

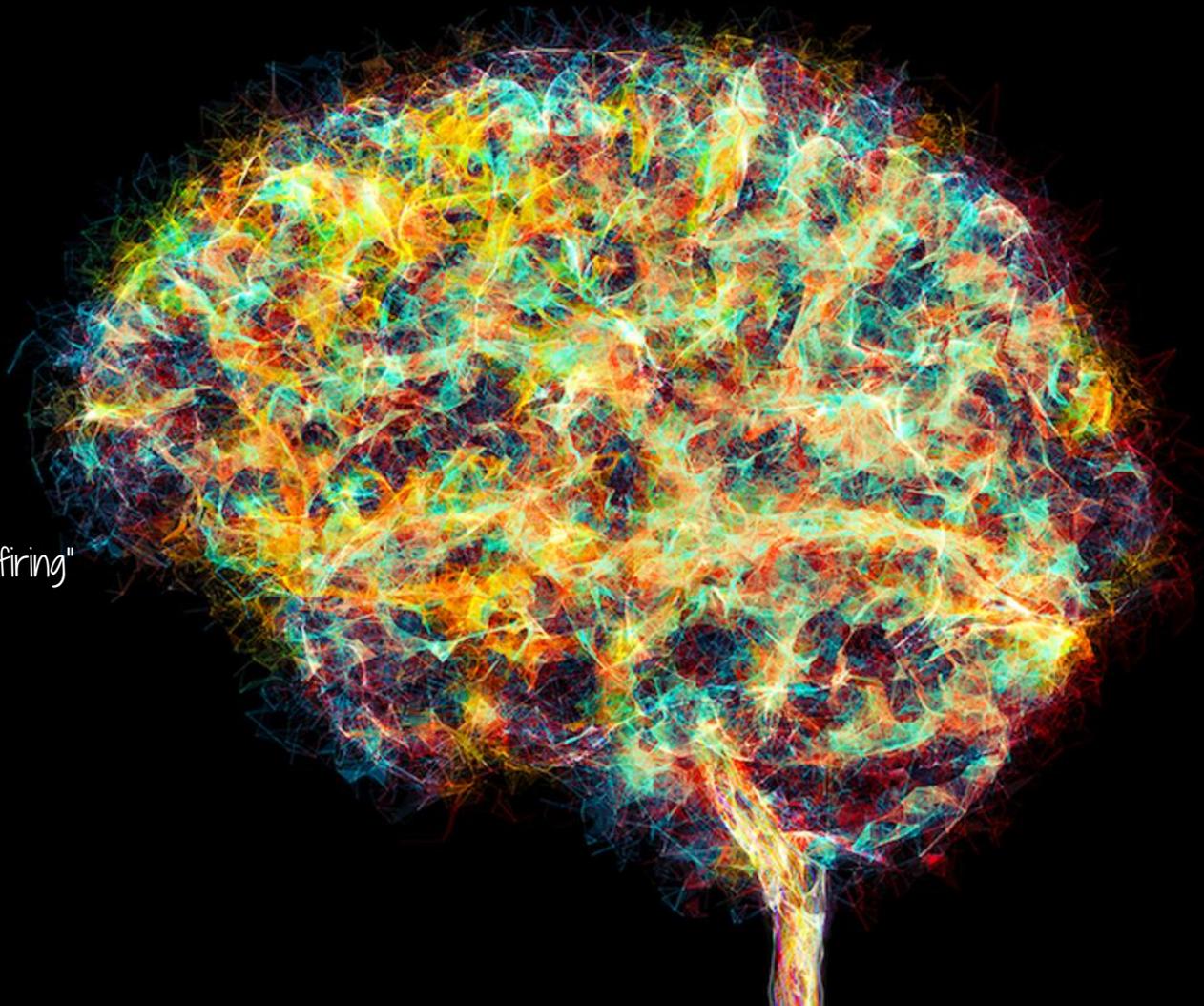
# IMPLICATIONS OF THE FIRE/WIRE RELATIONSHIP IN THE BRAIN

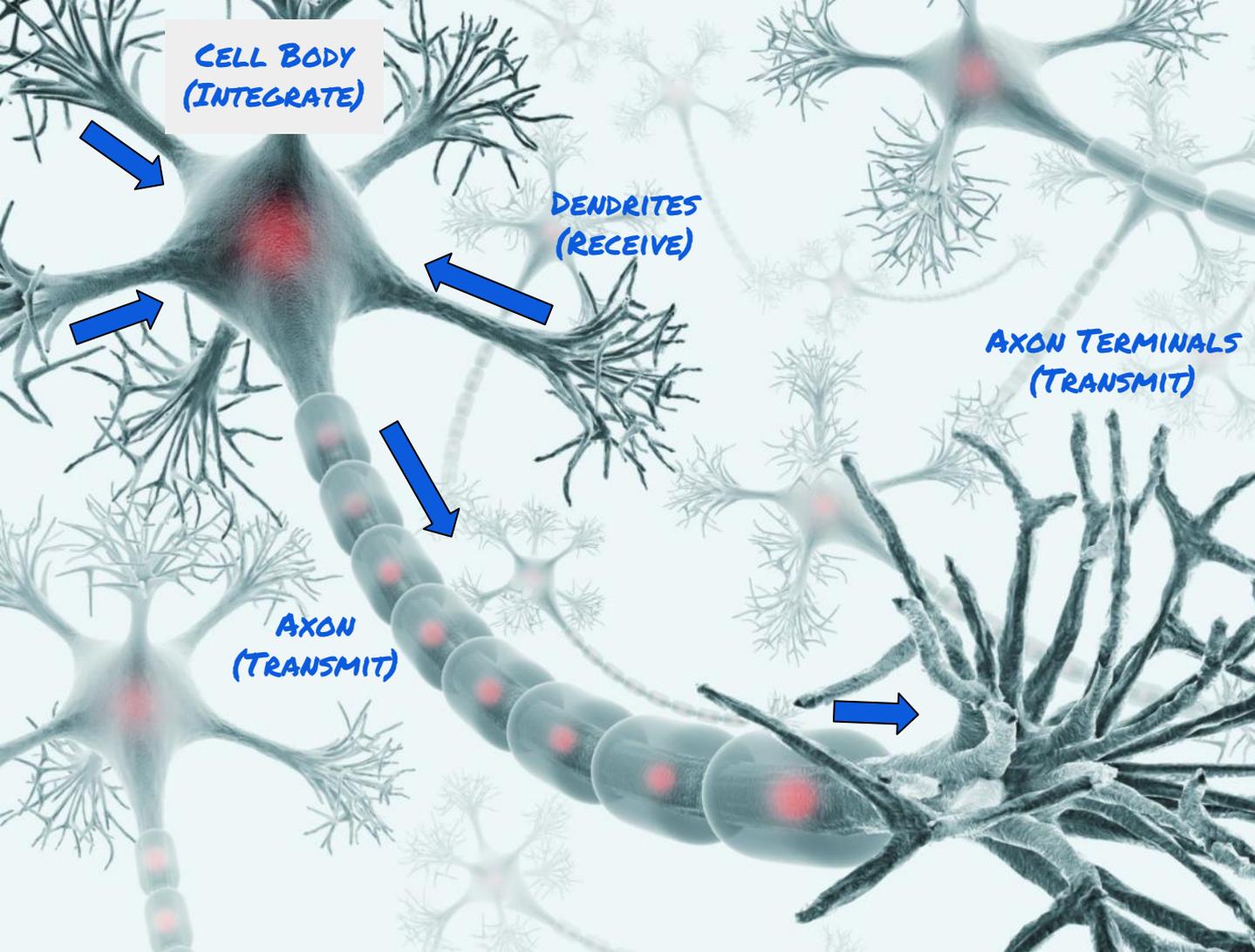
Holland Professional Club  
Oct 6, 2022



## Outline

- Neuroscience 101
  - What is meant by "fire"?
  - What is meant by "wire"?
- Neuroplasticity: "What you fire, you wire"
  - Political polarization
  - Religion and Religious Polarization
  - Foreign Interference
  - Ukraine
  - Education and Educational Disparities
  - Trauma/Counseling
  - Technology
  - Behavioral Addictions
- Neurolaw: "Your wiring determines your firing"
  - History
  - Neuroscience in the courtroom
  - Recidivism
- Neurolaw + Neuroplasticity: Rehabilitation





**CELL BODY  
(INTEGRATE)**

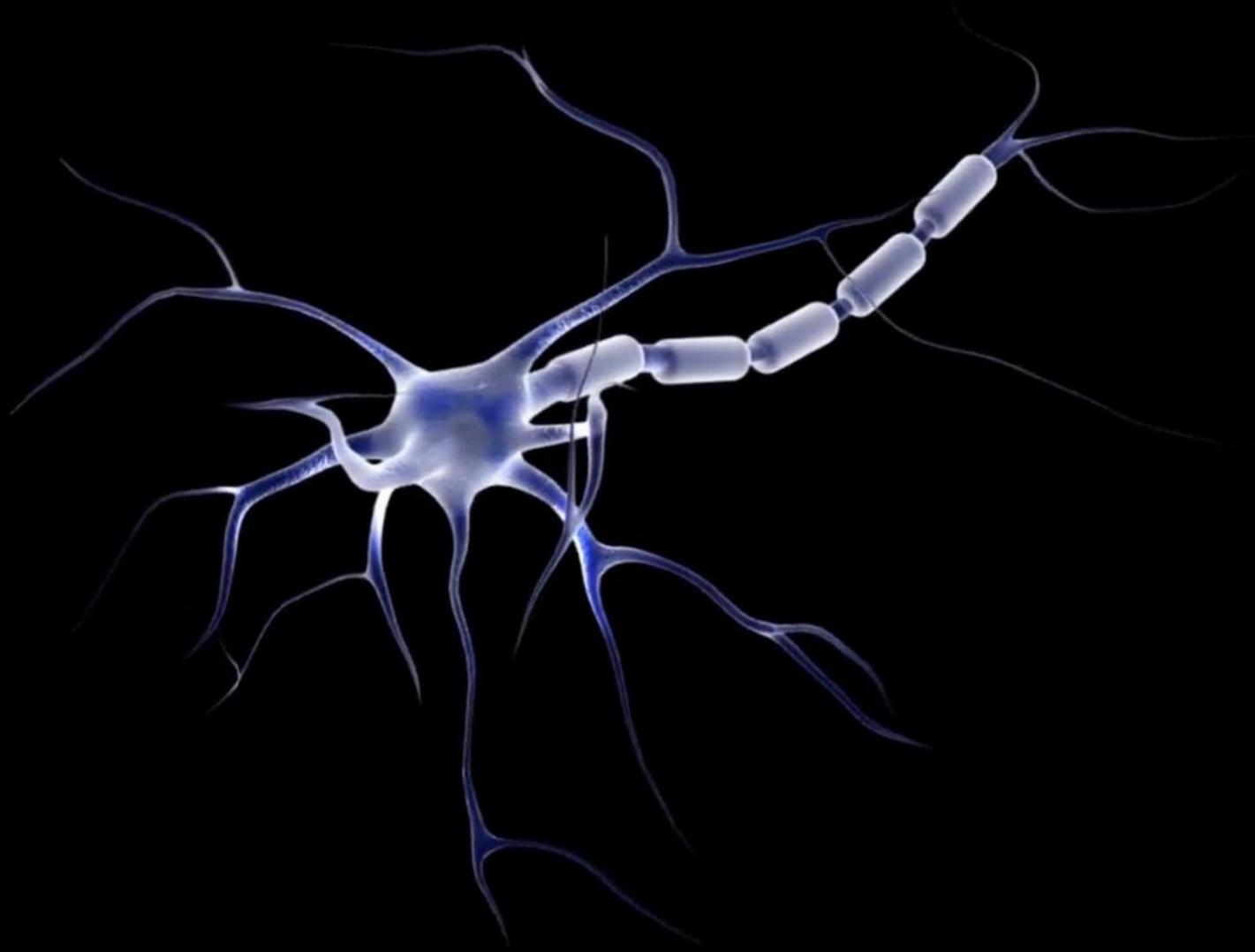
**DENDRITES  
(RECEIVE)**

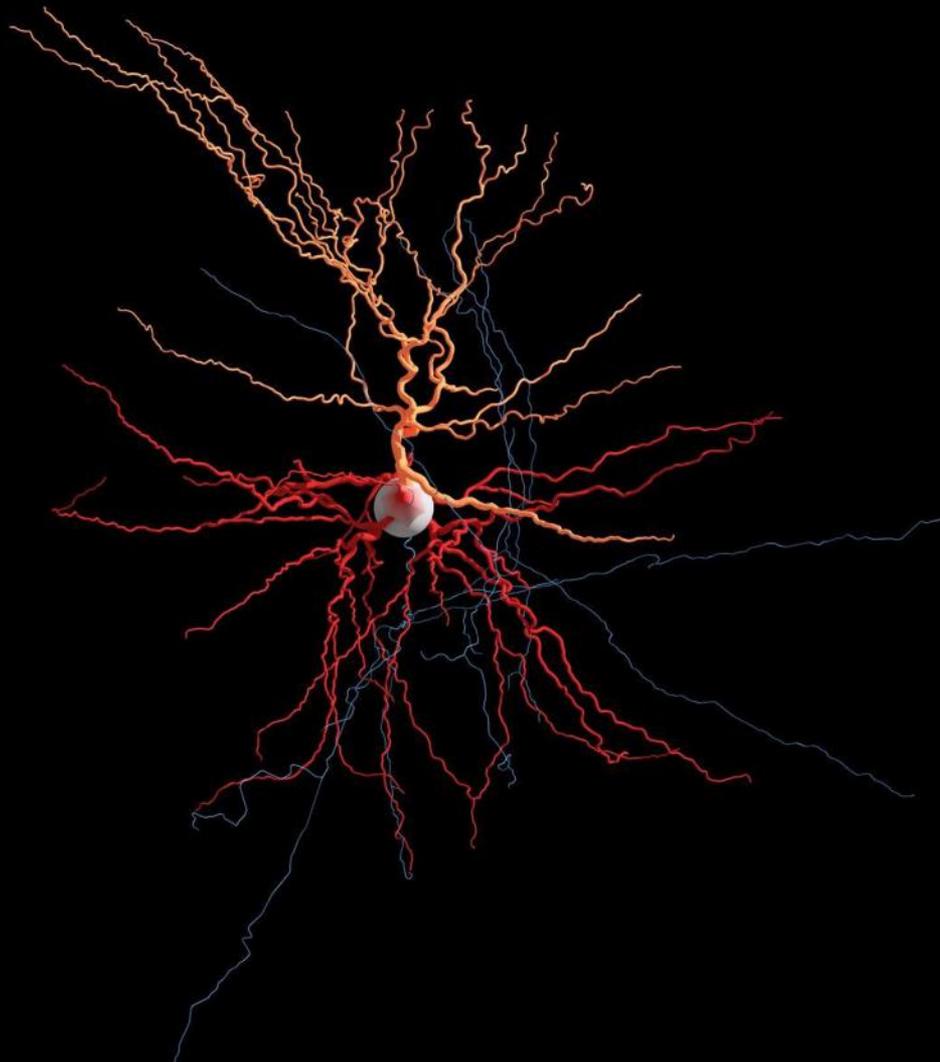
**AXON  
(TRANSMIT)**

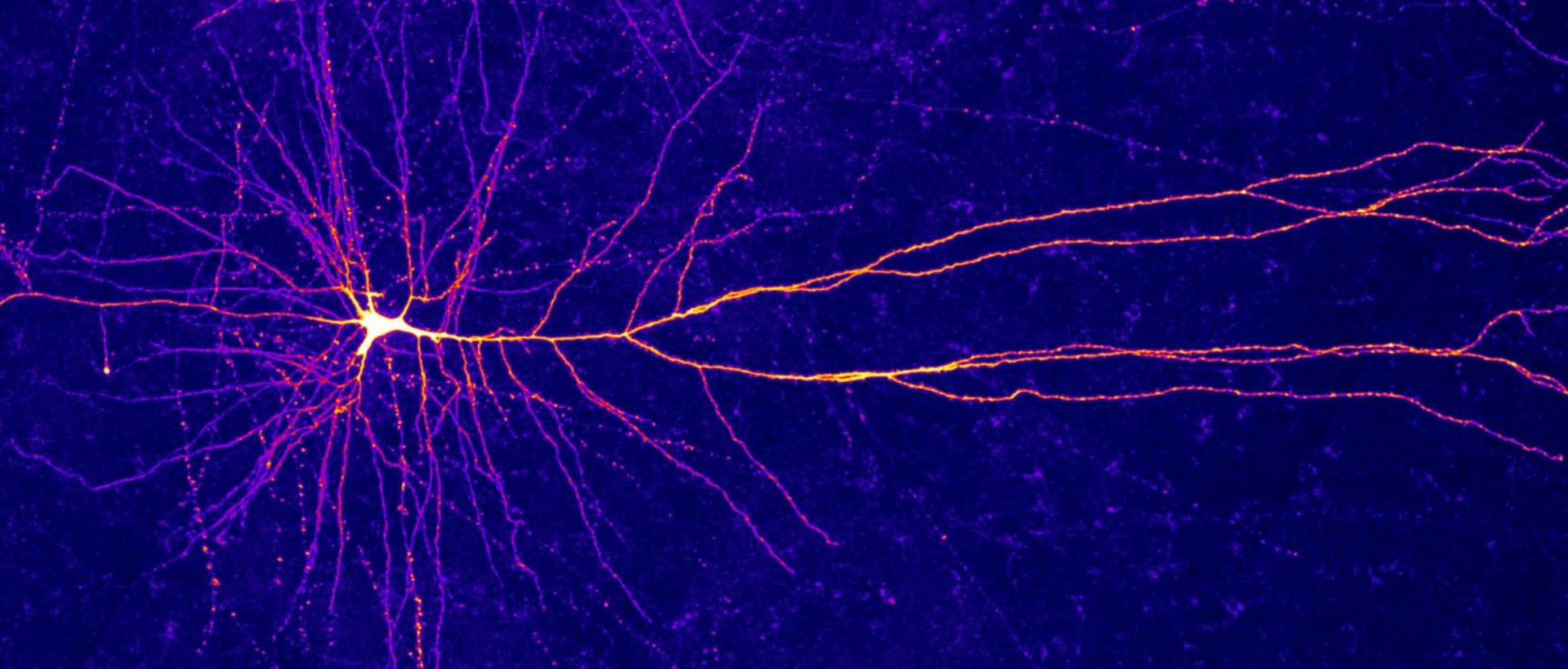
**AXON TERMINALS  
(TRANSMIT)**

**NEURONS (NERVE CELLS)**

- DENDRITES
- CELL BODY
- AXON + AXON TERMINALS







NEURON "FIRING"  
NEURON TO NEURON  
COMMUNICATION



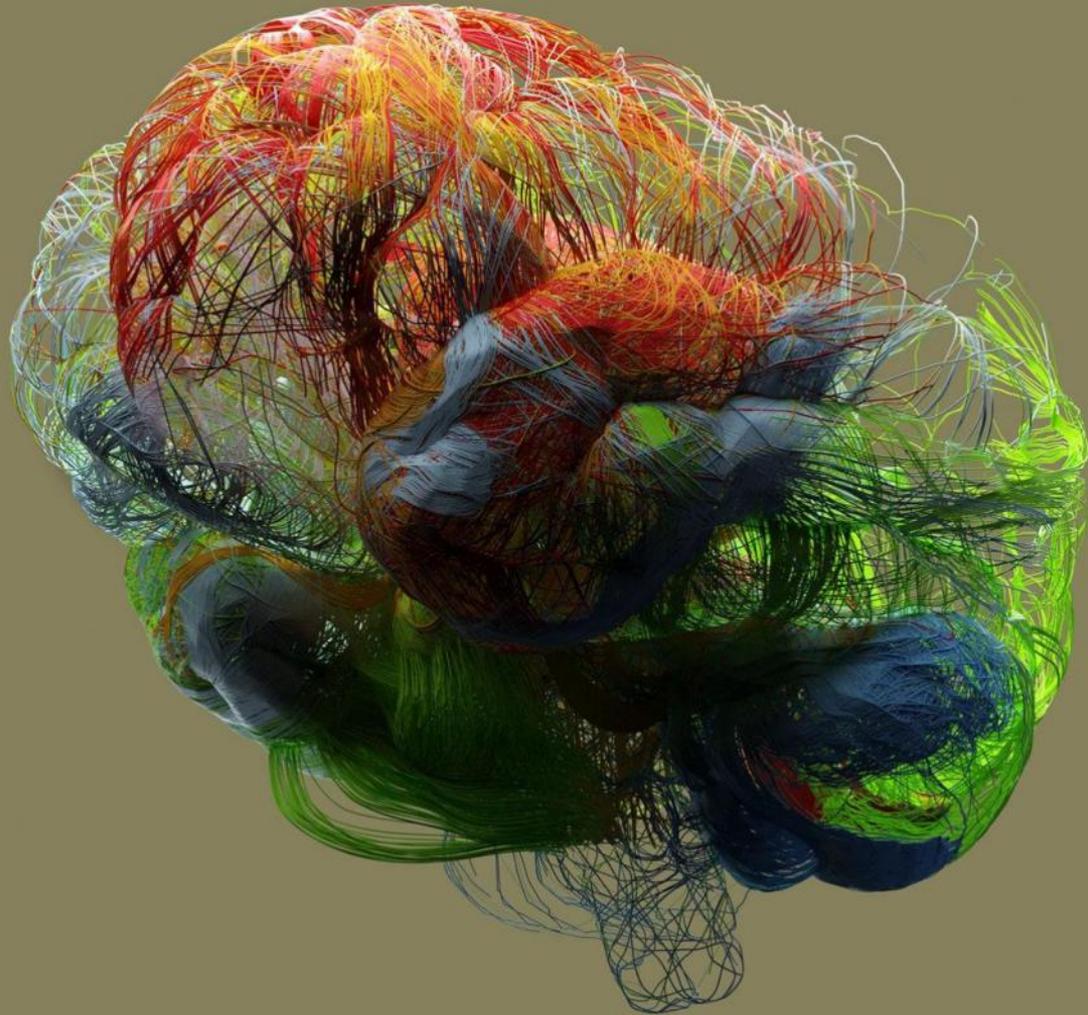
## BRAIN "WIRING"

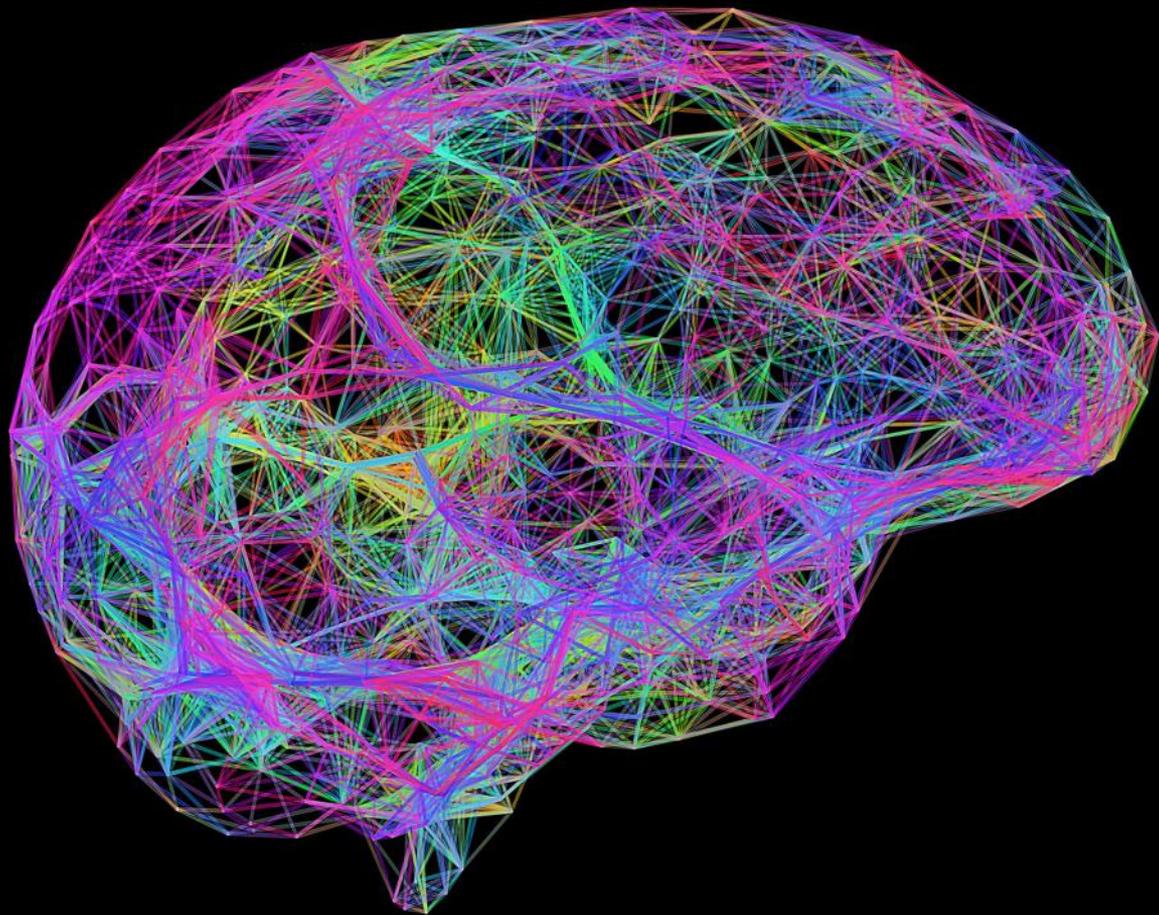
86 BILLION NEURONS

~1000 CONNECTIONS/NEURON

100-1000 TRILLION CONNECTIONS

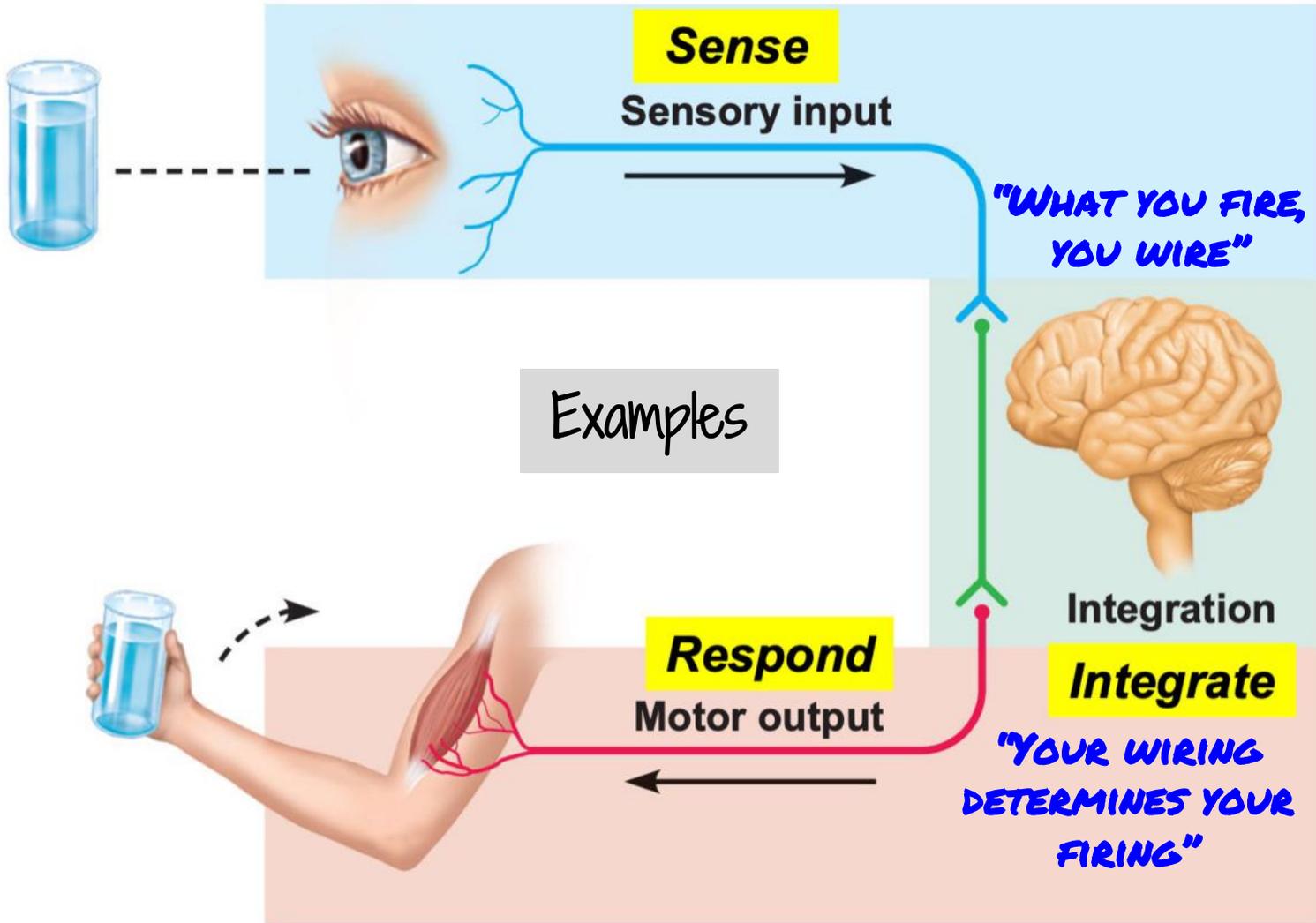
## Neuronal Circuits



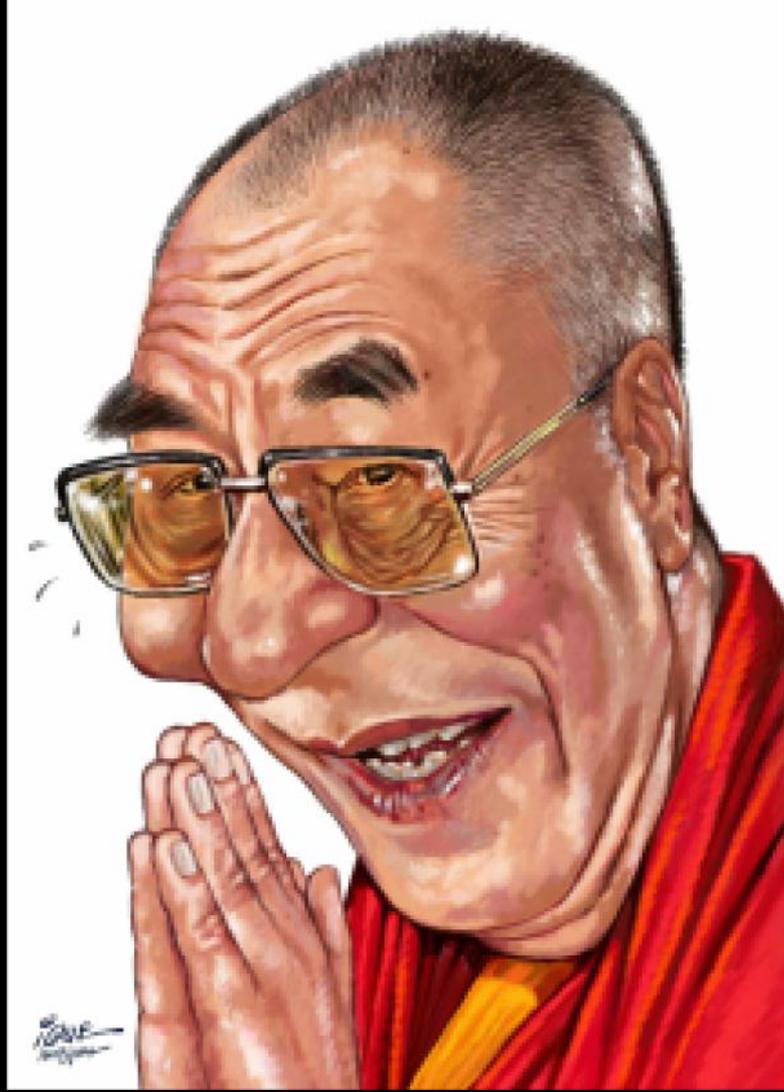


HUMAN  
CONNECTOME  
PROJECT















**MS**

**MS**



**SMACK**  
APPAREL



# NEUROPLASTICITY

What you fire, you wire



DONALD HEBB - 1949

**THE BRAIN'S CAPACITY TO CONTINUE GROWING AND EVOLVING IN RESPONSE TO LIFE EXPERIENCES; THE ABILITY FOR THE BRAIN TO ADAPT OR CHANGE OVER TIME, BY CREATING NEW NEURONS AND BUILDING NEW NETWORKS.**

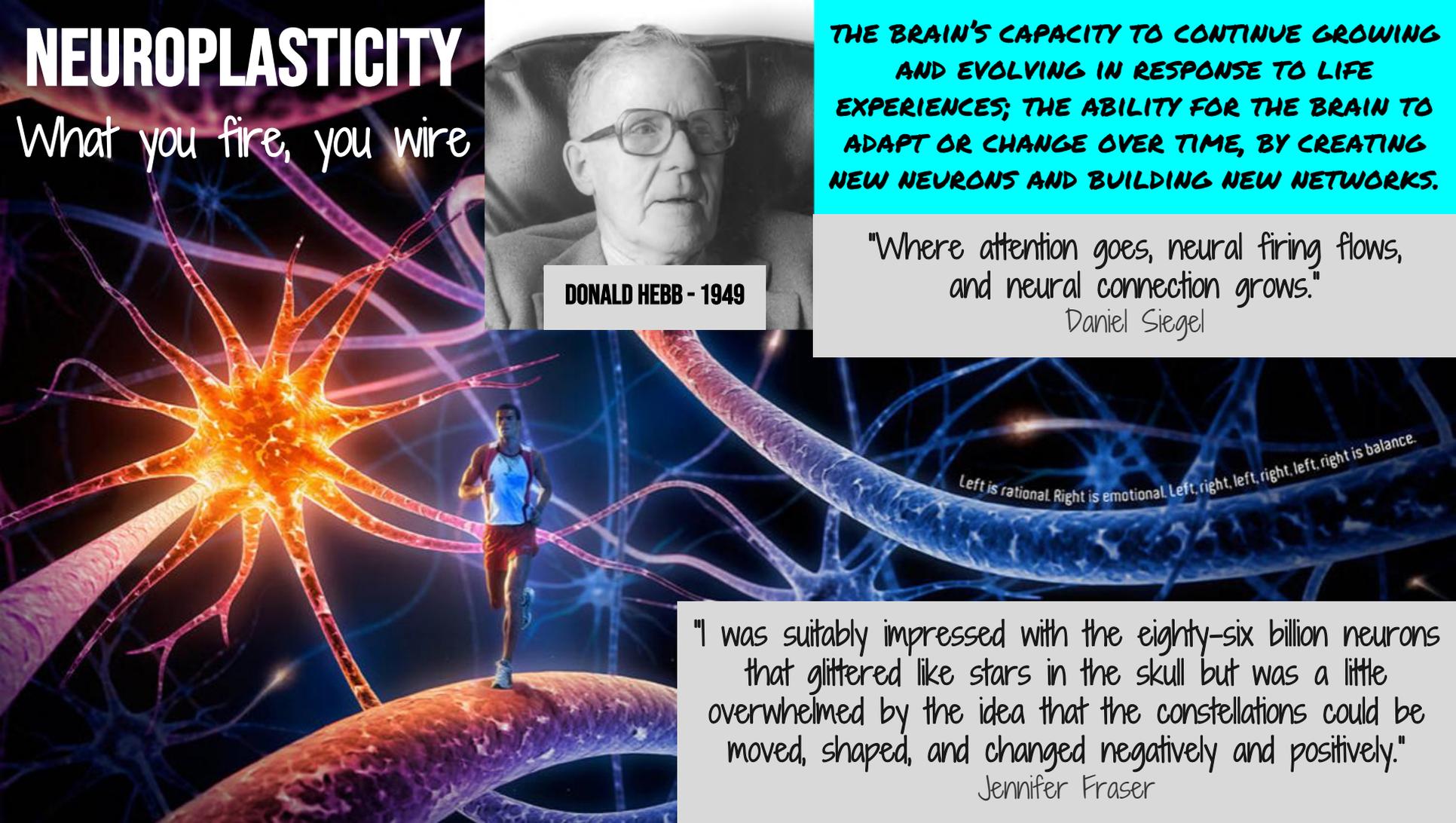
"Where attention goes, neural firing flows, and neural connection grows."

Daniel Siegel

Left is rational. Right is emotional. Left, right, left, right, left, right is balance.

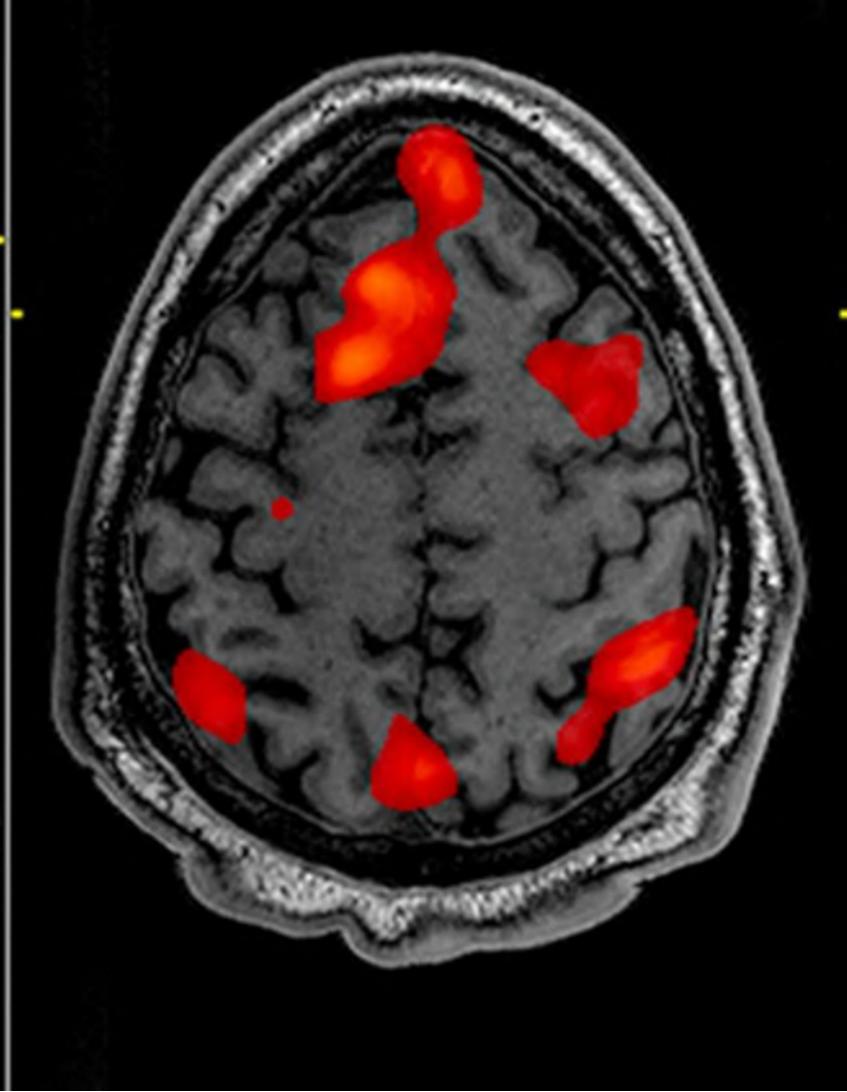
"I was suitably impressed with the eighty-six billion neurons that glittered like stars in the skull but was a little overwhelmed by the idea that the constellations could be moved, shaped, and changed negatively and positively."

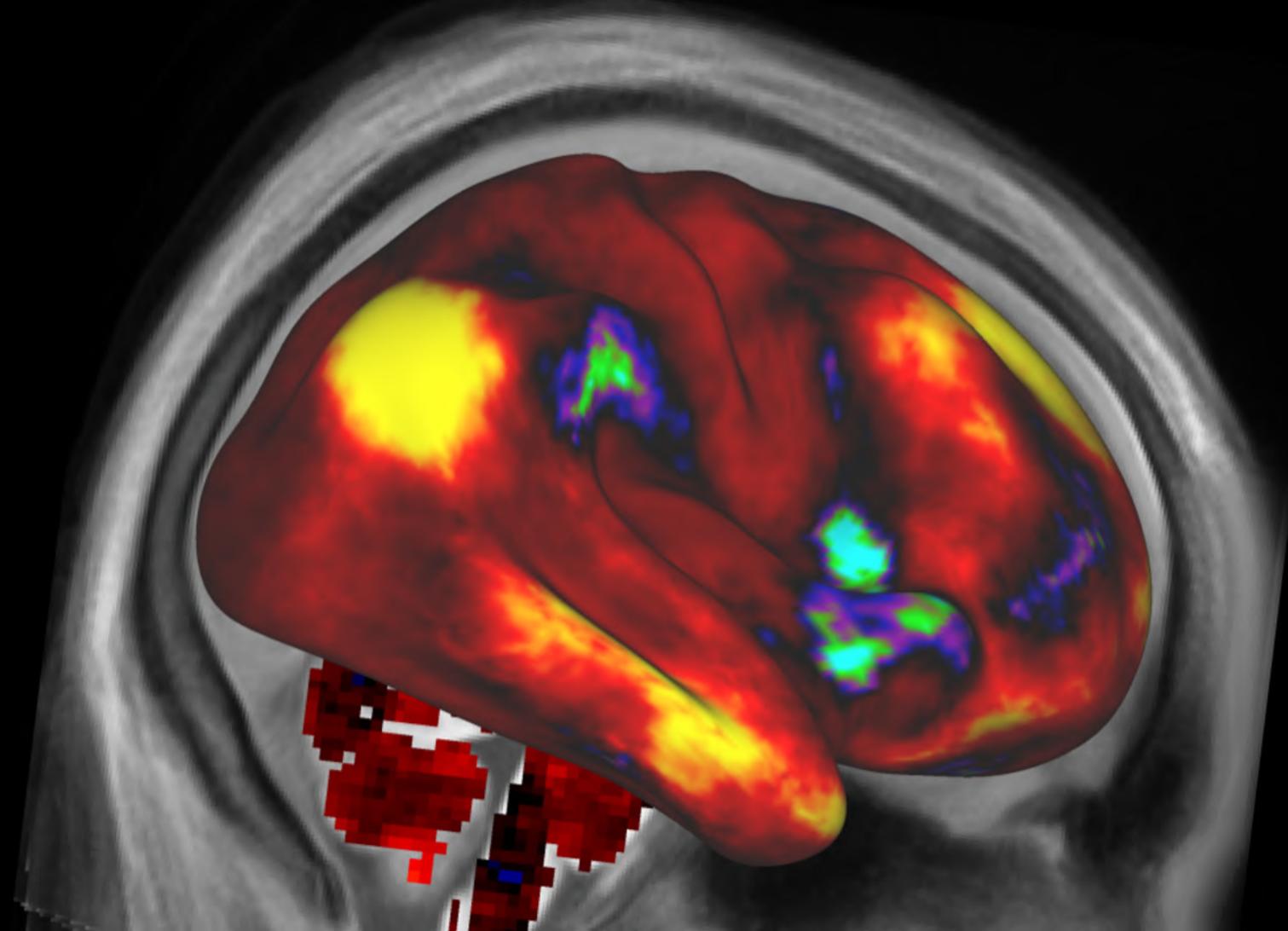
Jennifer Fraser



# Functional Magnetic Resonance Imaging (fMRI)







# Conservative and liberal attitudes drive polarized neural responses to political content

Yuan Chang Leong<sup>a,1</sup>, Janice Chen<sup>b</sup>, Robb Willer<sup>c</sup>, and Jamil Zaki<sup>d</sup>

PNAS | November 3, 2020

## **FMRI SCANNING:**

- **WATCHING VIDEOS RELATED TO IMMIGRATION POLICY**
- **LOOKED FOR "NEURAL POLARIZATION"**

## **THE BRAINS OF CONSERVATIVES AND LIBERALS PROCESS IMMIGRATION VIDEOS DIFFERENTLY**

"Despite watching the same videos, conservative and liberal participants exhibited divergent neural responses. This "neural polarization" between groups occurred in a brain area associated with the interpretation of narrative content and intensified in response to language associated with risk, emotion, and morality. Furthermore, polarized neural responses predicted attitude change in response to the videos. These findings suggest that biased processing in the brain drives divergent interpretations of political information and subsequent attitude polarization."

# Neural correlates of maintaining one's political beliefs in the face of counterevidence

nature.com/scientific reports 2016

Jonas T. Kaplan<sup>1</sup>, Sarah I. Gimbel<sup>1</sup> & Sam Harris<sup>2</sup>

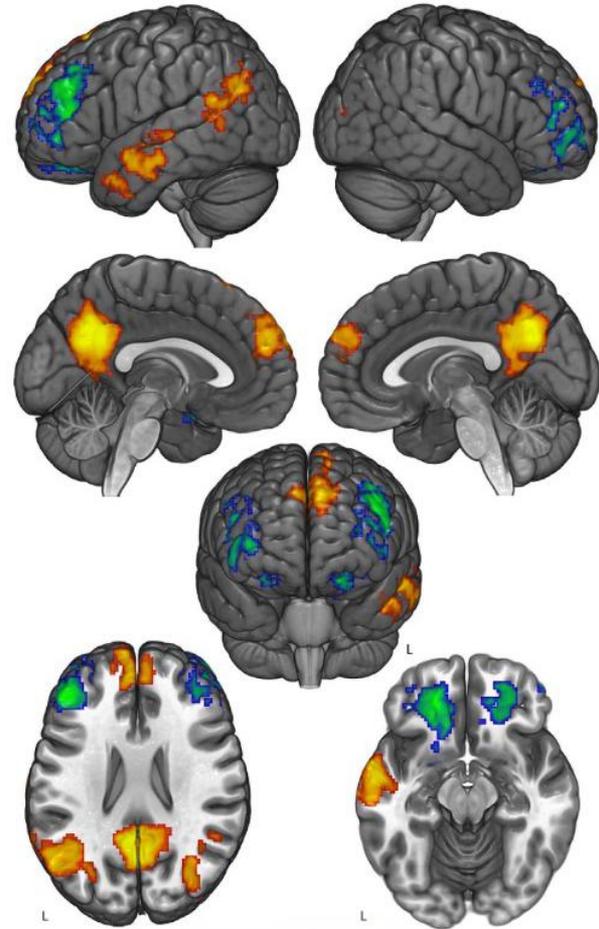
- 40 YOUNG ADULTS (AVERAGE AGE 24; RANGE 18-39)
- SELF-IDENTIFIED LIBERALS
- PRESENTED WITH COUNTER ARGUMENTS DURING FMRI

## WE ARE WIRED TO SHUT DOWN COUNTER ARGUMENTS

"Challenges to political arguments produced activity in the default mode network - a set of interconnected structures associated with self-representation and disengagement from the external world."

## SPECIFIC BRAIN REGIONS MODULATE RECEPTIVENESS TO CHANGE

"Participants who changed their minds more showed less BOLD signal in the insula and amygdala when evaluating counterevidence."



- 8 NON-PARTISAN TASKS
- FUNCTIONAL CONNECTIVITY

# Functional connectivity signatures of political ideology

Seo Eun Yang<sup>a,1</sup>, James D. Wilson<sup>b,\*,1</sup>, Zhong-Lin Lu<sup>c,d,e,f</sup> and Skyler Cranmer<sup>a</sup>

## **BRAIN CIRCUITS ACTIVATED DURING ALL 8 TASKS CORRELATED TO POLITICAL IDEOLOGY**

"... liberals and conservatives have noticeable and discriminative differences in functional connectivity that can be identified with high accuracy using contemporary artificial intelligence methods and that such analyses complement contemporary models relying on socio-economic and survey-based responses."

## **EVEN AT REST!**

"Even without any stimulus at all, functional connectivity in the brain can help us predict a person's political orientation."

## **WHAT YOU FIRE, YOU WIRE? .. OR .. YOUR WIRING DETERMINES YOUR FIRING?**

"What we don't know is whether that brain signature is there because of the ideology that people choose or whether people's ideology is caused by the signatures we found."

**POSITIVE FEEDBACK?**



## **Exposure to opposing views on social media can increase political polarization** | PNAS | September 11, 2018 | vol. 115 | no. 37

Christopher A. Bail<sup>a,1</sup>, Lisa P. Argyle<sup>b</sup>, Taylor W. Brown<sup>a</sup>, John P. Bumpus<sup>a</sup>, Haohan Chen<sup>c</sup>, M. B. Fallin Hunzaker<sup>d</sup>, Jaemin Lee<sup>a</sup>, Marcus Mann<sup>a</sup>, Friedolin Merhout<sup>a</sup>, and Alexander Volfovsky<sup>e</sup>

WHAT YOU FIRE, YOU WIRE

RELIGION AND RELIGIOUS POLARIZATION

FOREIGN INTERFERENCE

UKRAINE

EDUCATION AND EDUCATIONAL DISPARITIES

TRAUMA/COUNSELING

TECHNOLOGY

BEHAVIORAL ADDICTIONS

# NEUROLAW

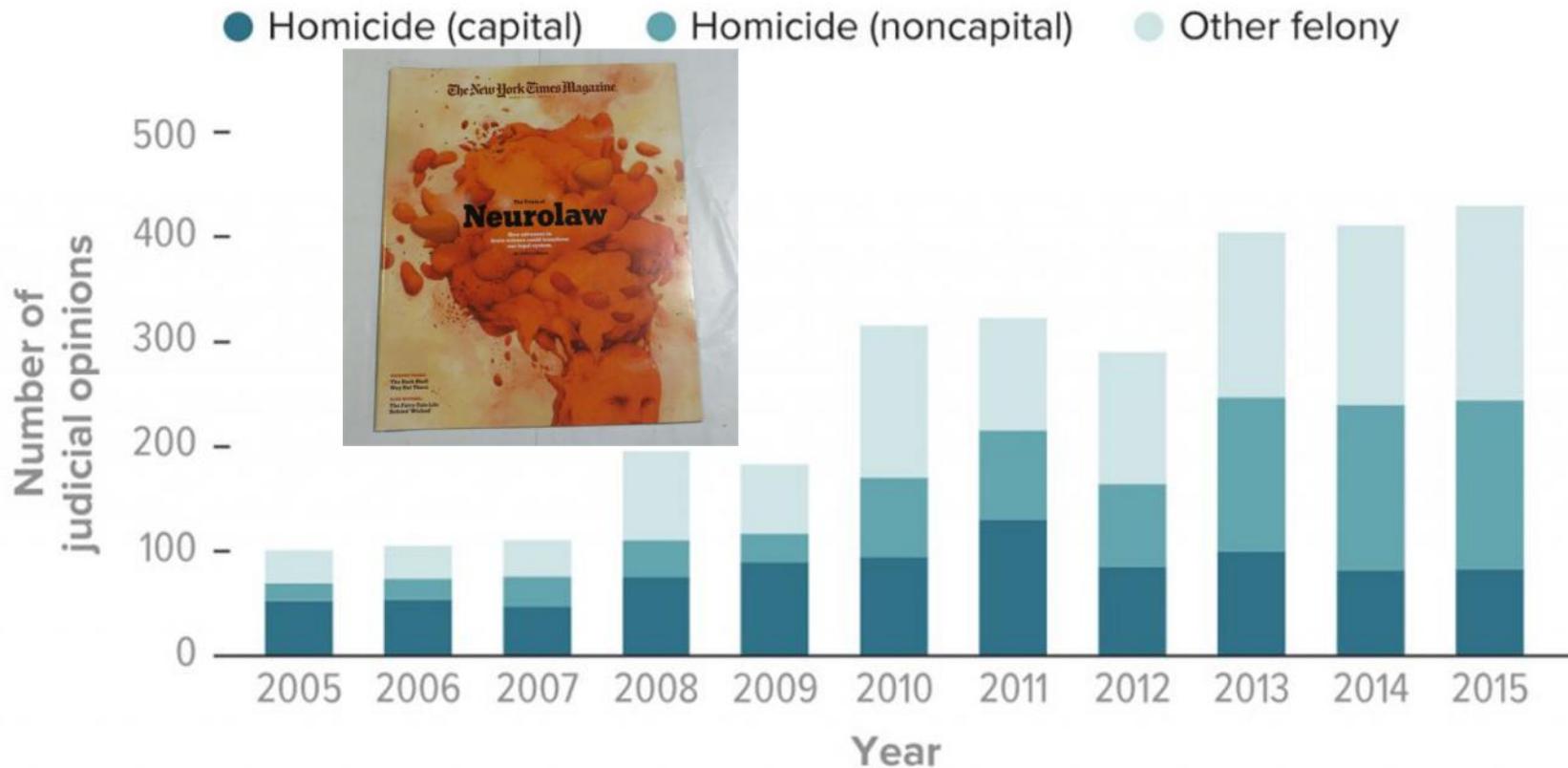
THE LEGAL USE AND GOVERNANCE  
OF NEUROSCIENTIFIC TOOLS,  
CONCEPTS, AND DATA.

Francis Shen

Your wiring determines your firing



# The growing use of neuroscience in criminal cases



## HISTORY

- 19TH CENTURY “INSANITY” CONSIDERATIONS
- 1930’S “PSYCHOSURGERY”
- 1940’S EEG FIRST USED FOR DEFENDANT WITH EPILEPSY
- 1980’S NEUROLAW, NEUROPSYCHOLOGY, AND NEUROIMAGING
  - 1981 JOHN HINCKLEY CT SCAN TO SUPPORT NGRI PLEA (SCHIZOPHRENIA)
  - 1990 FMRI DEVELOPED
  - 1991 “NEUROLAW” FIRST COINED BY SHERROD TAYLOR
  - 1992 *PEOPLE V. WEINSTEIN* PET SCAN REVEALED ARACHNOID CYST THAT RENDERED HIM NOT CRIMINALLY RESPONSIBLE

"Can new discoveries about the brain reclaim a million criminals?"

Can psychological research cut America's crime bill in half?

Can scientists, using drugs and surgery, eliminate dishonest impulses from the minds of crooks?"

1939 *Popular Science* "Have You a Wrong Way Brain?"  
Psychiatrist/criminologist Carleton Simon.

## NEUROSCIENCE AND LAW (OWEN JONES)

**Buttressing** - Provide supporting evidence (e.g. tumor supporting behavior)

**Challenging** - Challenge an assumption (e.g. eyewitness testimony)

**Detecting** - Gain otherwise elusive insights (e.g. extent of brain injuries, lie detection)

**Sorting** - Categorize people into legal classifications (e.g. sane vs insane)

**Intervening** - Recommend interventions (e.g. neuroactive drugs)

**Explaining** - Explain uncontested but poorly understood phenomenon (e.g. fMRI data)

**Predicting** - Predict future behavior (e.g. recidivism)

## NEUROLAW CONSIDERATIONS

- Most often used by the defense (>90%)
- Greater impact on sentencing than verdict
- Insufficient neuroscience evidence often basis of "ineffective assistance of counsel" plea by defendant; ~25% success rate
- 5th Amendment

**NITA FARAHANY**  
**ROBINSON O. EVERETT DISTINGUISHED**  
**PROFESSOR OF LAW & PHILOSOPHY**  
**DUKE UNIVERSITY**



FRANCIS SHEN  
PROFESSOR OF LAW  
MCKNIGHT PRESIDENTIAL FELLOW  
UNIVERSITY OF MINNESOTA

For more talks visit [TEDMED.com](https://www.tedmed.com)

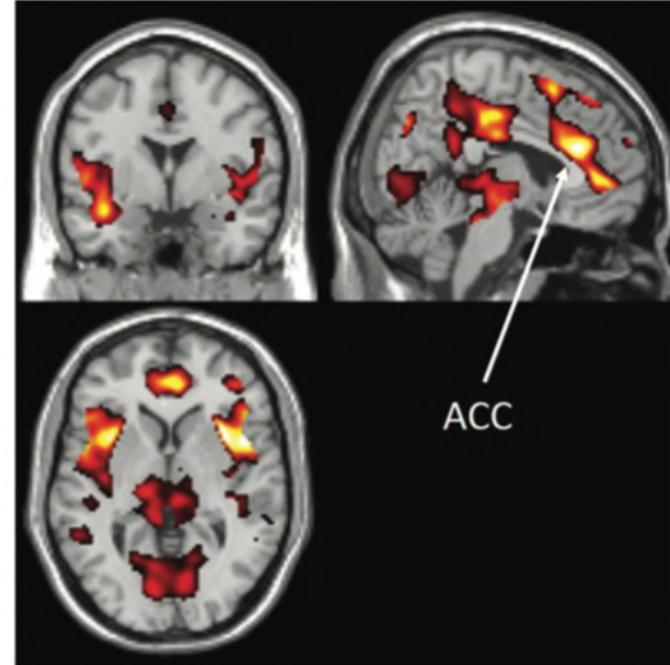
# The predictive value of neurobiological measures for recidivism in delinquent male young adults

J Psychiatry Neurosci 2021;46(2)

Josjan Zijlmans, PhD; Reshmi Marhe, PhD; Floor Bevaart, PhD;  
Laura Van Duin, MSc; Marie-Jollette A. Luijckx, MSc; Ingmar Franken, PhD;  
Henning Tiemeier, MD, PhD; Arne Popma, MD, PhD

- 127 DELINQUENT YOUNG MEN (18-27 YEARS OLD)
- DEMOGRAPHICS, EDUCATION, PREVIOUS DELINQUENCY, DRUG USE, BEHAVIORAL TRAITS
- EEG, FMRI SCANNING,
- FOLLOWED FOR 30 MONTHS

"In the predictive model, demographics, past delinquency, drug use and behavioural traits had moderate predictive power for overall and for serious recidivism. Neurobiological measures significantly improved predictive power. This led to good predictive function, particularly for serious recidivism."



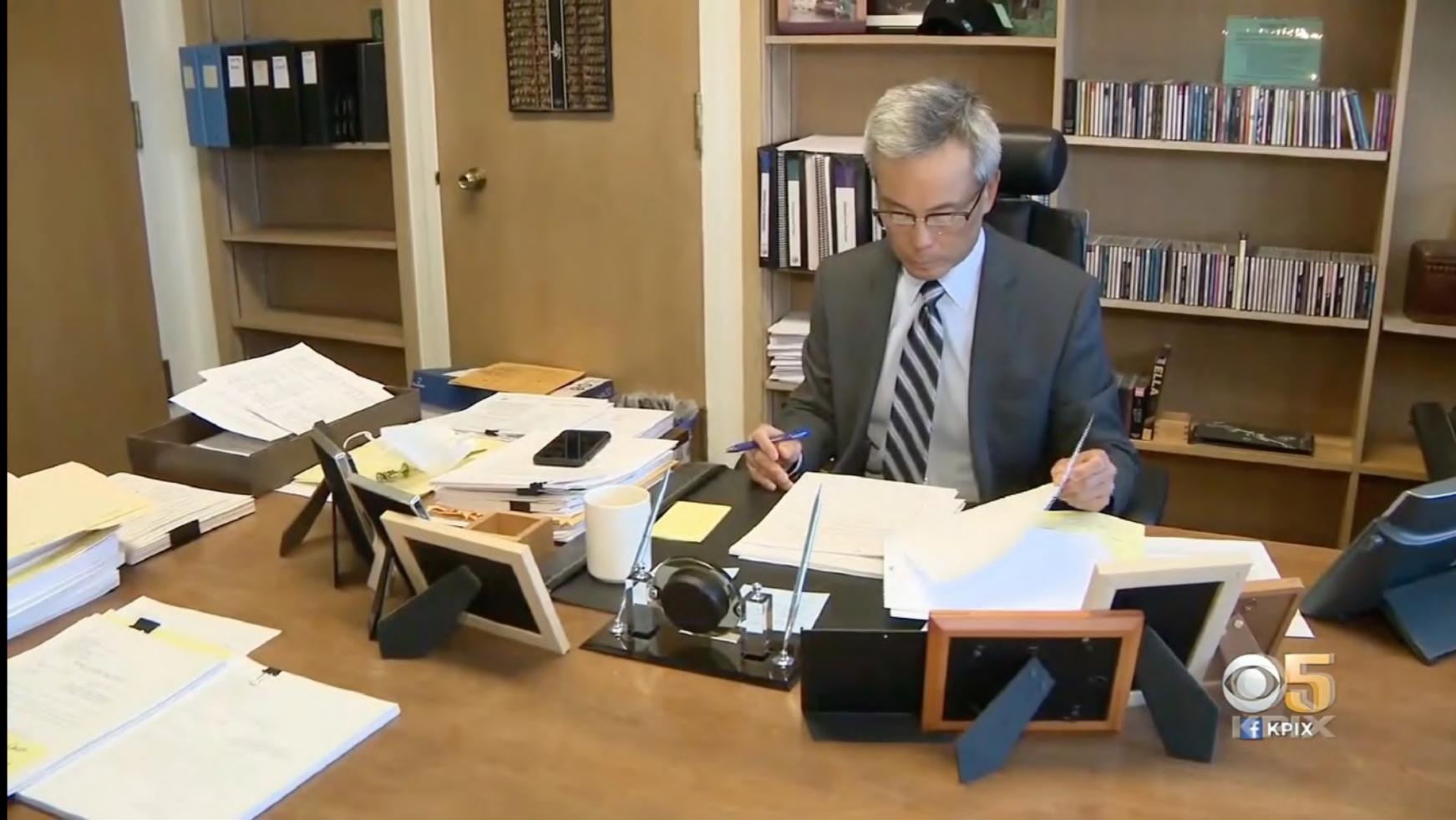
# YOUNG ADULT COURT IN SAN FRANCISCO

"The prefrontal cortex of the brain – responsible for our cognitive control – does not fully develop until the early to mid-20s. We are going through this critical developmental period, transitioning into adulthood without the support of our parents. Our traditional justice system is not designed to address cases involving these individuals, who are qualitatively different in development, skills, and needs from both children and older adults.

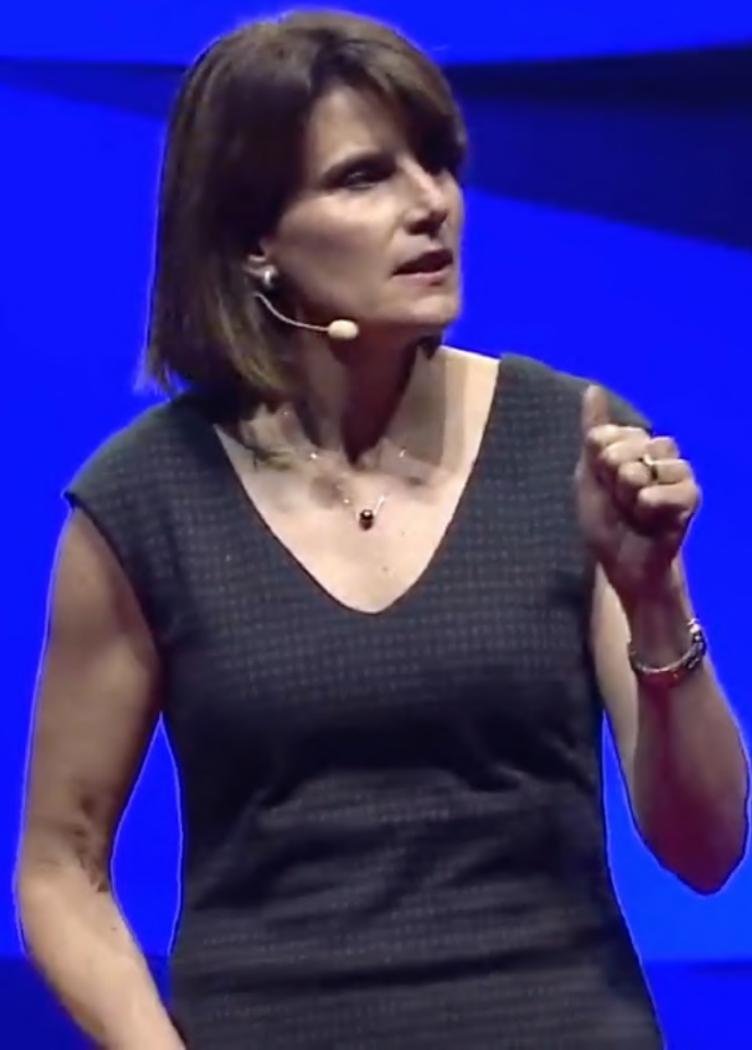
**YOUR WIRING DETERMINES YOUR FIRING**

Young Adult Court (YAC) in San Francisco was created for eligible young adults, ages 18-24. The court provides a supportive environment and transformation with the potential stage of this age group."

**WHAT YOU FIRE, YOU WIRE**



LARA BOYD  
NEUROSCIENTIST  
UNIVERSITY OF BRITISH COLUMBIA



## POOH AND PIGLET

"Rabbit's clever," said Pooh thoughtfully.

"Yes," said Piglet, "Rabbit's clever."

"And he has Brain."

"Yes," said Piglet, "Rabbit has Brain."

There was a long silence.

"I suppose," said Pooh, "that that's why he never understands anything."

A.A. Milne, Winnie-the-Pooh