so can bioengineers! (So, it's not just philosophy - it matters for practical reasons).
  - Physics is what we call things that are *constrained* by these patterns;
  - Biology is what we call things that are *enabled* by and exploit these patterns.
- This magic is not quantum, it already exists in a deterministic, classical world because even Newton's universe was already "in-formed" by truths of mathematics which affect it but are not determined by its properties; embryos are haunted by morphogenetic patterns as triangular objects are haunted by facts of geometry.
- Mind::Brain as Math::Physics. We *are* patterns in the Platonic Space, along with other denizens. Math = the behavioral science of certain kinds of objects in that space (the low agency ones?).
  - Reasons = your interface is controlled by high-level Patterns; Causes = it's controlled by low-level Patterns; it's all a continuum.
  - "Free Will" = degree to which your current interface (determined by genetics, physics, and *your past history of action*) enables your highest Form to come through un-tarnished by others' or low-level forms

Research Program:

- Build new interfaces to observe new ingressing forms - our synthetic morphology work provides tools/vehicles/periscopes for exploration of the space.
- Infer a rigorous mapping between properties of the pointers and the patterns they facilitate.
- Quantify the “free lunch” aspects - how much information/influence/ evolvability is injected into the physical world? Free compute?
- Are the contents of this space under positive pressure?
- Is the space sparse? Are some attractors “better” than others?
- Are the contents of this space purely passive (eternal, unchanging) or can we define a kind of “chemistry” of how these things interact and live in their own space?
- Are mathematical objects really “low agency”? Can we extend standard behaviorist tests to their native space?
- Why? Where did the Platonic Space and its structure/contents ‘come from’? Could it have been otherwise?