Understanding Our Livewired Brains

By Jim Myers

Dr. David Eagleman wrote about comparing a Komodo dragon born today with a Komodo dragon born thirty thousand years ago.

> Komodo dragons come to the table with **a brain that unpacks to approximately the same outcome each time**. **The skills on their resume are mostly hardwired** (eat! mate! swim!), and **these allow them to fill a stable niche in the ecosystem**. But they're **inflexible workers**. If they were airlifted from their home in southeastern Indonesia and relocated to snowy Canada, there would soon be no more Komodo dragons.

Next Dr. Eagleman compared humans that were born in the same time periods.

> Humans thrive in ecologies around the globe, and soon enough we'll be off the globe. What's the trick? It's not that we're tougher, more robust, or more rugged than other creatures: along any of these measures, we lose to almost every other animal. Instead, it's that **we drop into the world with a brain that's largely incomplete**. As a result, **we have a uniquely long period of helplessness in our infancy**. But that cost pays off, because **our brains invite the world to shape them** — and this is how **we thirstily absorb our local languages, cultures, fashions, politics, religions, and moralities**. Dropping into the world with a half-baked brain has proven a winning strategy for humans. **We have outcompeted every species on the planet**: covering the landmass, conquering the seas, and bounding onto the moon. **We have tripled our life spans**. **We compose symphonies, erect skyscrapers, and measure with ever-increasing precision the details of our own brains**. **None of those enterprises were genetically encoded**.
>
> At least they weren't encoded directly. Instead, **our genetics bring about a simple principle**: **don't build inflexible hardware; build a system that adapts to the world around it**. **Our DNA is not a fixed schematic for building an organism**; rather, **it sets up a dynamic system that continually rewrites its circuitry to reflect the world around it and to optimize its efficacy within it**.

> The thrill of life is not about who we are but about **who we are in the process of becoming**. Similarly, the magic of our brain lies not in its constituent elements but **in the way those elements unceasingly reweave themselves to form a dynamic, electric, living fabric**.

The brain controls most of the body's activities, including movement, thoughts, emotions, and sensory processing. It also regulates automatic functions like breathing and heart rate, making it essential for survival and daily functioning. The brain is created by a DNA code, which created the entire human body.

Reading just a little over a page in this newsletter has already changed your brain: the symbols (letters) on the page have orchestrated millions of tiny changes across the vast seas of your neural connections, crafting you into someone just slightly different than you were at the beginning.[1]

Quick Review

1. DNA is not a fixed schematic for building an organism. We drop into the world with a brain that's largely incomplete and have a uniquely long period of helplessness in our infancy.

2. Our genetics bring about a simple principle: don't build inflexible hardware; build a system that adapts to the world around it. Our brains invite the world to shape them by setting up a dynamic system that continually rewrites its circuitry to reflect the world around it and to optimize its efficacy within it. We thirstily absorb our local languages, cultures, fashions, politics, religions, and moralities.

3. The brain controls most of the body's activities and regulates automatic functions. The brain is essential for survival and daily functioning.

[1] *Livewired: The Inside Story of the Ever-Changing Brain* by David Eagleman © 2020, Pantheon Books, New York, NY; pp. 9-10, 16.

The Functions of the Human Brain

Now I will return to the story that Dr. David Eagleman wrote.

> Brains are not born into the world as blank slates. Instead, **they arrive pre-equipped with expectations**.
>
> > Consider the birth of a baby chicken: moments after hatching, it wobbles around on its little legs and can clumsily run and dodge. In its environment, it simply doesn't have time to spend months or years learning how to move around.
>
> **Human infants come to the table with a good deal of pre-programming**.
>
> > Take the fact that we come pre-equipped to absorb language. Or that babies will mimic an adult sticking out her tongue, a feat requiring a sophisticated ability to translate vision into motor action. Or that fibers from your eye don't need to learn how to find their targets deep in the brain; they simply follow molecular cues and hit their goal — every time. Or that babies will mimic an adult sticking out her tongue. A feat requiring a sophisticated ability to translate vision into motor action. Or that fibers from your eye don't need to learn how to find their targets deep in the brain; they simply follow molecular cues and hit their goal – every time. **For all this sort of hardwiring, we can turn to our genes**.
>
> However, genetic hardwiring does not provide the whole story, especially for humans. The system's organization is too complex, and the genes are far too few. Even when you take into account the slicing and dicing that produces many different flavors of the same gene, the number of neurons and their connections vastly outstrips the number of genetic combinations. So we know that **the details of brain wiring involve more than the genetics**.[2]
>
> The first lesson is that **the fine structure of the brain reflects the environment to which it is exposed** . . . As we'll learn shortly, **world experiences modulates almost every measurable detail of the brain, from the molecular scale to overall brain anatomy**.

[2] *Livewired: The Inside Story of the Ever-Changing Brain* by David Eagleman © 2020, Pantheon Books, NY, NY; p. 17.

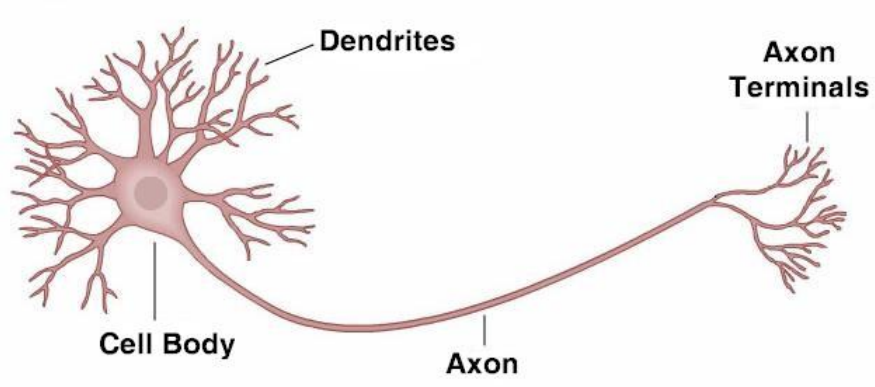
Despite some genetic pre-specification, **nature's approach to growing a brain relies on receiving a vast set of experiences, such as social interaction, conversation, play, exposure to the world, and the rest of the landscape of normal human affairs**. **The strategy of interaction with the world allows the colossal machinery of the brain to take shape from a relatively small set of instructions**. *It's an ingenious approach for unpacking a brain (and body) from a single microscopic egg*.[3]

Quick Review

1. Nature's approach to unpacking the colossal machinery of the brain relies on a relatively small set of instructions because of the strategy of interaction with the world.

2. Growing a brain relies on receiving a vast set of experiences, such as social interaction, conversation, play, exposure to the world, and the rest of the landscape of normal human affairs.

The Social Life of Neurons



To understand even the basics of how the brain functions, we need to learn about **neurons**, because the human brain has about **86 billion neurons**, of which **30 billion** make up the main information processing area called **the cortex**. A *neuron* is the basic cell type of the nervous system. It is typically called a "*brain cell*."[4]

[3] *Livewired: The Inside Story of the Ever-Changing Brain*; p. 22.
[4] *Behave: The Biology of Humans at Our Best and Worst* by Robert M. Sapolsky © 2017; Penguin Press, New York, NY; p. 680.

- The inputs of a *neuron* are called *dendrites*.

- The impulse travels down a single long cable called an *axon* -- a long thin tube that is electrically active.[5]

- The axon then splits up into branches called axon terminals which are the outputs.

- Axon terminals connect to dendrites of other neurons.

The information above is the standard textbook model, but it is inadequate because it misses the most interesting part of the story. **The brain is a dynamic system, constantly altering its own circuitry to match the demands of the environment and the capabilities of the body.** If you had a magical video camera with which to zoom in to the living, microscopic cosmos inside the skull, **you would witness the neurons' tentacle-like extensions grasping around, feeling, bumping against one another, searching for the right connections to form or forgo, like citizens of a country establishing friendships, marriages, neighborhoods, political parties, vendettas, and social networks.** *Think of the brain as a living community of trillions of intertwining organisms.*

Much stranger than the textbook picture, **the brain is a cryptic kind of computational material, a living here-dimensional textile that shifts, reacts, and adjusts itself to maximize its efficiency**. **The elaborate pattern of connections in the brain -- the circuitry — is full of life**: **connections between neurons ceaselessly blossom, die, and reconfigure**. You are a different person than you were at this time last year, because **the gargantuan tapestry of your brain has woven itself into something new**.[6]

Quick Review

1. The human brain has about 86 billion neurons which are like a living community of trillions of intertwining organisms.

2. Their tentacle-like extensions are grasping around, feeling, bumping against one another, searching for the right connections to form or forgo.

[5] http://umdberg.pbworks.com/w/page/84111850/Capacitance%20in%20nerve%20cells
[6] *Livewired: The Inside Story of the Ever-Changing Brain*; pp. 7-8.

3. The brain is a cryptic kind of computational material, a living here-dimensional textile that shifts, reacts, and adjusts itself to maximize its efficiency.

4. Connections between neurons ceaselessly blossom, die, and reconfigure.

The Seven Principles of Livewiring

1. Brains match themselves to their input. ***Reflect the world***.

2. Brains leverage whatever information streams in. ***Wrap around the inputs***.

3. Brains learn to control whatever body plan they discover themselves inside of. ***Drive any machinery***.

4. Brains distribute their resources based on relevance. ***Retain what matters***.

5. Some parts of the brain are more flexible than others, depending on the input. ***Lock down stable information***.

6. Plasticity emerges from a struggle for survival of the parts of the system. ***Compete or die***.

7. The brain builds an internal model of the world, and adjusts whenever predictions are incorrect. ***Move toward the data***.

   Livewiring is quite possibly the most gorgeous phenomenon in biology. Because of livewiring, we are each a vessel of space and time. We drop into a particular spot on the world and vacuum in the details of that spot. We become, in essence, a recording device for our moment in the world.

   But livewiring is more than a jaw-dropping curiosity of nature; it is the fundamental trick that allows for memory, flexible intelligence, and civilizations. It is about finding oneself without the tools for a job and fine-tuning the brain to create those tools. Livewiring is the mechanism through which evolution by natural selection is relieved of some impossible pressures: instead of predicting every eventuality, brains can adjust billions of parameters on the fly to meet the unforeseen.

> Of all the objects our species has discovered on the planet, nothing rivals the complexity of our own brains. The human brain consists of eighty-six billion cells called neurons: cells that shuttle information rapidly in the form of traveling voltage spikes. Neurons are densely connected to one another in intricate, forest-like networks, and the total number of connections between the neurons in your head is in the hundreds of trillions (around 0.2 quadrillion). To calibrate yourself, think of it this way: there are twenty times more connections in a cubic millimeter of cortical tissue than there are human beings on the entire planet.

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Exploring the Bible, Biblical Heritages, and Livewiring

In September 1991, a German couple hiking in the Tyrolean Alps came across a dead body. The bottom 90 percent of the body was frozen solidly into the glacial ice; only the head and shoulders were exposed. The man in the ice was perfectly intact and freeze-dried. The bodies of several wayward mountain climbers had been found in these mountains over the years, but this discovery was different. This man froze here five thousand years ago. The frozen specimen came to be known as the Tyrolean Iceman and was given the name Otzi. One can gather a tremendous amount of data from a body, because a body is shaped by its experiences. As we've seen, a much more specific shaping takes place in the brain. At some point we might perhaps be able to read the rough details of someone's life — what he did and what was important to him -- from the exact molding of his neural resources. If feasible, this would amount to a new kind of science.

Otzi died about 3,000 years before Abraham was born. Scientists have also recovered DNA from people who lived long before Otzi. Therefore, Exploring the Bible and Biblical Heritages must include an awareness of the effects of "Livewiring." ***BHC***

[7] *Livewired: The Inside Story of the Ever-Changing Brain*; pp. 244-245.