

Towards neural mechanisms of intelligence:

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W boson mass 0.1% > predicted by Standard model

Standard Model of Elementary Particles

	three generations of matter (elementary fermions)			three generations of antimatter (elementary antifermions)			interactions / force carriers (elementary bosons)	
	I	II	III	I	II	III		
mass	≈2.2 MeV/c ²	≈1.28 GeV/c ²	≈173.1 GeV/c ²	≈2.2 MeV/c ²	≈1.28 GeV/c ²	≈173.1 GeV/c ²	0	≈124.97 GeV/c ²
charge	2/3	2/3	2/3	-2/3	-2/3	-2/3	0	0
spin	1/2	1/2	1/2	1/2	1/2	1/2	1	0
	u up	c charm	t top	ū antiup	c̄ anticharm	t̄ antitop	g gluon	H higgs
	d down	s strange	b bottom	d̄ antidown	s̄ antistrange	b̄ antibottom	γ photon	
	e electron	μ muon	τ tau	e⁺ positron	μ̄ antimuon	τ̄ antitau	Z⁰ Z ⁰ boson	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	ν̄_e electron antineutrino	ν̄_μ muon antineutrino	ν̄_τ tau antineutrino	W⁺ W ⁺ boson	W⁻ W ⁻ boson

The Standard Model
 Quantum Physics, Relativity
 Newton's laws
 Kepler's laws
 Galileo

$$\begin{aligned}
 & \text{Tr}[\bar{\epsilon}(x)\gamma_\mu \tilde{h}(x,y)\tilde{G}(y,x)\gamma_\nu \lambda(x) - \bar{\epsilon}(y)\gamma_\mu h'_{\nu\mu}(x,y)\tilde{G}(y,x)\gamma_\nu \lambda(x)] \\
 &= \int d^4x \int d^4z \frac{e^{-z^2/4t}}{16\pi^2 t^2} \text{tr} \left\{ \bar{\epsilon}(x)\gamma_\mu \sum_{n=0}^{\infty} \sum_{m=0}^{\infty} \left[\frac{(z \cdot \bar{\partial})^m}{m!} [\bar{a}_n \delta_{\mu\nu} - (a'_n)_{\nu\mu}] \Big|_{y=x} \right] \tilde{G}(x+z,x)\gamma_\nu \lambda(x) \right. \\
 & \quad \left. - \sum_{l=1}^{\infty} \frac{(z \cdot \partial)^l}{l!} \bar{\epsilon}(x)\gamma_\mu \sum_{n=0}^{\infty} \sum_{m=0}^{\infty} \left[\frac{(z \cdot \bar{\partial})^m}{m!} (a'_n)_{\nu\mu} \right] \tilde{G}(x+z,x)\gamma_\nu \lambda(x) \right\}, \tag{53}
 \end{aligned}$$



What's so special about the brain?

Slow, sloppy, sleepy & **Efficient**



20W

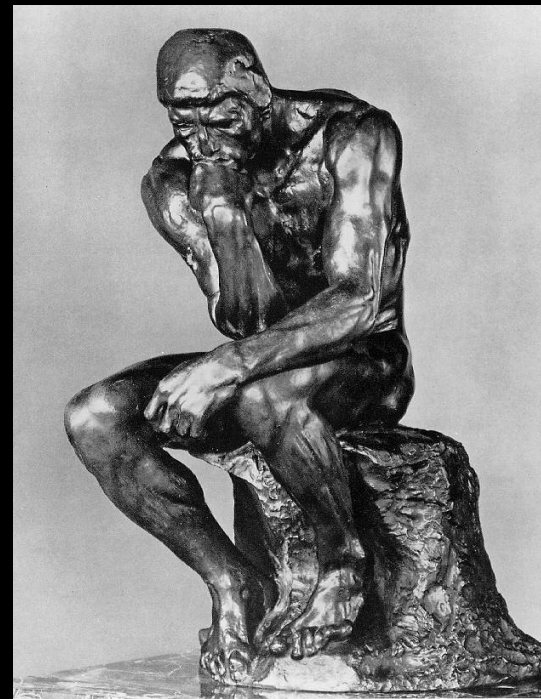
10^3Hz

10^{11}

20KW

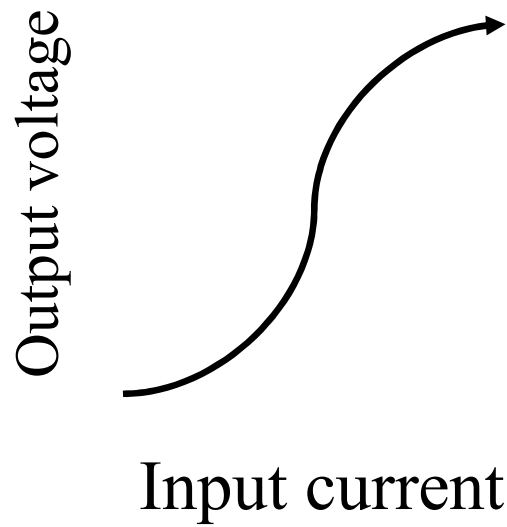
10^9Hz

$>10^{11}$



ReLU

$$\text{Response} = \tanh(\text{input})$$



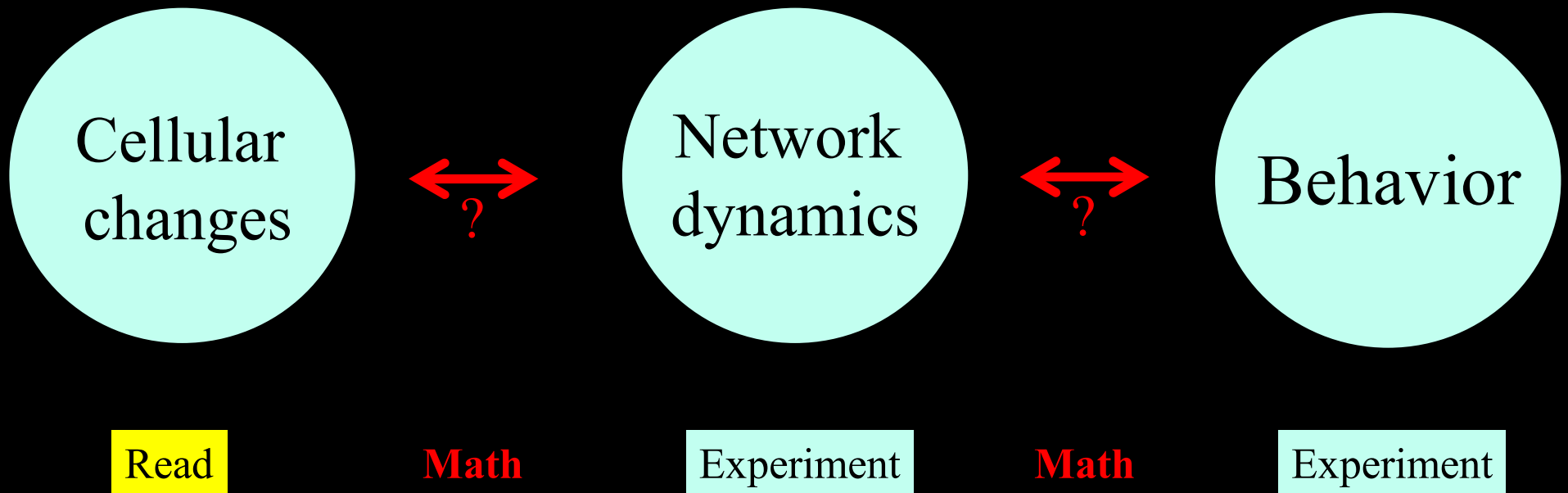
We can introspect about the mind
not the brain

**Regular Spiking
Pyramidal Cell:
Visual Response**

Space & Time



Emergent Learning



Neuronal soma are the fundamental unit
of neural computation: Digital code

