Psychology 2.0:
The Emergence of Individuality

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Author's Note

The ideas discussed here were inspired by my work on computational models of learning and by 15 semesters of teaching Abnormal Psychology and Theories of Personality - that is, repeated attempts to organize this information in a coherent progression and to integrate it in the broader scientific enterprise. This work has been discussed, in various stages of development, in Popa, 2015; 2016; and 2017. This document aims to provide a concise outline of the main thesis.

1. PREMISE

Physical forces acting on particles explain how physical systems change over time. Evolutionary forces acting on populations of genomes explain change in the genetic structure of populations across generations. The dynamics of development, i.e., change in psychological systems, is not yet understood. This is a step in that direction.

***When* did we become who we are?**

Modern psychological explanations recognize that human development is influenced by biological, psychological, and sociocultural variables, variables that interact in complicated ways throughout an individual's lifetime (any textbook).

***How*, *when*, and *where* do these variables *interact*, exactly?**

How does society *influence* biology?
Where do genes *interact* with families?
How do nature and nurture *mediate* each other?

If one would want to *observe* and *influence* these *interactions*, where would one begin?

A handful of bio-psycho-sociocultural variables, somehow, give rise to seven billion unique personalities. *How*? Statistical jargon aside, to *interact* is to *modify*: something, somewhere, must undergo some kind of observable transformations.

When and where do these transformations occur?
How do they map on the plethora of contributing factors and developmental outcomes?
What are *sentience*, *agency*, *will*? What role, if any, do they play in human life?

2. WHAT IS BEING CHANGED: A PROPOSAL

Neurons are located in a confined, 3-dimensional space. A neuron can be in one of two states: 1 or 0. The configuration of neurons that "fire" in a given time window (e.g., 100ms) changes continuously, as action potentials travel from cell to cell.

The succession of configurations of active neurons is the material counterpart of all forms of *experience* and *expression*[1] and the interface between biology and culture, agent and environment, vulnerability and stressors, etc.

All high-level structures, like personality traits, psychological disorders, cognitive strategies, parenting and attachment styles, etc. *emerge* from this low-level dynamic, from the succession of configurations of activation states.

Every variable that contributes to the emergence of such structures, does so by interfering with this dynamic, either directly or indirectly, by affecting properties of the brain that affect neuronal activity (e.g., the number and distribution of neurons, speed of transmission, frequency and length of synapses, white/grey matter ratio, etc.).

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[1] **experience**: everything that is traditionally referred to as input, sensation, memory, context, stimulus, discriminative stimulus, reinforcer, family, culture, environment.

expression: everything that is traditionally referred to as output, behavior, response, decision, activity, exhibited, etc. (e.g. thinking, imagining, disorders, personality, will, sentience, heuristics, algorithms, language, behavior, response, self, attitude,)

all: psychology is *written* in neuronal activity, just like evd.py is written in Python; all information needed to modify the phenomenon is coded in the succession of configurations of active neurons;

2.1. Key features

Close as it comes to the brain without being brain, *per se*.

- Causally speaking, changes in neuronal activation states begin after physicochemical changes, and *before* psychological phenomena, like cognitive, behavioral, emotional reactions.

Fast and sensitive enough

- *to react* to any immediate experience, no matter how subtle or short-lived (e.g., "a look", subtle voice inflections, etc.) and
- *to be proximate cause* for every form of expression (e.g., implicit cognition, thinking, carrying a conversation, ruminating, etc.)

Complex and versatile enough to represent (i.e., "encode") the richness of psychological dimensions and phenomena.

Domain independent; common, binary-based representation for all psychological phenomena.

Amenable to scientific investigation:

- Structures that can be described in terms of nodes and edges - like neurons and synapses - are called graphs. The *transition* between any two consecutive configurations of active neurons is equivalent to *morphing* graph A into graph B, *ad infinitum* (Figure 1).

- These structures can be described mathematically (e.g., Reimann et al., 2017) and the transformations can be represented computationally.

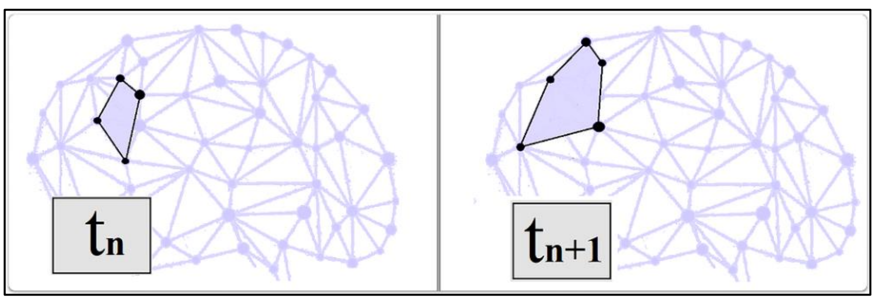


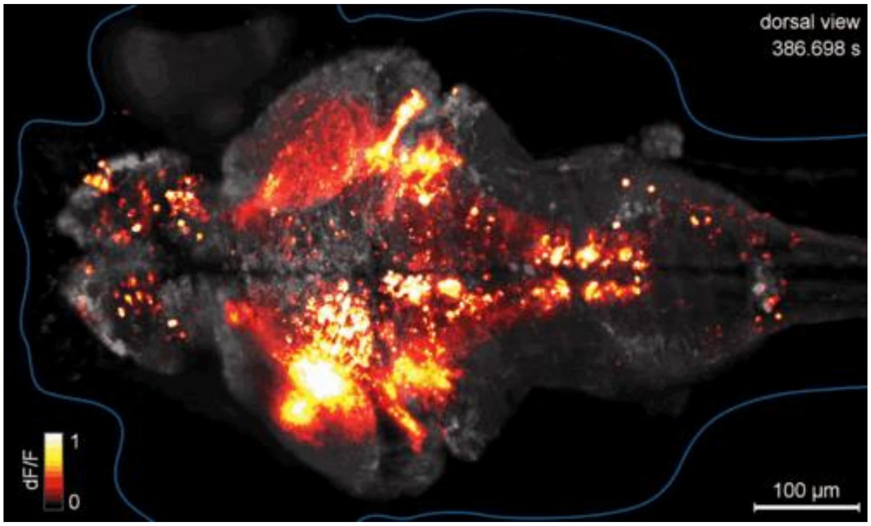
Fig. 1. The *transition* between two configurations of active neurons is equivalent to transforming on graph (t_n; left) into another (t_{n+1}; right panel).

- Computational findings can then be used to guide experiments with biological agents and vice-versa: laboratory findings can fuel theoretical developments.

3. HOW DOES ONE CONFIGURATION *BECOME* ANOTHER?

Efforts to map the graph's structure are well under way (think connectome; Seung, 2012). In addition, we must also identify the basic rules (i.e., "forces", "principles", etc.) that transform one configuration into another, thus shaping, little by little, an initial structure into a mature connectome, i.e., the dynamics of *development*, *learning*, or *adaptation*.

One approach to identify principles of change is to use computational models to implement theories of *neuronal dynamics* and to simulate their *behavioral-cognitive* outcomes. The evolutionary framework is a strong candidate (see McDowell, 2010, for a relevant reading; until supporting materials will become available, see also Popa, 2013). In parallel, one can start from raw data - recordings of neurons (Figure 2) - and use machine learning to "deduce" possible rules or to eliminate impossible ones. The two approaches can inform and verify each other in interesting ways.



Retrieved: https://www.cell.com/current-biology/fulltext/S0960-9822(13)00002-X

Fig. 2. Recent advancements in neuroscience (e.g., Muto et. al., 2013) made it possible to record the succession of activation states in simpler organisms during key activities, like stalking prey. Such methodologies can be used to further our understanding about the relation between stimuli, neuronal activation, and approach/avoidance behavior, knowledge that can be used to further verify computational theories of neuronal dynamics, and so on.

4. THE SHAPE OF WILL

If *will* can manifest itself in the material world, then it must impact neuronal activity in observable ways (see Libel, 1985); same goes for *agency*, *intentions*, *expectations*, etc. The huge number of neurons that may go in these phenomena will pose a challenge. On the other hand, the differences of interest should be detectable in a short time window (e.g., 1000 ms). The search for their neuronal signatures can begin by studying the alternatives (e.g., involuntary, unintentional, etc.). They are easier to define and can be provoked systematically in laboratory conditions, independent of the participant, which makes them useful baselines. Any systematic perturbations in baseline would be worth exploring further.

For example (below), pick a simple behavior, like moving an index finger, and compare neuronal activity in scenarios A, B, and C. Whatever is in B but not in A could be an indicator of *agency*, or *intentionality*; whatever is unique to C could be a neuronal signature of *trying*, or *mental effort*; etc.

(A)	Participants move their index when instructed, for *n* seconds.	*going along*
(B)	Participants *decide* when to move the index and for how long.	*choice/agency*
(C)	Move index by stimulating the brain; instruct participants to resist.	*refuse/will/try*

5. IMPLICATIONS FOR ARTIFICIAL INTELLIGENCE AND TRANSHUMANISM

A working framework for the emergence of individuality will have far-reaching implications, from social policy, to artificial intelligence, human augmentation, etc. One of the questions that emerges is how much does biochemistry matter? Is organic material necessary, or is it just "the best evolution could do", not engineering, but doodling mindlessly for too many years? If only neuronal activity is essential, does it mean that any medium would do? Can the same phenomena be created from a different material? Can this dynamic be recorded, “cloned” in digital form? If yes, if one does “clone” the nervous system of a human, what exactly has one achieved? The way we will engage such questions will define the evolutionary trajectory of our species.

6. SUMMARY

The succession of configurations of active states is proposed as the "vehicle of change" in psychological systems and the material and conceptual "bridge" between high-level theories of brain functioning (e.g., Edelman's Neuronal Darwinism) and theories of behavior change (e.g., Skinner's Behavioral Darwinism; see McDowell, 2010, for a parallel). It is the proposed "medium" for all forms of expression and experience; as the "interface" between biology and culture; between nurture and nature; the "source code" of thinking, of doing, of being who we are. We are being written in it as we happen, by low-level Darwinian tendencies (behaviorally manifested as *approach* and *avoidance*), with a splash of consciousness.

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