MIDTERM 1 REVIEW

INTRODUCTION TO COGNITIVE SCIENCE
COGSI – SPRING 2019

Exam scope: All of the readings and lectures for weeks 1, 2 and 3.

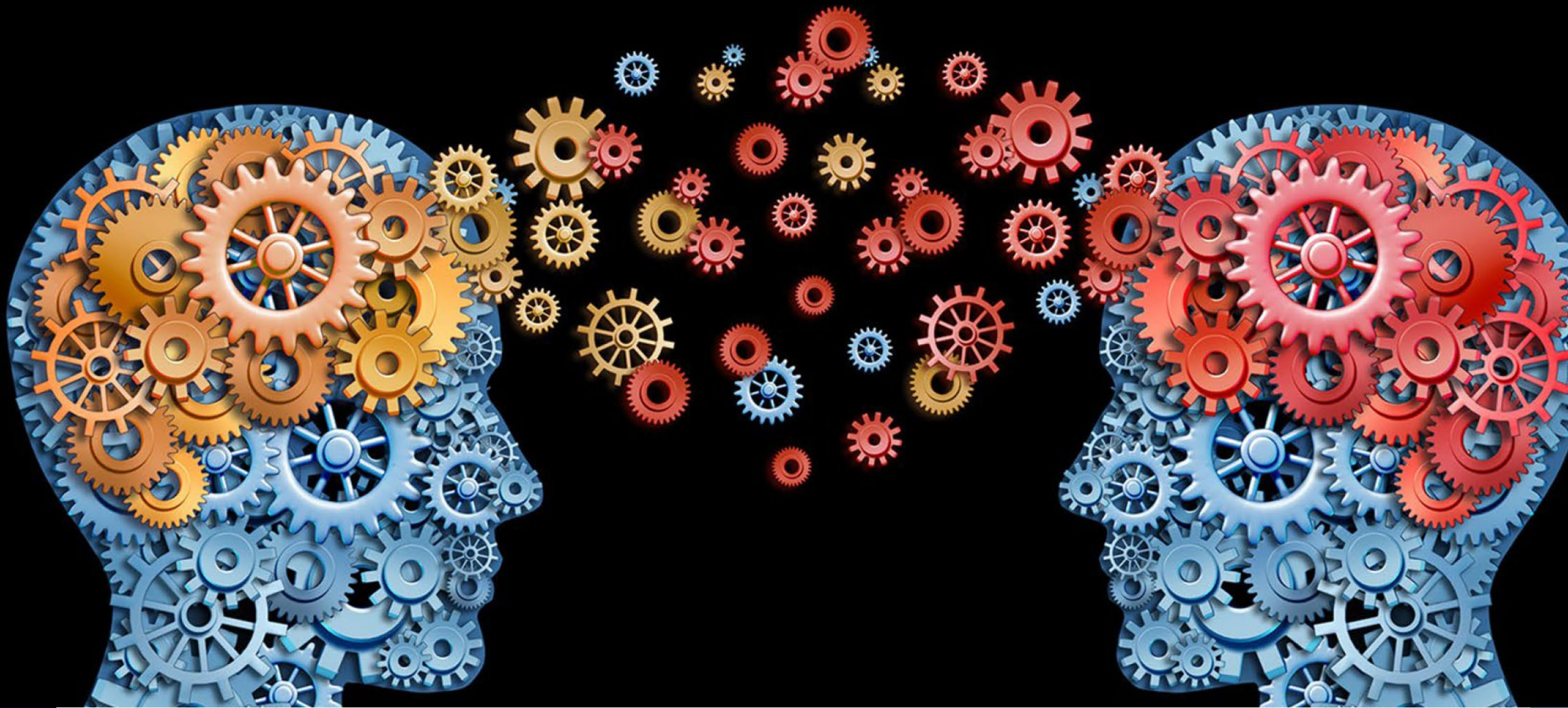
Read and think about the review questions for each week.

Write out short answers for the questions....

TIP: Try to do it without your notes.

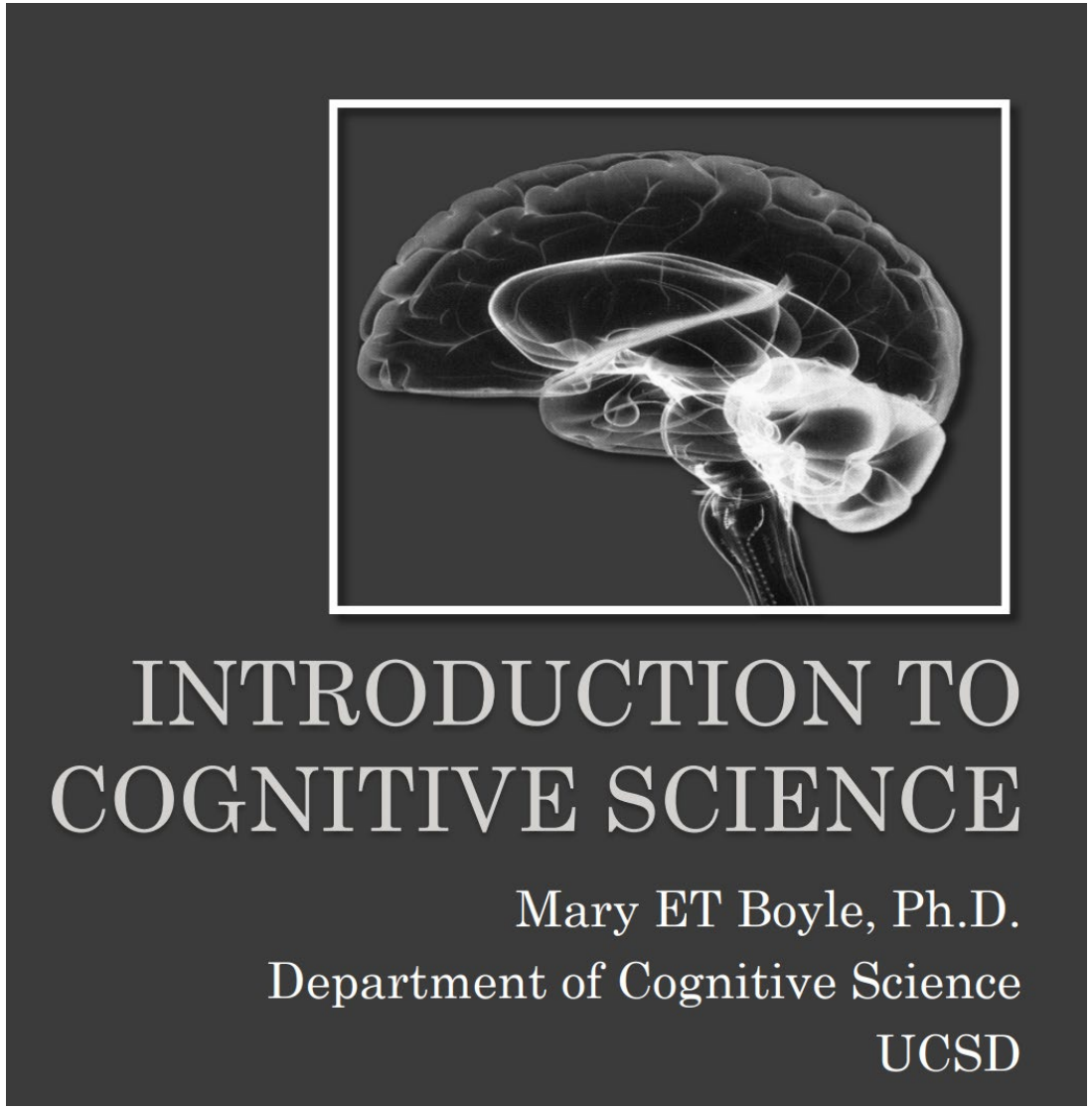
Share your knowledge: Participate on Piazza, call mom, tell your roommate…

When you actively process the information that is when the magic of learning happens.



INTRODUCTION TO COGNITIVE SCIENCE

- Boyle
- Week 1
- Quiz A
- No Assigned Reading



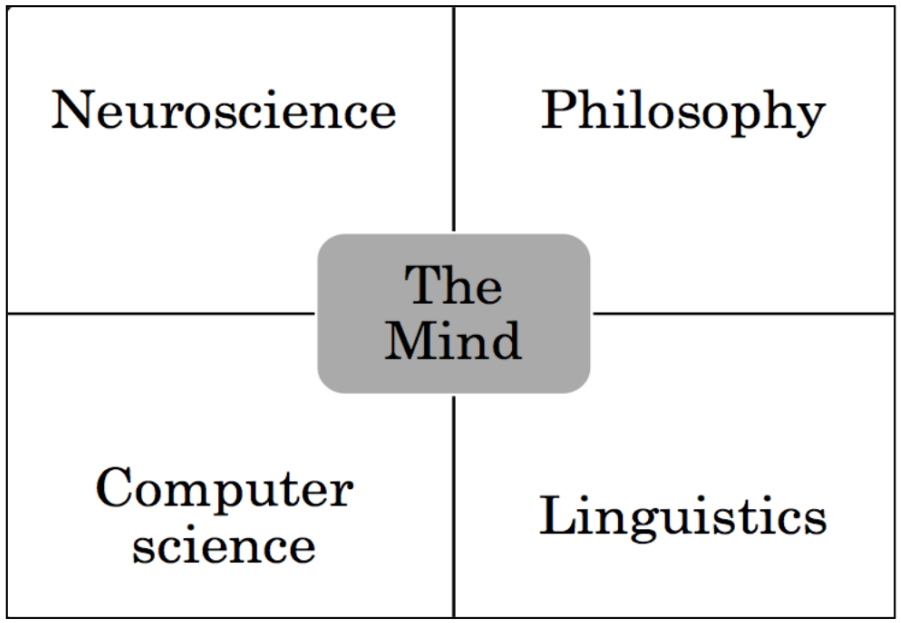
THE BIG QUESTION FOR THIS LECTURE:

WHAT IS COGNITIVE SCIENCE ANYWAY?

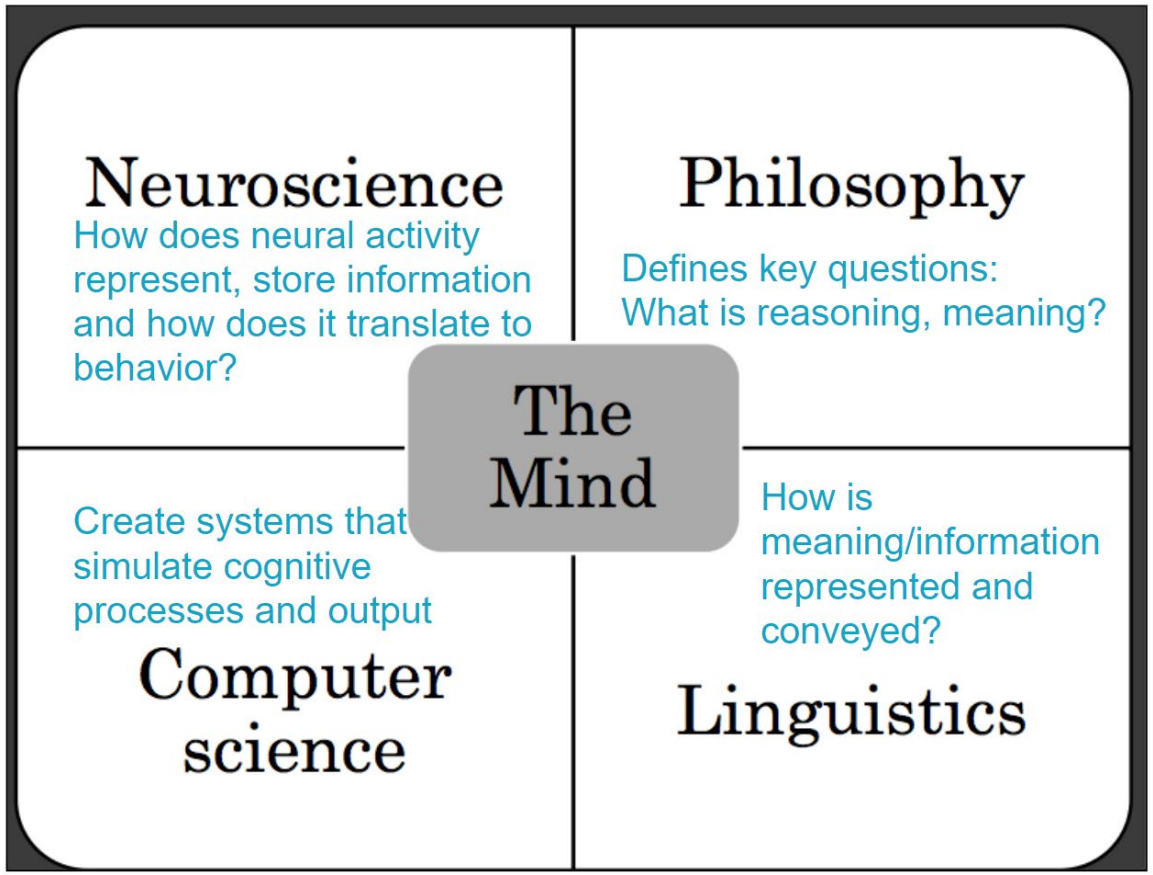
What is Cognitive Science?

Interdisciplinary study of mind and its processes. **Main objective**: Understand how information is acquired, processed, transformed into behavioral output

What are its main disciplines?



How are these disciplines related?

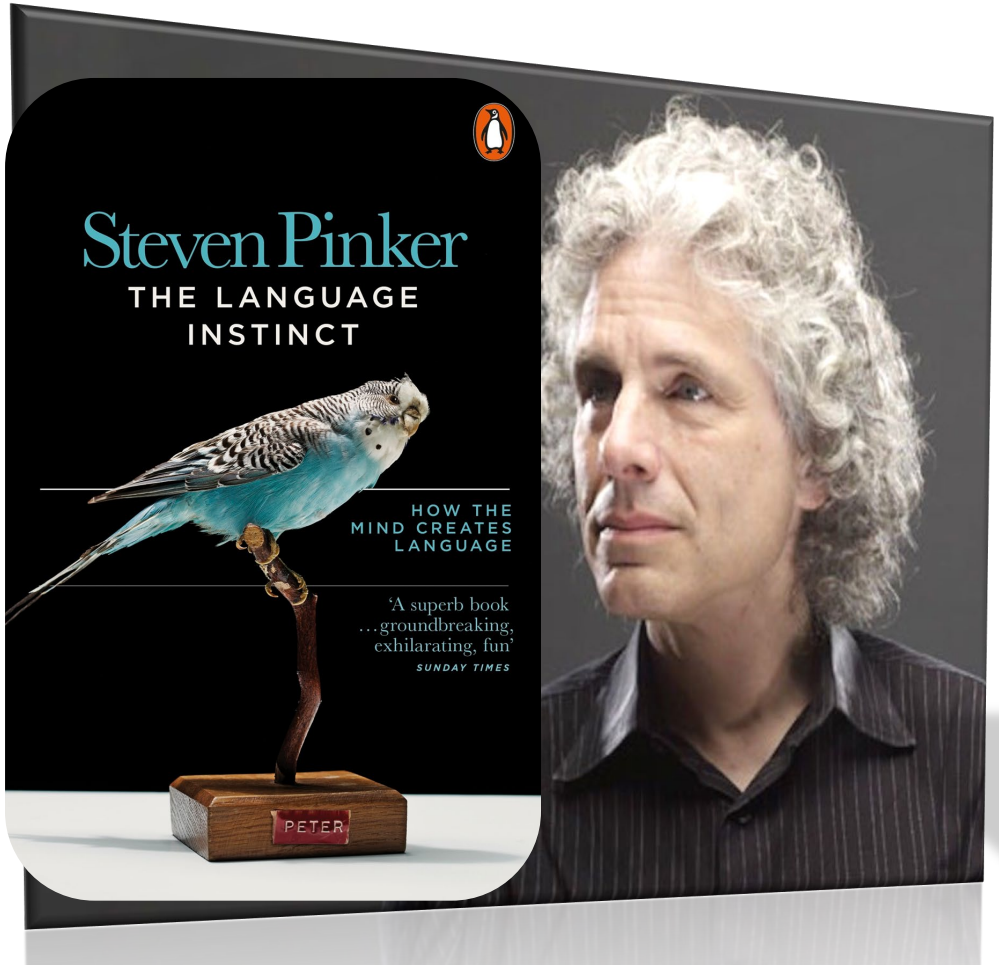


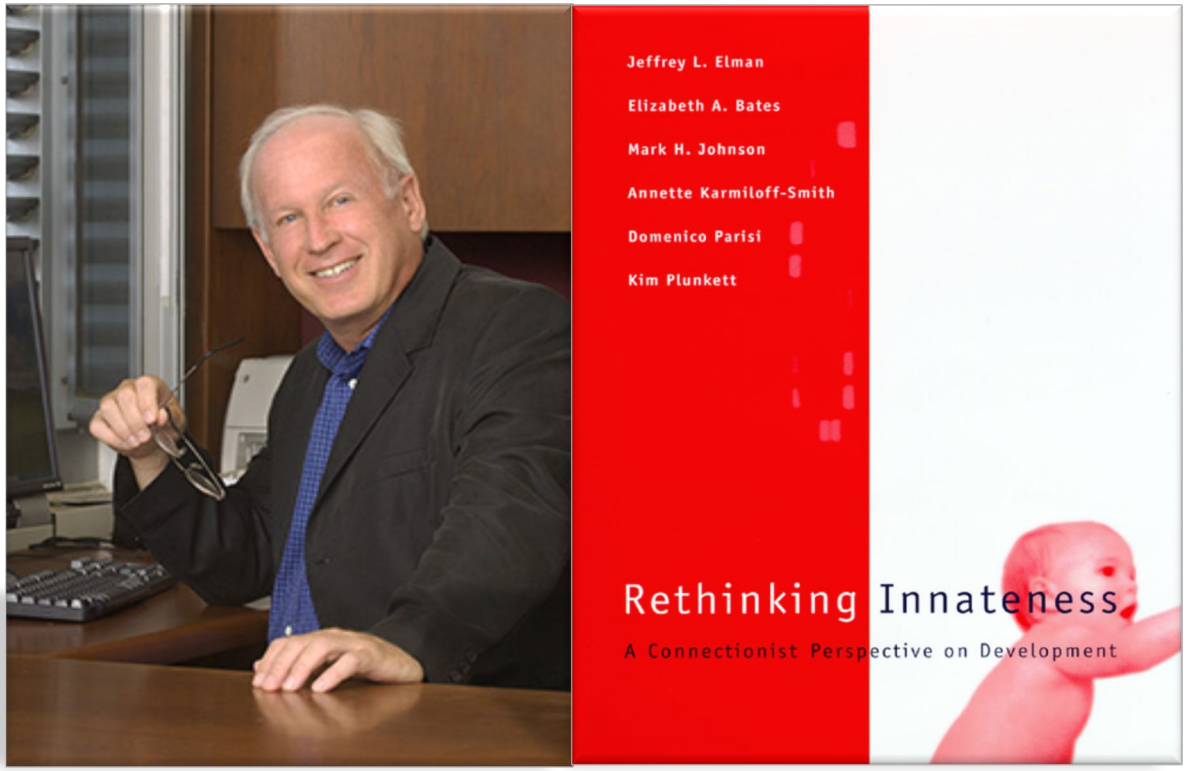
Language: Nature v. Nurture?

This is what some linguists study and argue about! Some main theories by:

Pinker, argues language is innate human ability

Elman, argues language use arises from experience, it is learned





BCI: "READING MINDS"

What is BCI?

What does it mean to "read the mind"?

Brain Computer Interface.

Field of research, uses...

...sensors to record electrical activity, which computer decodes in order to control external device accordingly

HOW DOES COGNITIVE SCIENCE DIFFER FROM…

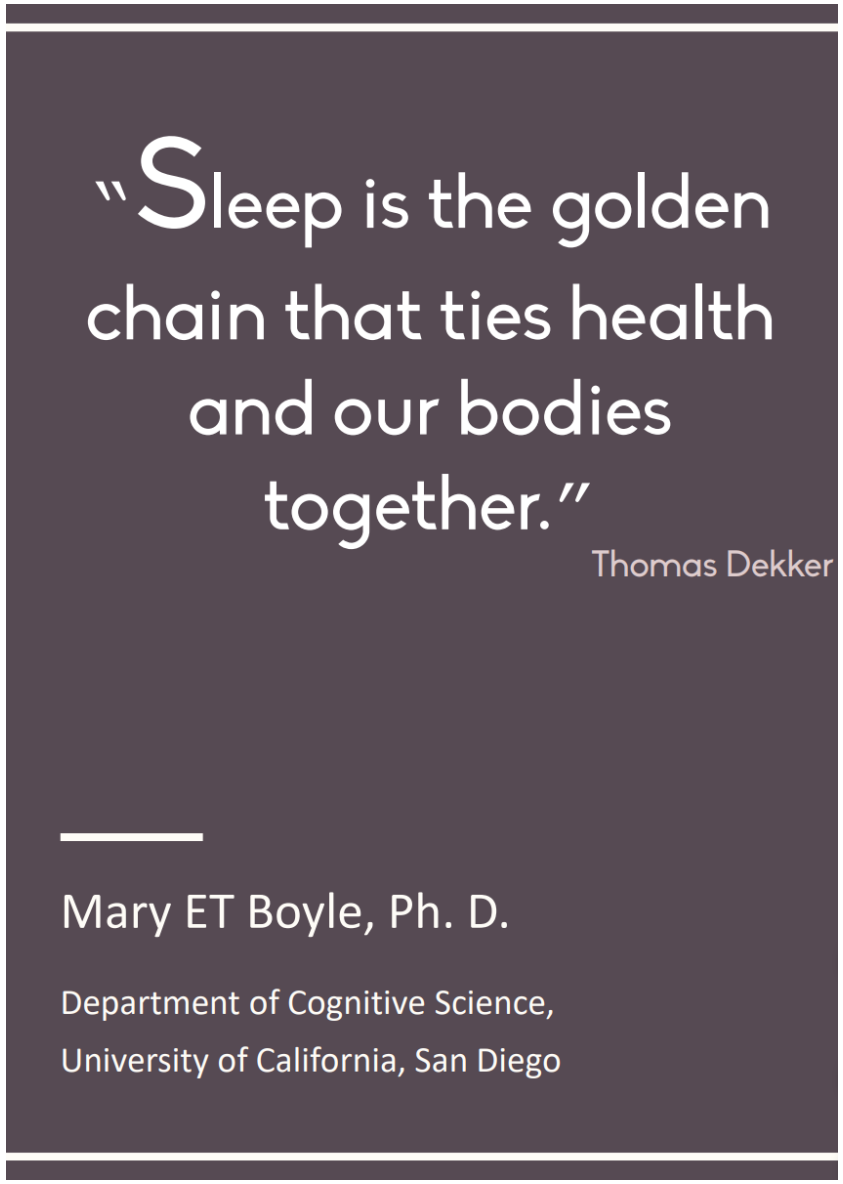
computer science, neuroscience, philosophy, psychology, and linguistics?

Independently, each field *could* investigate questions unrelated to cognition.

Cognitive science, however, requires each field's input in order to form a **complete picture of cognition**.

SLEEP

- Boyle
- Week 1
- Quiz A
- Assigned Readings:
  - Clocks Within Us
  - Why Can't We Fall Asleep?
  - The Work We Do While We Sleep
  - The Walking Dead
  - Brain Facts Chapter 6: Sleep
  - Brain Facts Chapter 12: Degenerative Disorders



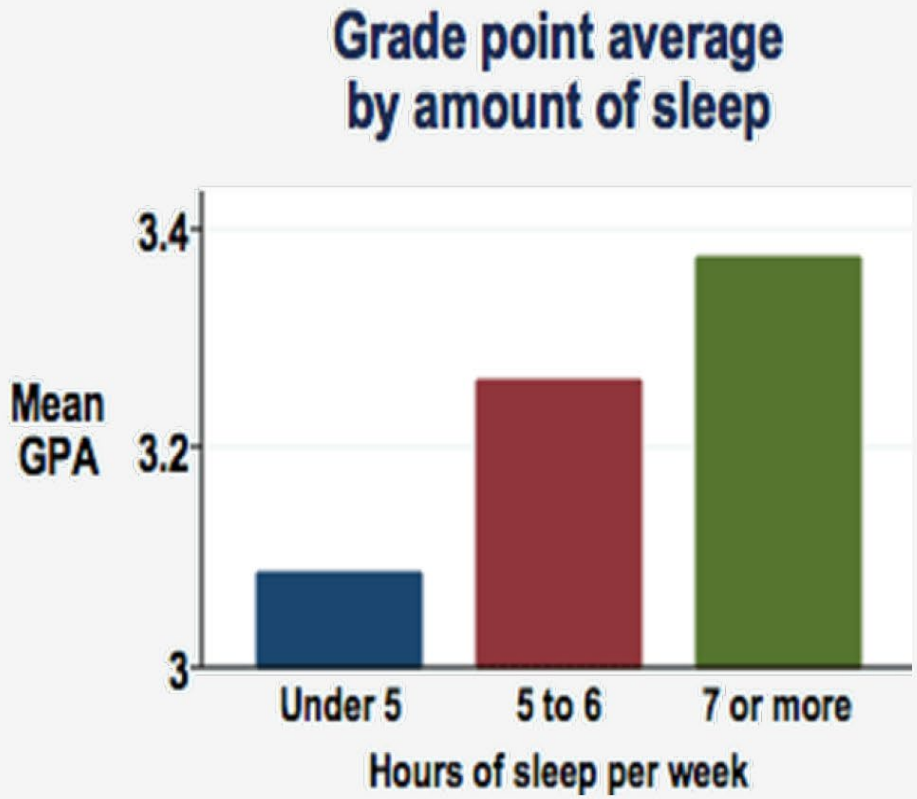
THE 3 BIG QUESTIONS FOR THIS LECTURE ARE:

WHAT IS SLEEP?

WHAT IS ITS RELATIONSHIP TO COGNITION?

HOW DOES IT RELATE TO YOUR HEALTH?

What does sleep have to do with it anyway?



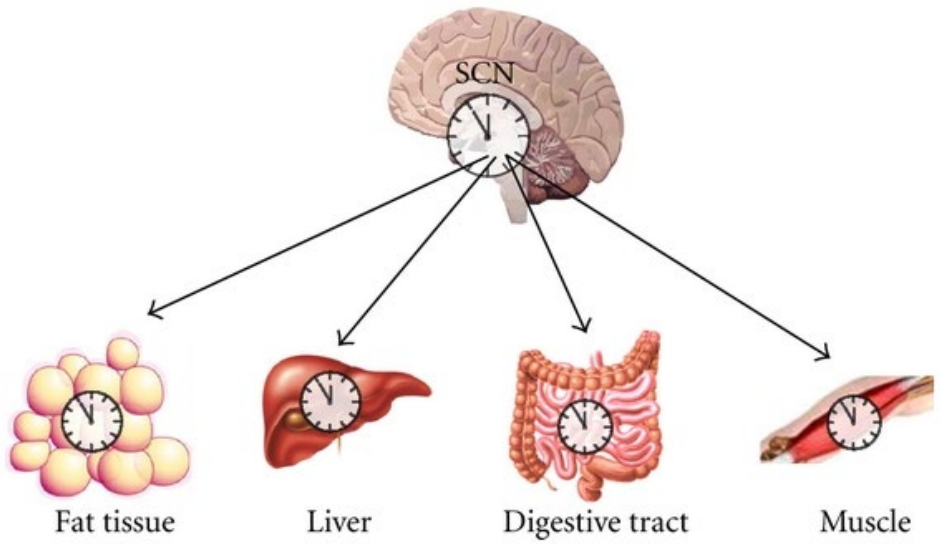
https://www.berkeley.edu/news/media/releases/2008/01/23_ucues2.shtml

HOW DO WE FALL ASLEEP?

External Cues

- What is a zeitgeber? Examples?
- What is the role of melatonin and light in regulating circadian rhythms?
- What is so important about blue light?
- What factors are associated with our ability to go to sleep?

Internal Regulators of Sleep & Wakefulness



How does it perform this function?

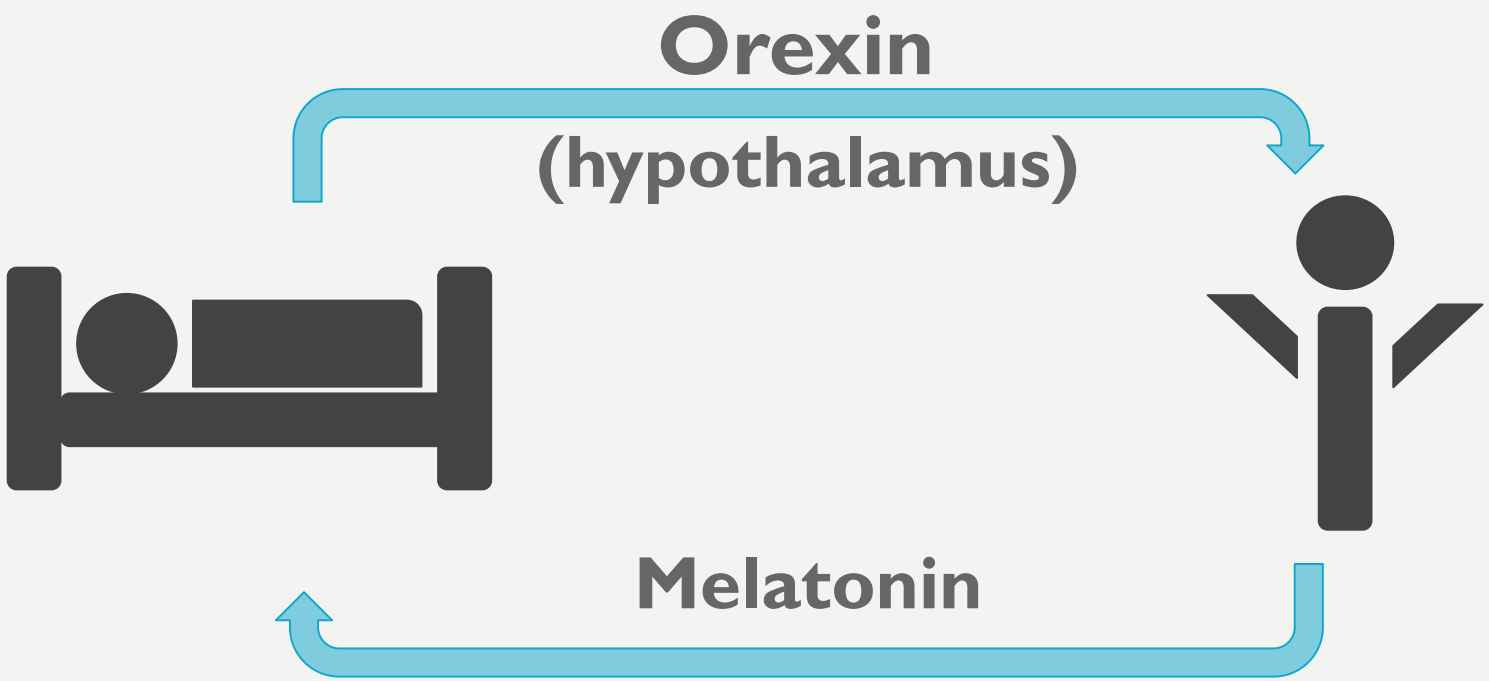
SUPRACHIASMATIC NUCLEUS (SCN)

What is it?

Where is it?

What is its function?

MORE REGULATORS…



(SCN - bundle of cells located in hypothalamus)

Adenosine (Basal forebrain and cortex, ↑ awake time ↑production)

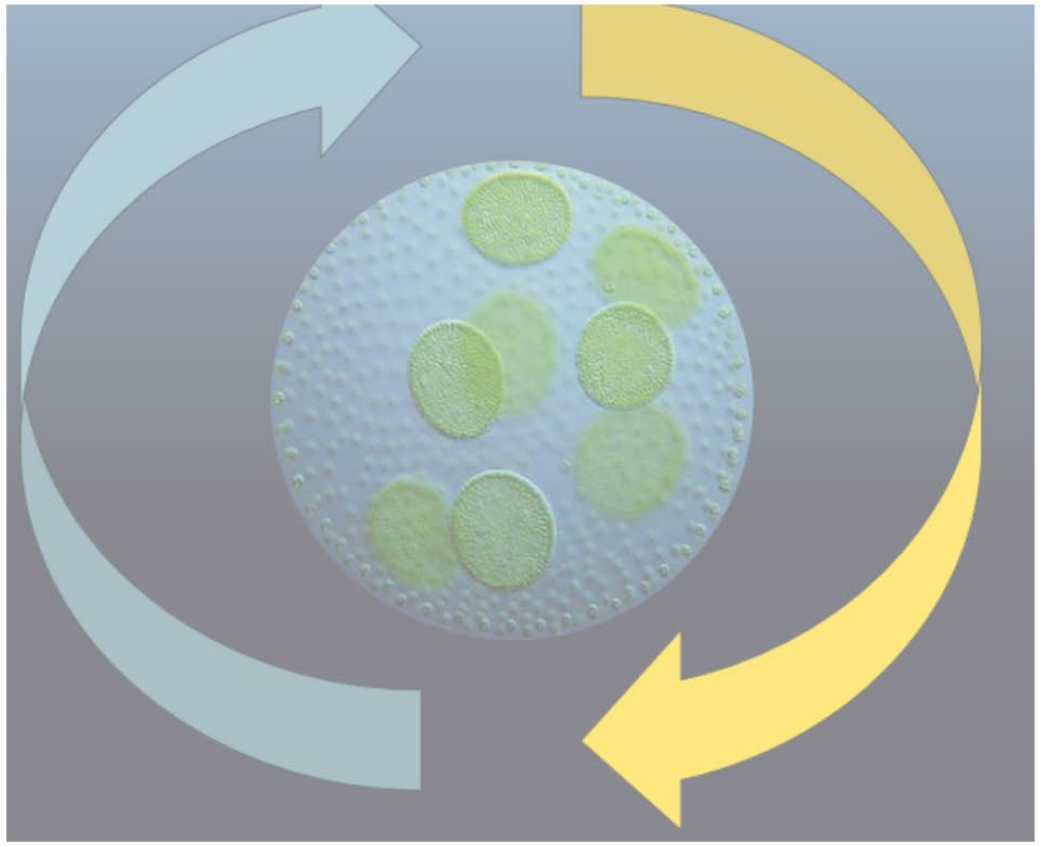
ME AND YOU AND CYANOBACTERIA:

How are we similar to cyanobacteria?

- Predict rather than respond!
- Anticipate metabolic demands by increasing or suppressing protein expression, hormone, and neurotransmitter release

Why does “When we go to bed affects how long you sleep, no matter how tired you are.”?

How is the functionality of insulin affected by time of day?



What happens to your body when you fall asleep?

SWS
(slow wave sleep)

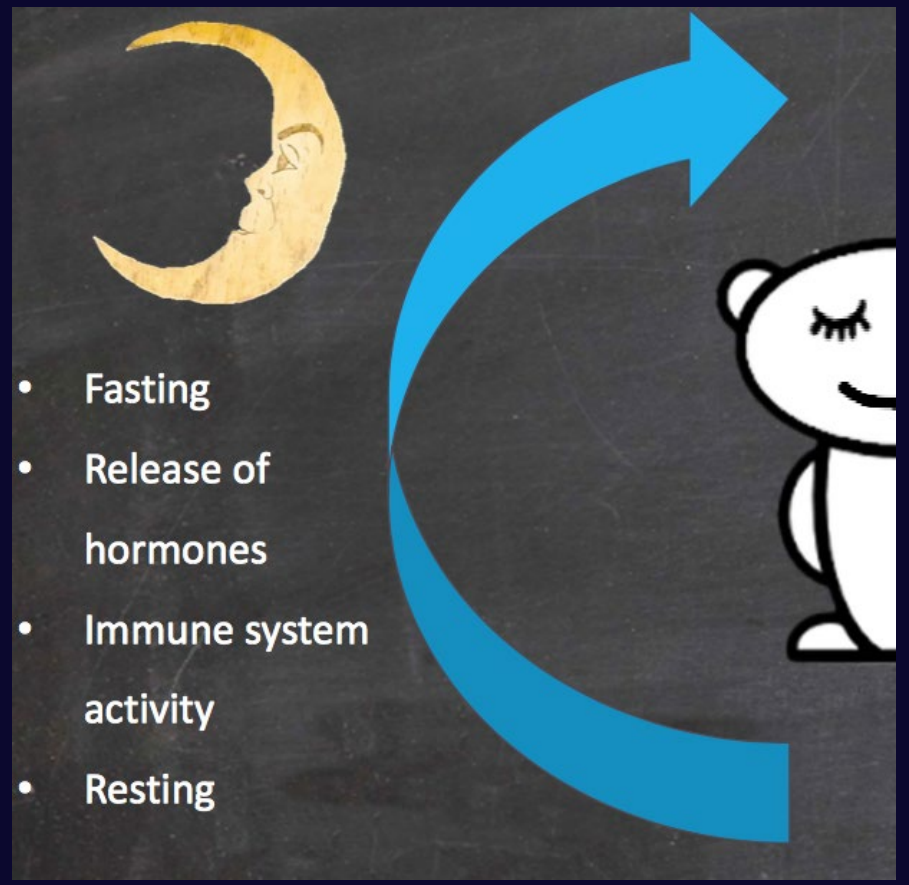
- muscle relaxation
- ↓HR, BP, body temperature

REM
(rapid eye movement)

- atonia (muscle paralysis; exceptions for respiratory muscles-yay! And eye muscles)

- Both duration of overall sleep and the duration of individual stages of sleep vary over the course of development.

PHASES OF HEALTHY SLEEP:



EFFECTS OF SLEEP DEPRIVATION:

Short term sleep deprivation leads to:

- Cognitive and behavioral changes
- Decreased ability to concentrate
- Decreased short-term memory
- Paranoia and hallucinations

Long term sleep deprivation leads to:

- Cardiovascular stress (elevated heart rate and blood pressure)
- Disruption of the glymphatic system and thus build up of toxins
- Impaired executive functions
- Impaired emotional responses
- Impaired decision making

In children chronic sleep deprivation may lead to hyperactivity and impaired interpretation of social cues

CHRONIC SLEEP DEPRIVATION DISORDERS

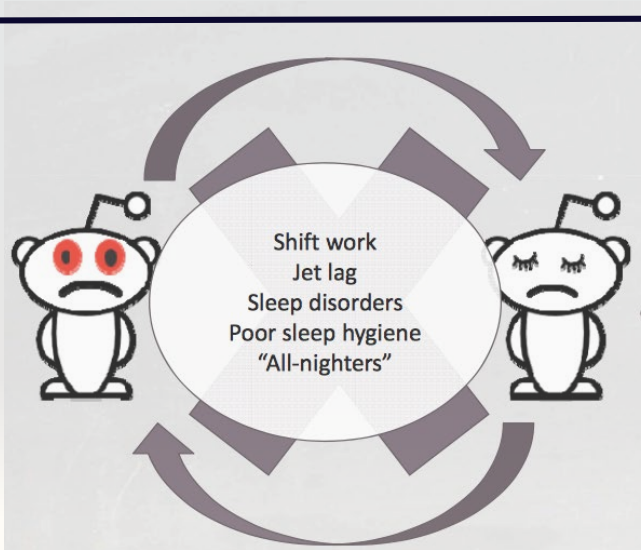
REM-sleep behavior disorder

- Paralysis during REM sleep does not occur
  → dreams are acted out
- Increased risk for neurodegenerative diseases

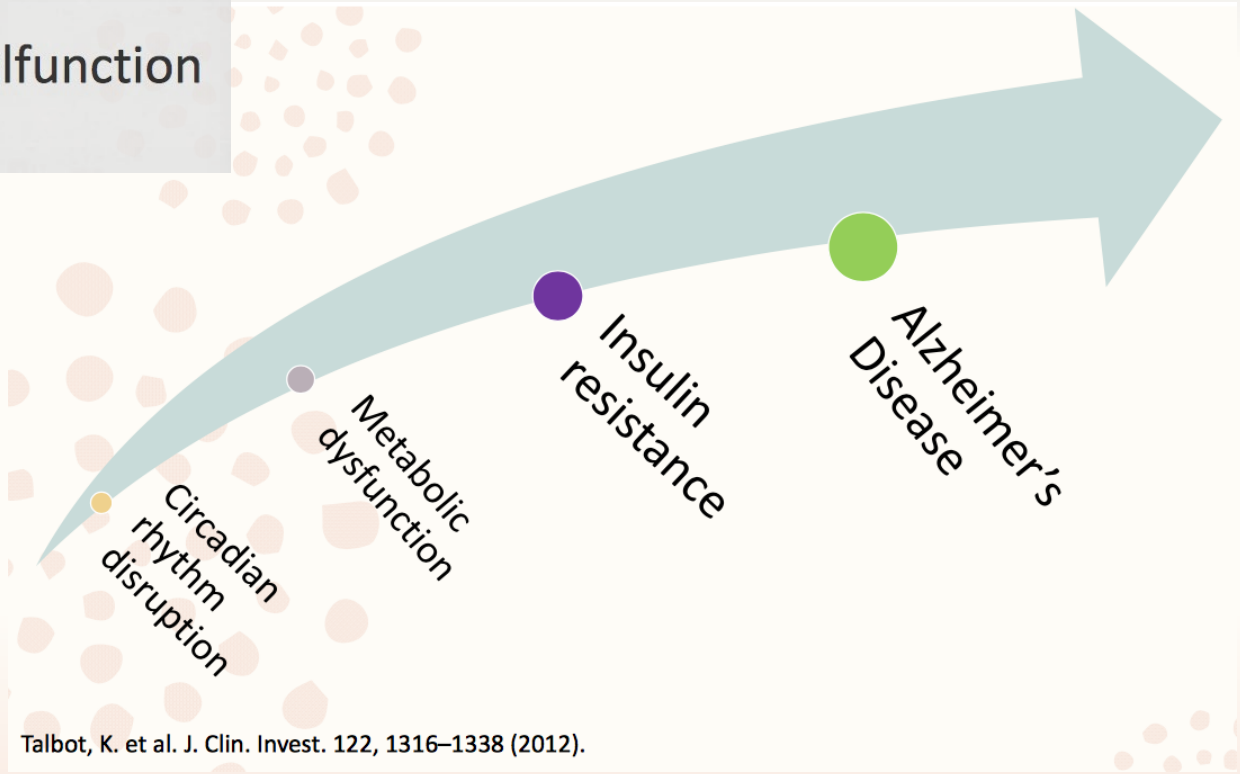
Sleep apnea

- Breathing pauses for seconds to minutes during sleep
  → body briefly jolts to continue breathing
- Cognitive impairments
- Increased risk for diabetes, cardiovascular diseases

THE INFLUENCE OF SLEEP DISRUPTION ON DIABETES AND AD



- metabolic disruption
- weight gain, obesity
- impaired immunity
- cognitive malfunction



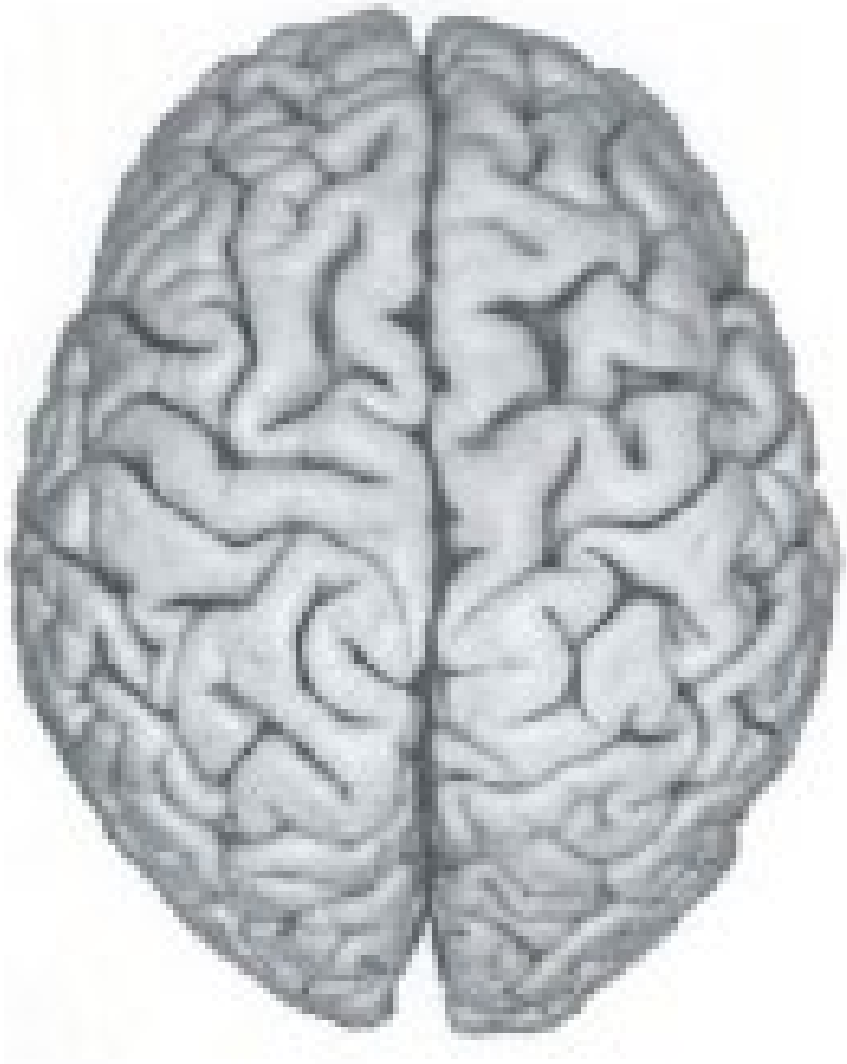
Talbot, K. et al. J. Clin. Invest. 122, 1316–1338 (2012).

OTHER SLEEP STUFF TO MAKE SURE THAT YOU UNDERSTAND:

- ❑ Where and what is the master clock?
- ❑ What is the big deal about blue light?
- ❑ What is sleep inertia?
- ❑ What is the cognitive and physical performance of someone who has not slept in a 24-hour period?

LATERALIZATION OF FUNCTION

- Coulson
- Week 2
- Quiz B
- Assigned Readings
  - Seeing the Brain Speak
  - Images of the Brain Refute Theory of Language



THE 2 MAIN QUESTIONS FOR THIS LECTURE ARE:

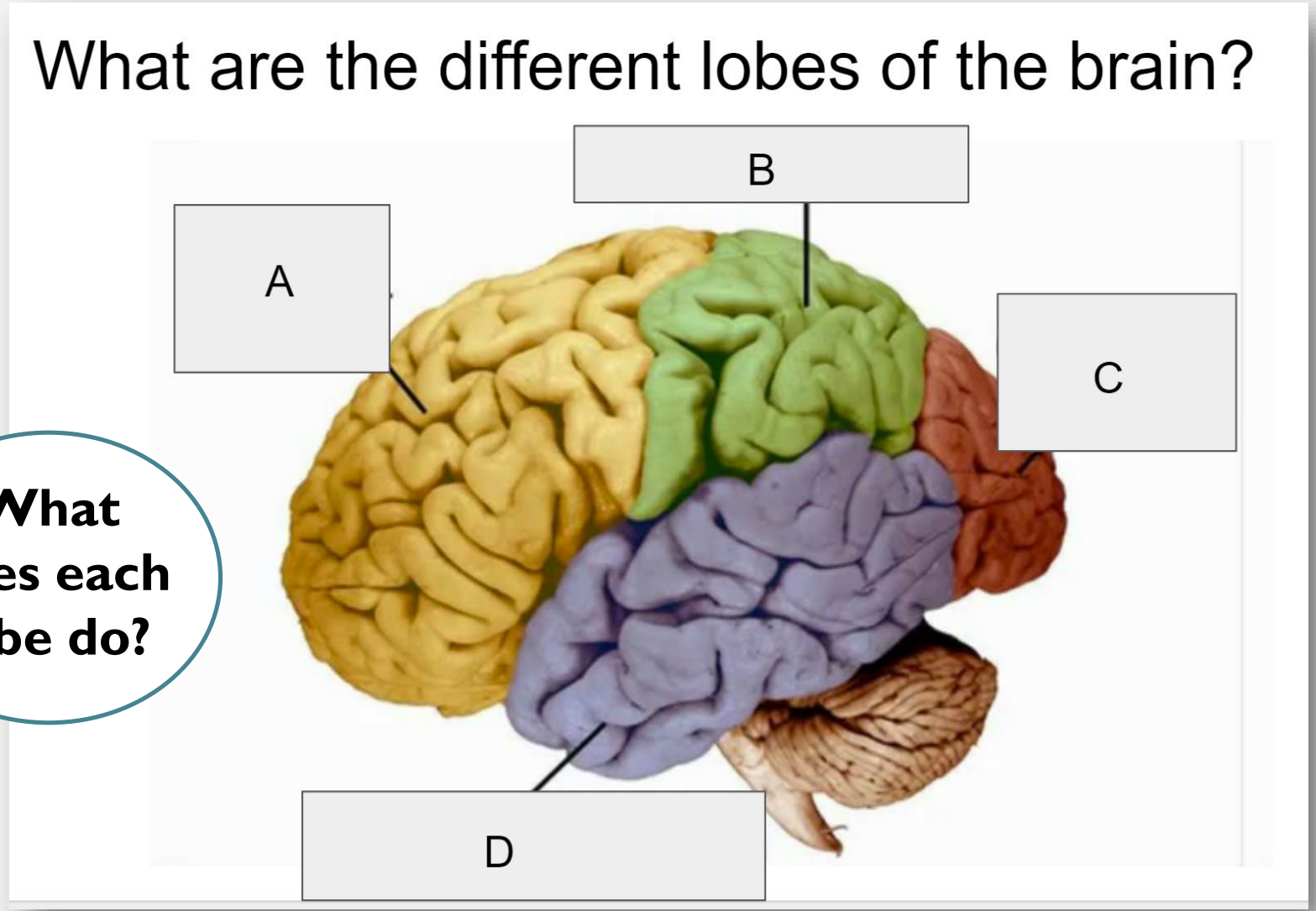
HOW IS THE BRAIN ORGANIZED?

HOW DOES LANGUAGE PROVIDE INSIGHT INTO THE ORGANIZATION?

GOTTA KNOW THE BRAIN!

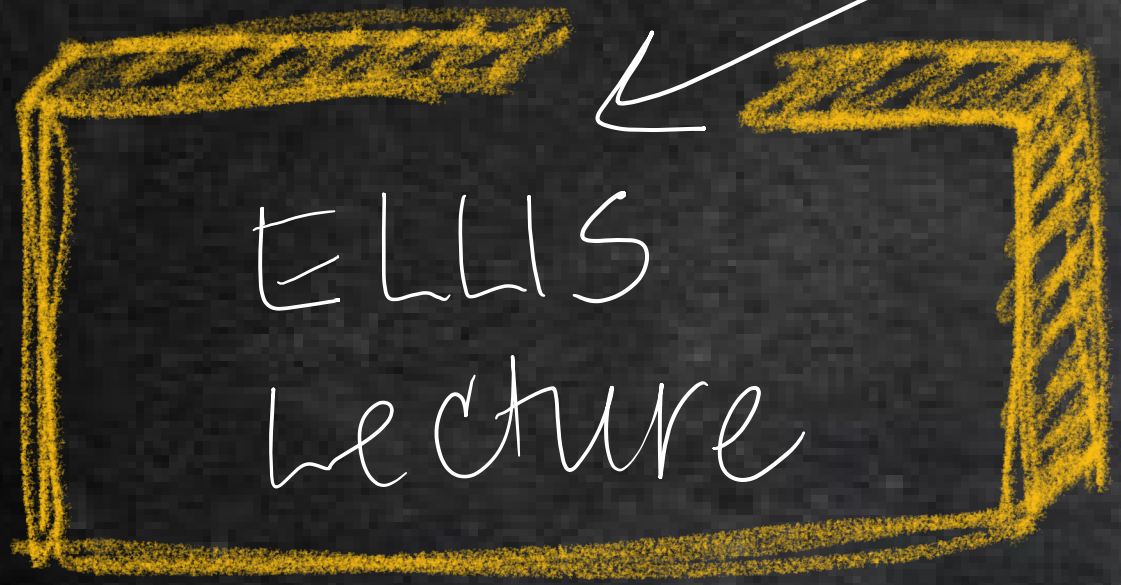
Where is:
M1
A1
V1
S1
Broca's area
Wernicke's area
SCN
Hippocampus
Corpus callosum
Dentate gyrus
CA1,CA2, CA3
?

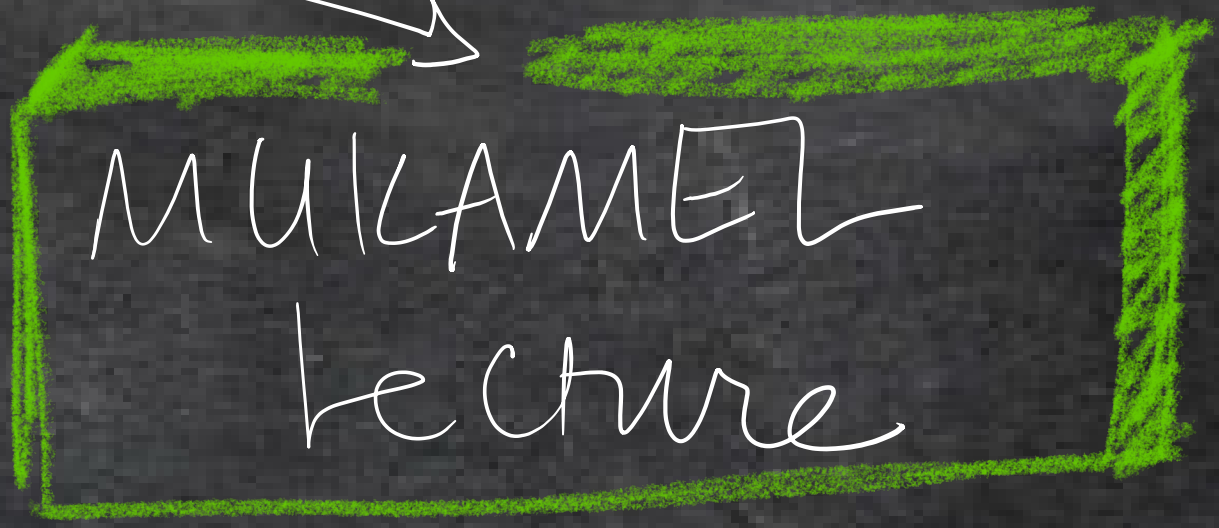
What does each lobe do?



Perspective:

Q. Why would COGNITIVE SCIENTISTS care about genetics and epigenetics?

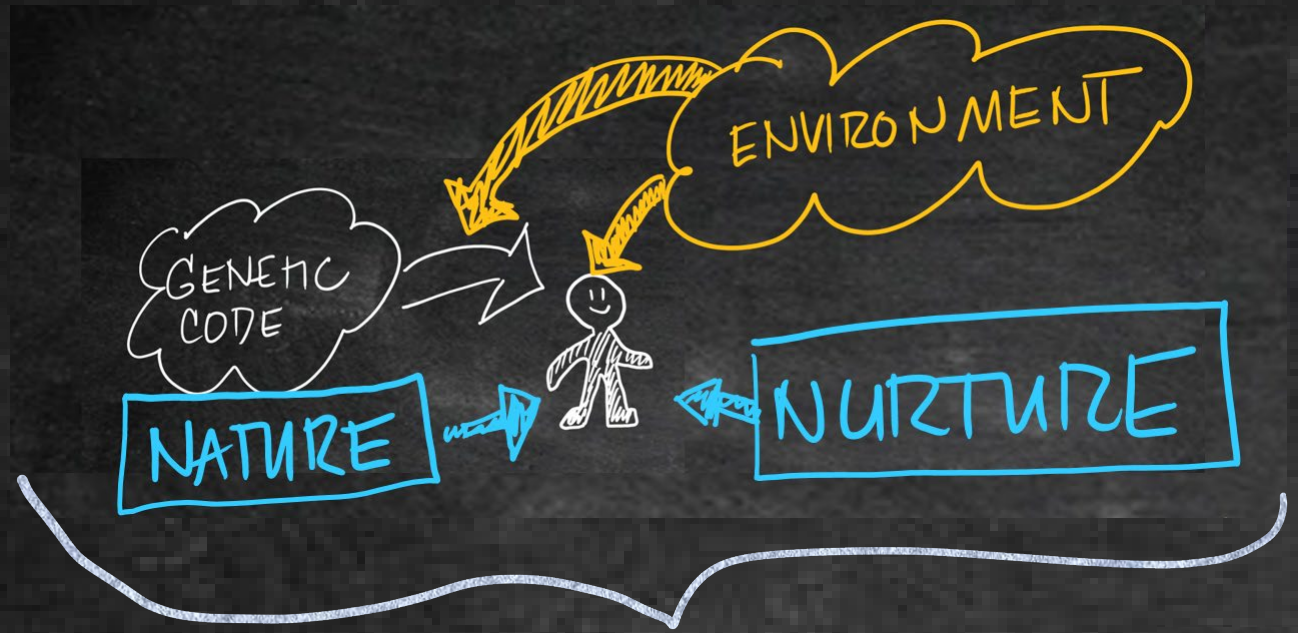




- DETERMINES A LOT OF WHO YOU ARE
- BUT, NOT EVERYTHING!

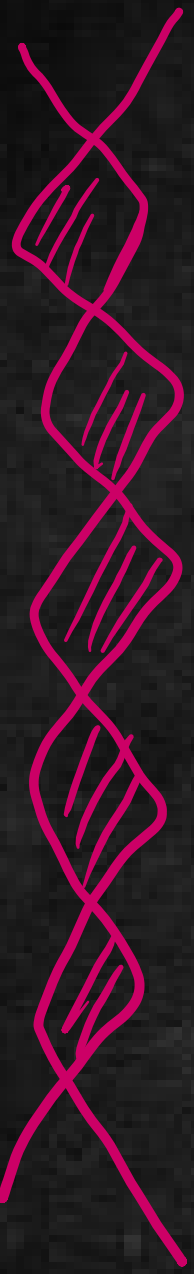
THE EPIGENOME "MARKS" CAN CONTROL THE GENOME'S FUNCTIONS.

EPIGENOME IS SENSITIVE TO THE ENVIRONMENT



MEMORY
DEVELOPMENT
DISEASE

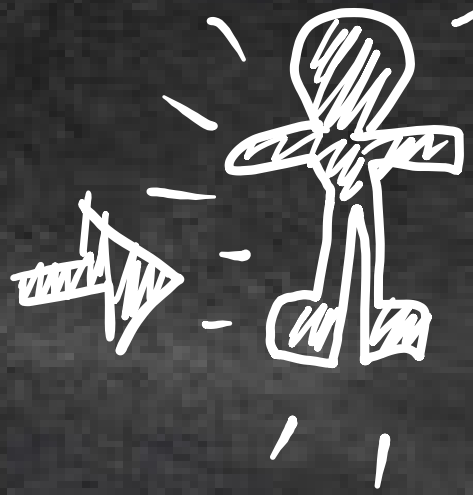
} COGNITIVE SCIENCE QUESTIONS



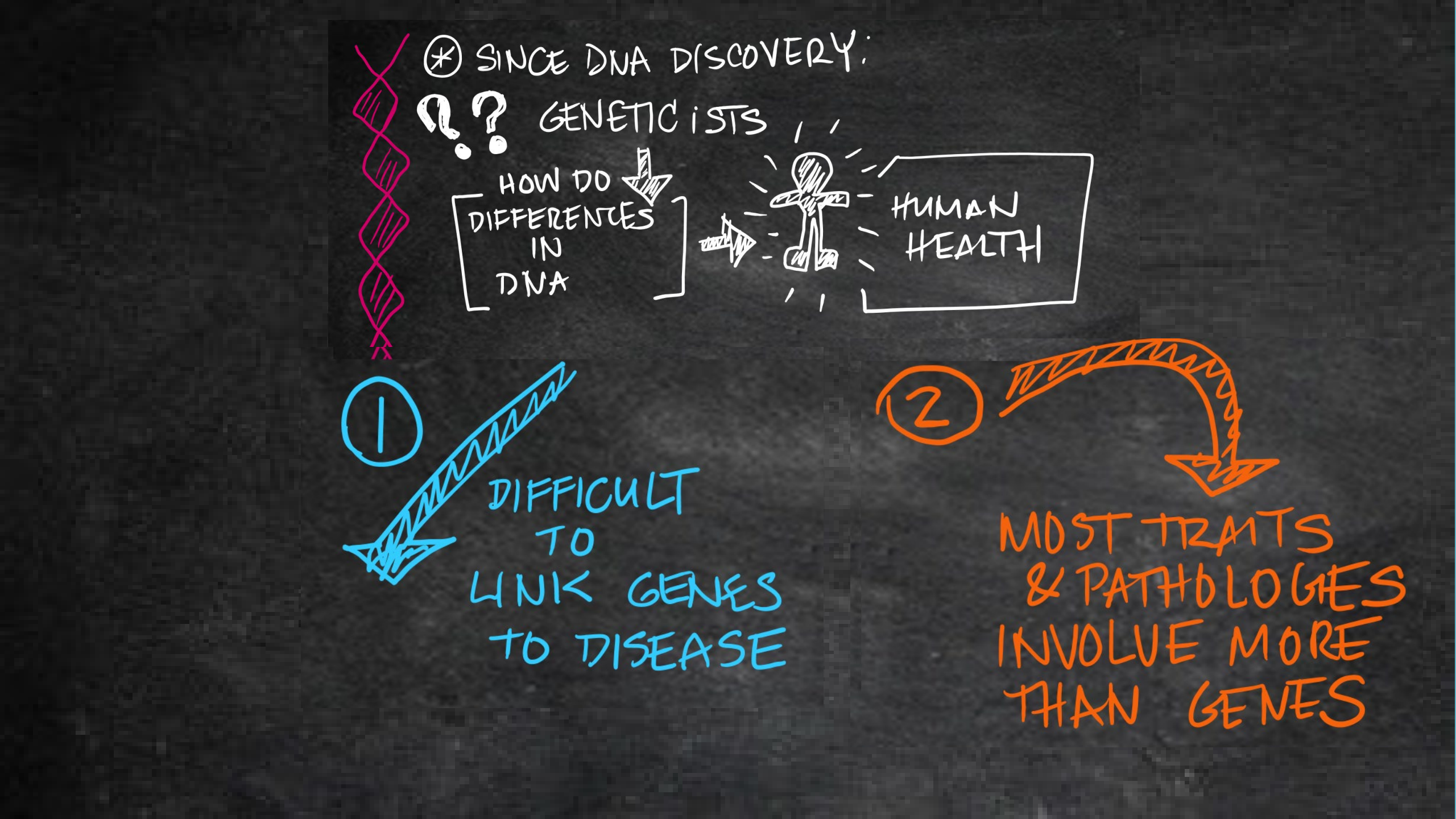
* SINCE DNA DISCOVERY:

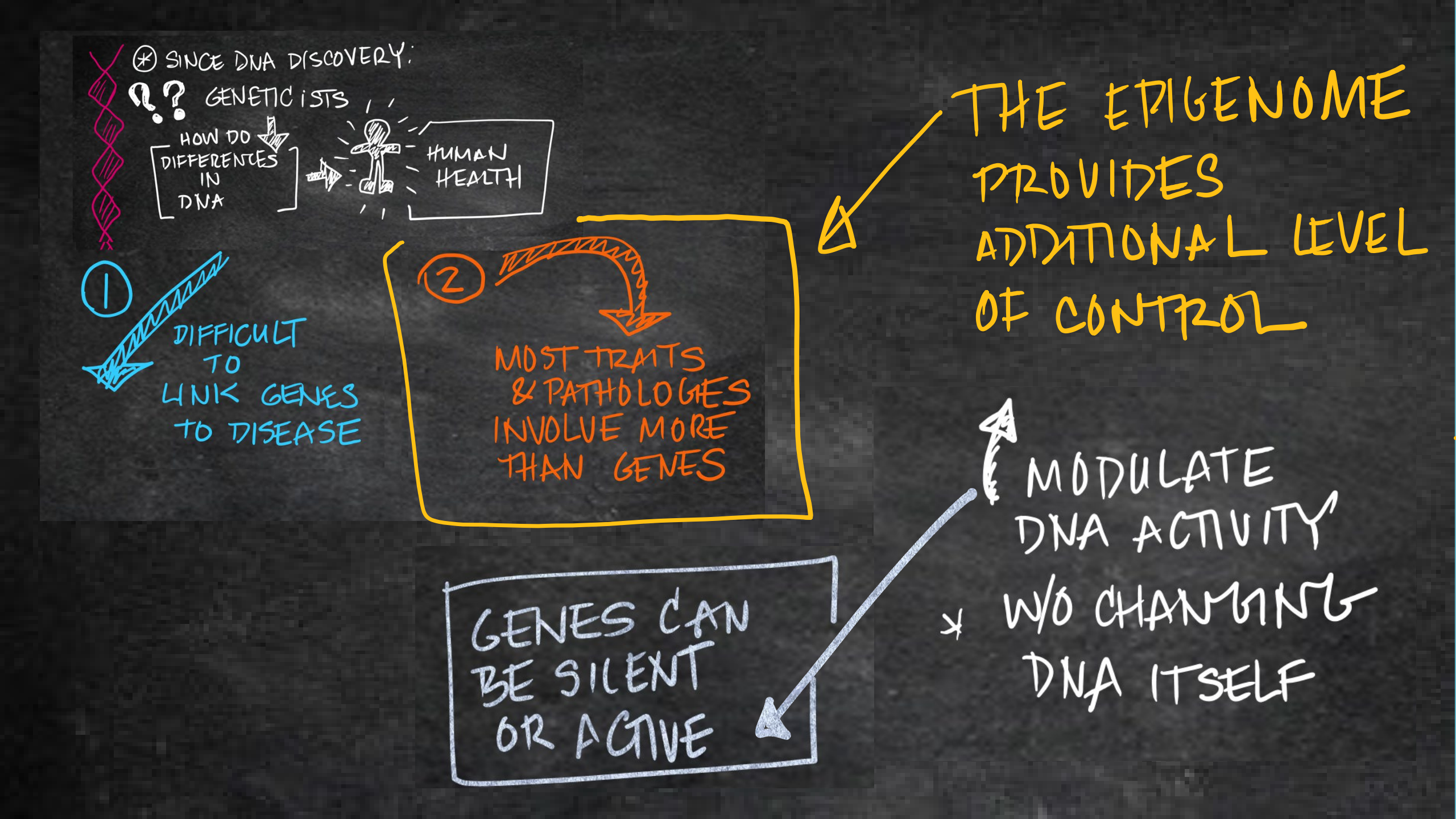
GENETICISTS

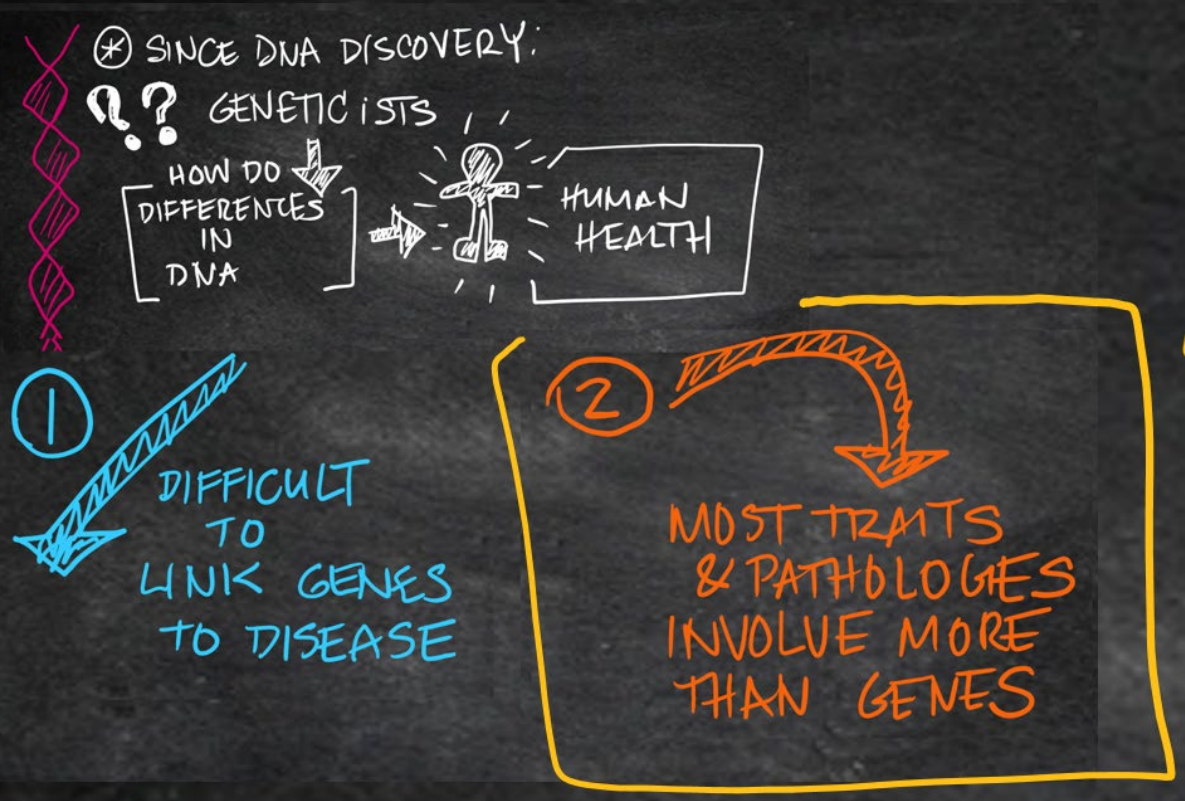
HOW DO DIFFERENCES IN DNA



HUMAN HEALTH


SINCE DNA DISCOVERY:
GENETICISTS
HOW DO DIFFERENCES IN DNA
HUMAN HEALTH
1
DIFFICULT TO LINK GENES TO DISEASE
2
MOST TRAITS & PATHOLOGIES INVOLVE MORE THAN GENES


SINCE DNA DISCOVERY:
GENETICISTS
HOW DO DIFFERENCES IN DNA
HUMAN HEALTH
1
DIFFICULT TO LINK GENES TO DISEASE
2
MOST TRAITS & PATHOLOGIES INVOLVE MORE THAN GENES
THE EPIGENOME PROVIDES ADDITIONAL LEVEL OF CONTROL
GENES CAN BE SILENT OR ACTIVE
MODULATE DNA ACTIVITY
W/O CHANGING DNA ITSELF

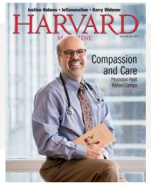


There is debate as to the heritability of epigenetic changes

EPIGENETIC PROCESS

① DYNAMIC - NOT FIXED

↓ the effects can be seen in multiple generations

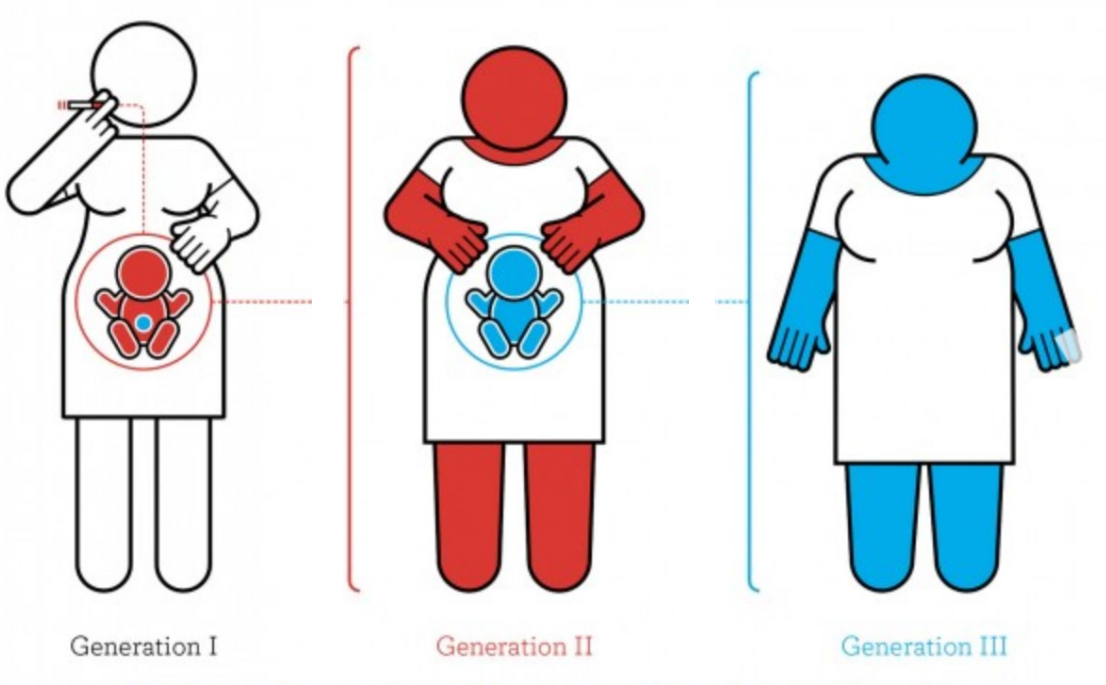


RIGHT NOW | ON AGAIN, OFF AGAIN

Is Epigenetics Inherited?

by JONATHAN SHAW

MAY-JUNE 2017



A woman who smokes while pregnant induces epigenetic changes in three generations at once: In herself, her unborn daughter, and her daughter's reproductive cells.

https://harvardmagazine.com/2017/05/is-epigenetics-inherited

Week 3.

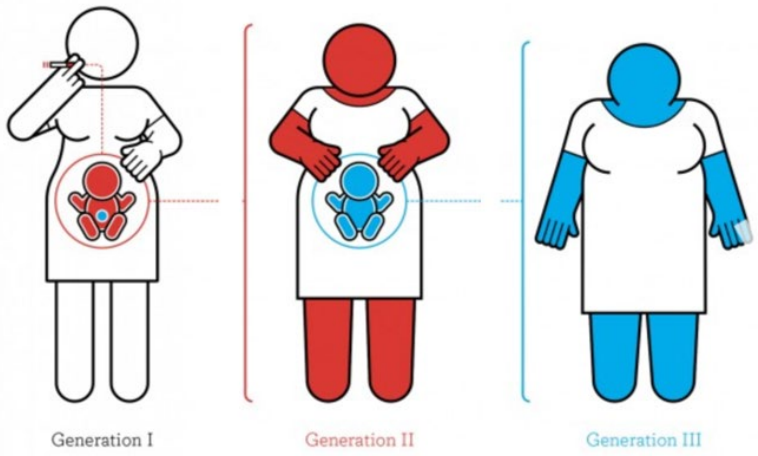
Dr. Eran Mukamel - Tales of Adversity

read

Tales of Adversity reading.

It is well established that a pregnant woman's habits affect the health of her unborn child, but the extent of the impact is less well known. Recent studies of tragic historical events, namely the Dutch Hongerwinter and the Great Chinese Famine, have begun to highlight the trans-generational relationship between food and genes.

Many children conceived during the Hongerwinter were small and underweight. What's more, certain health problems have persisted long into their adult lives. Compared to their siblings conceived before or after the famine, the Hongerwinter children are at increased risk for obesity, for example. A propensity for obesity was also found in children of the 1968–1970 Biafra famine in a recent study in Nigeria.



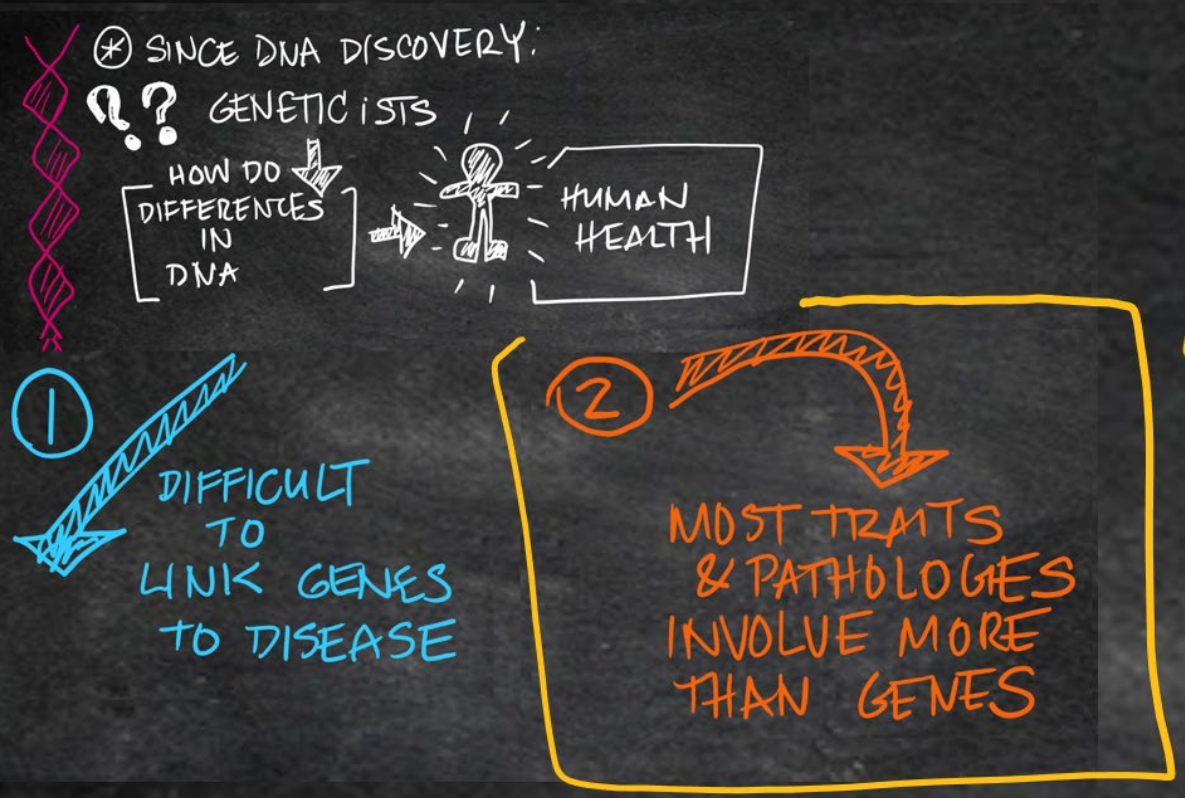
LAMARCK

Theory of Inheritance of Acquired Characteristics

DARWIN

Theory of Survival of the Fittest

EPIGENETIC PROCESS



(2) STRONGLY INFLUENCED BY THE ENVIRONMENT

diet, toxin exposure, drugs, exercise, sleep

EPIGENETIC PROCESS

✱ SINCE DNA DISCOVERY:

?? GENETICISTS

HOW DO DIFFERENCES IN DNA

HUMAN HEALTH

1 DIFFICULT TO LINK GENES TO DISEASE

2 MOST TRAITS & PATHOLOGIES INVOLVE MORE THAN GENES

3 CAN IMPACT ANY STAGE OF LIFE

Development → maturity

EXAMPLE:

MUSCLE CELL

EPIGENETIC MARKERS GOVERN CELL DIFFERETIATION.

INTRO TO GENETICS WITH DATA SCIENCE

- Ellis
- Week 2
- Quiz B
- Assigned Reading:
  - Predicting your future using your genes.

THE 2 MAIN QUESTIONS FOR THIS LECTURE ARE:

GENETICS – A WHIRLWIND TOUR

HOW CAN WE USE DATA SCIENCE TOOLS TO INFORM AND VALIDATE SCIENCE?

BRAIN CELLS AND EPIGENETICS

- Mukamel
- Week 3
- Quiz C
- Assigned Readings:
  - Epigenetics Explained-Scientific American
  - Mice Inherit Specific Memories, Because of Epigenetics
  - Tales of Adversity

THE 3 BIG QUESTIONS FOR THIS LECTURE ARE:

WHAT IS EPIGENETICS?

HOW DOES EPIGENETICS INFORM THE NATURE/NURTURE DEBATE?

WHAT TOOLS/TECHNIQUES ARE USED TO UNDERSTAND COMPLEX DATA?

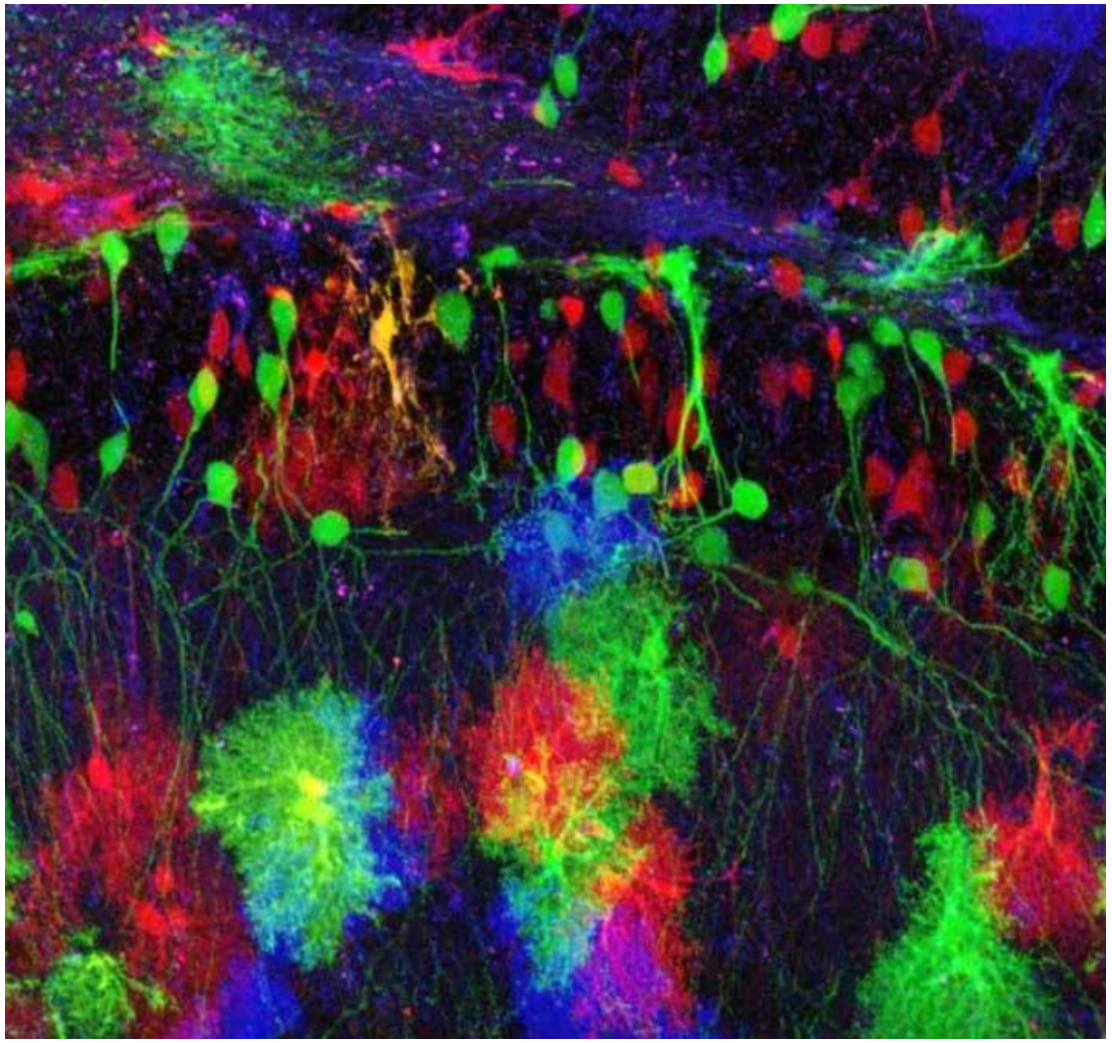
http://www.scientificamerican.com/article/epigenetics-explained/

HEALTH

Epigenetics Explained [Animation]

By Ricki Rusting on November 22, 2011

SCIENTIFIC AMERICAN™

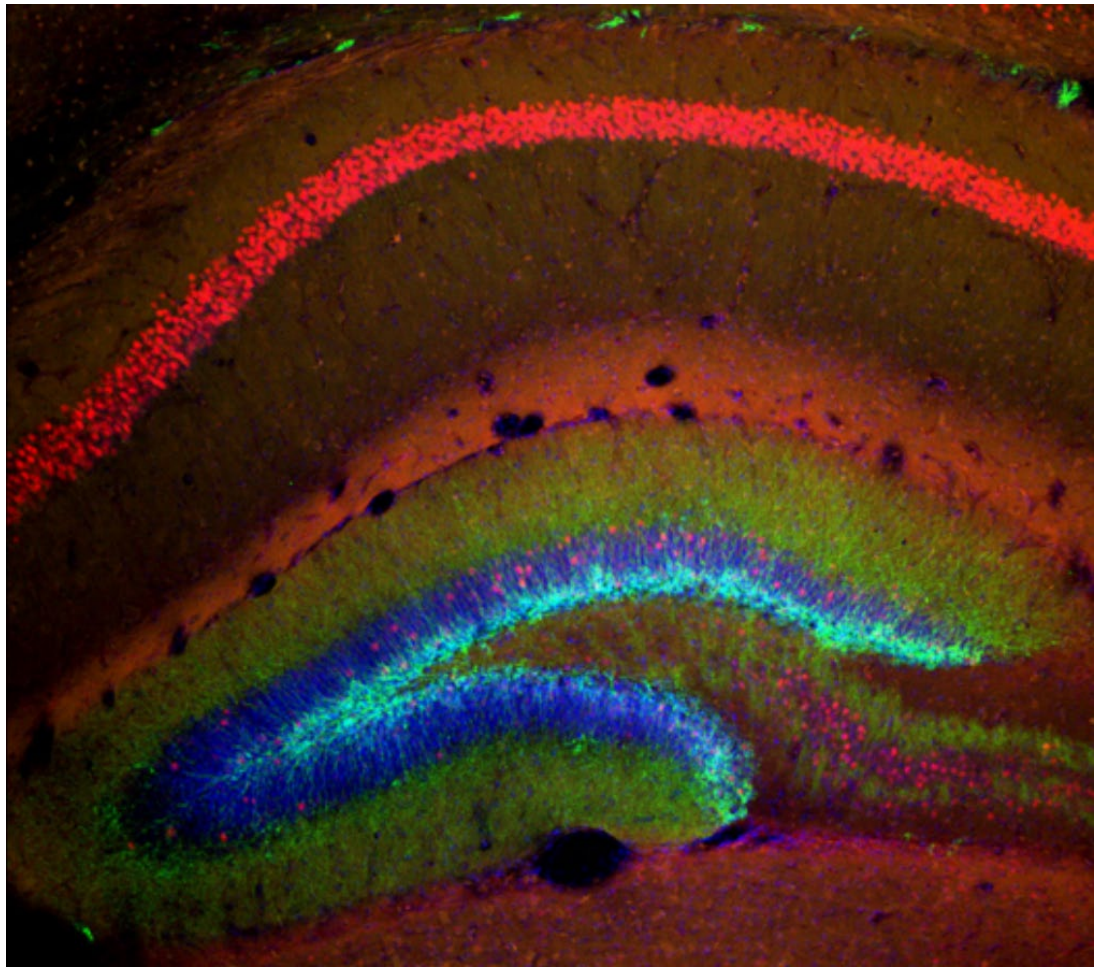


Categories of Differences:

- Location (area, layer)
- Connection (inputs / outputs)
- Electrical / chemical responses
  - Excitatory or inhibitory?
- Morphology

ADULT NEUROGENESIS

- Rangel
- Week 3
- Quiz C
- Assigned Reading:
  - Saving New Brain Cells

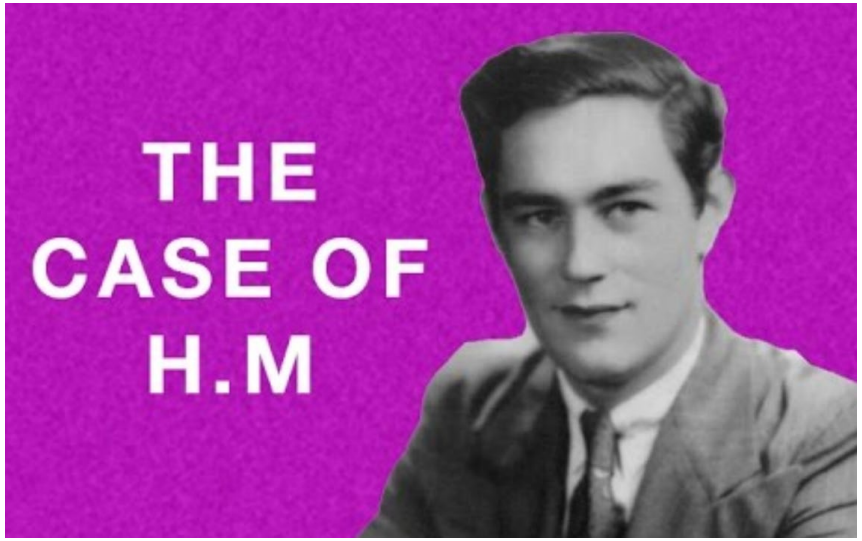


THE 3 BIG QUESTIONS FOR THIS LECTURE ARE:

WHAT IS NEUROGENESIS?

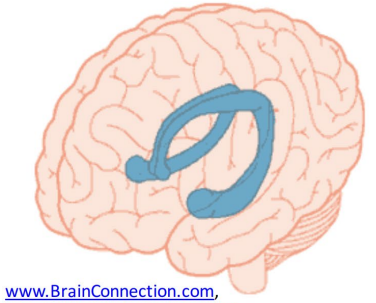
WHERE AND WHEN DOES NEUROGENESIS OCCUR?

HOW DOES NEUROGENESIS IMPACT COGNITION?



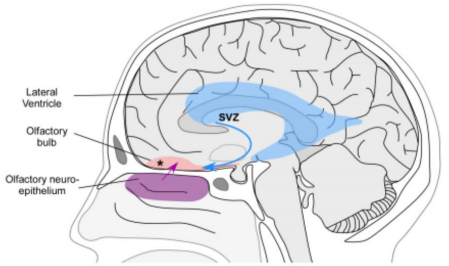
There are two main neurogenic regions

The **subgranular zone**
of the dentate gyrus:

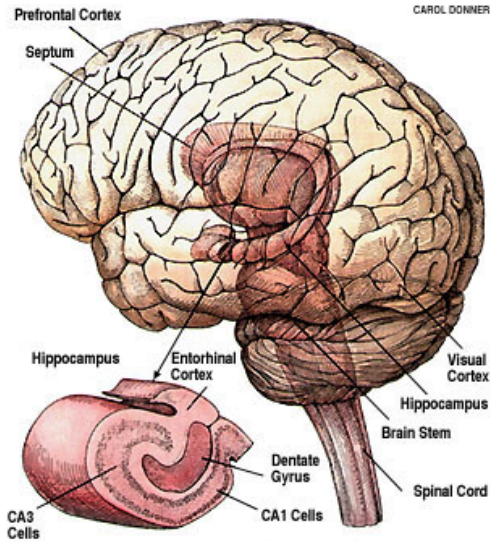


www.BrainConnection.com,
Scientific Learning Corp., 1999

The **subventricular zone**
of the lateral ventricle:

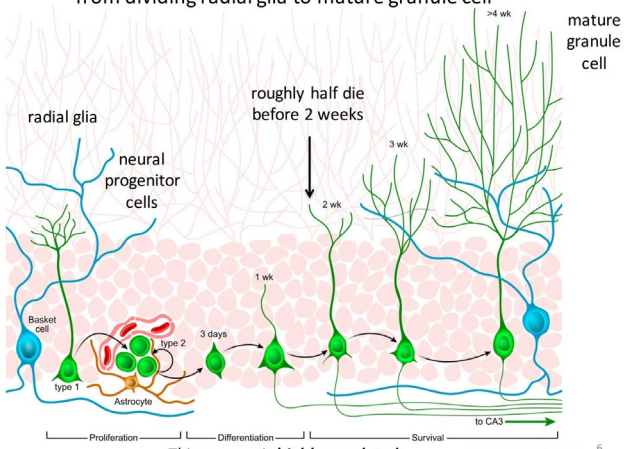


Huart, Rombaux, and
Hummel, 2013



New neuron development:

from dividing radial glia to mature granule cell



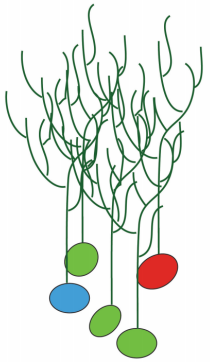
This process is **highly regulated**

Aimone et al., 2014

The dentate gyrus is important for helping us discriminate between similar experiences.

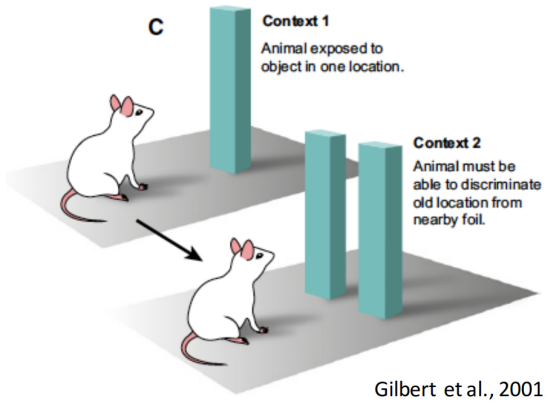
Neurons in the dentate can detect differences between experiences by demonstrating highly selective and specialized activity.

Adult-born neurons may facilitate the allocation of selective and dedicated activity for new experiences in the dentate gyrus.



The dentate gyrus (in the hippocampus) is important for being able to discriminate between similar experiences.

Rats require a dentate gyrus in order to discriminate between a new and old spatial location.

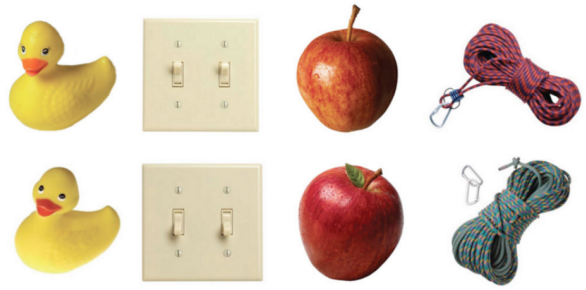


Gilbert et al., 2001

Aimone et al., 2011

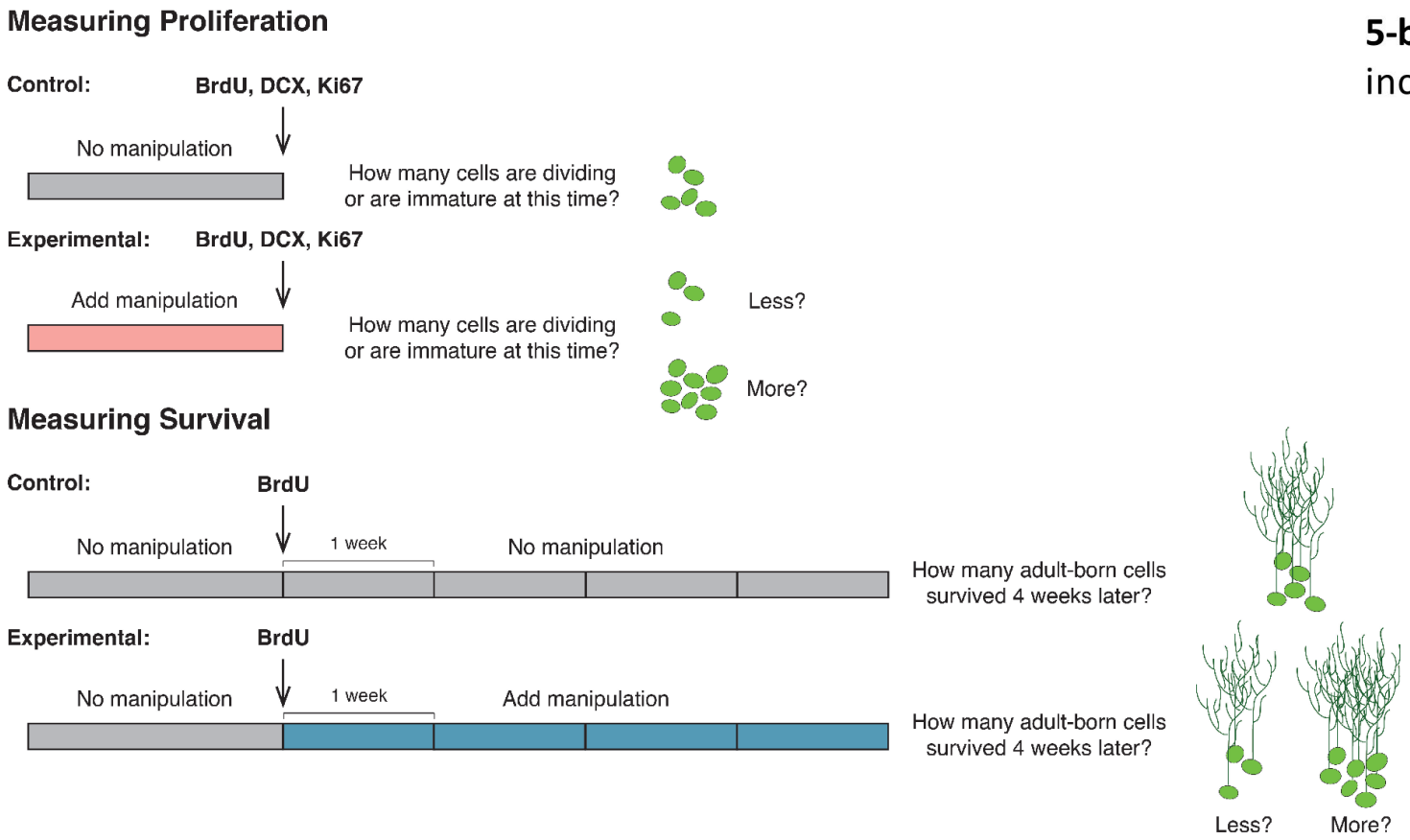
The dentate gyrus (in the hippocampus is important for being able to discriminate between similar experiences.

Humans show stronger activation of dentate gyrus when presented with an object subtly different from another object seen previously.

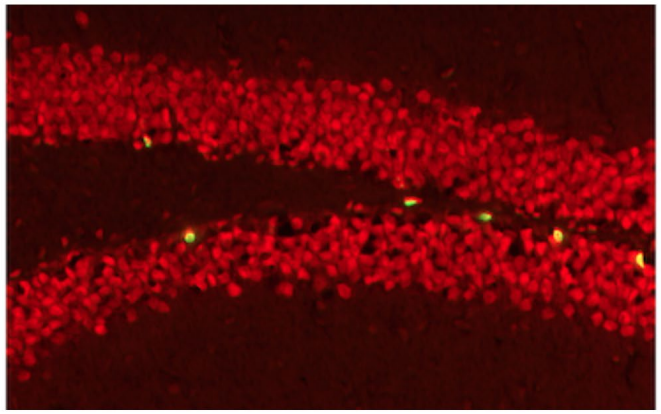


Bakker et al., 2008

Quantifying neuron **proliferation** (rate of division) and **survival**



5-bromo-2'-deoxyuridine (BrdU): a thymidine analog that is incorporated into the DNA of dividing cells during their S-phase



Mak et al., 2013

Proliferation (rate of division):

- Stress
  Schoenfeld and Gould, 2012
- Physical Exercise
  van Praag et al., 1999
- Antidepressants
  Boldrini et al., 2009
- Aging
  Kuhn et al., 1996
- Seizures
  Jessberger and Parent., 2015

decreases

increases

increases

decreases

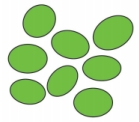
increases

Adult neurogenesis can be regulated at different stages of neuron development.

Increased proliferation does not necessarily mean that there are more that survive.

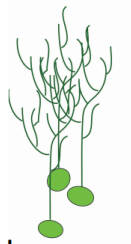
Many things can influence adult neurogenesis

survival is highly regulated

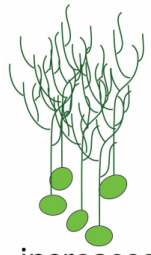


Survival:

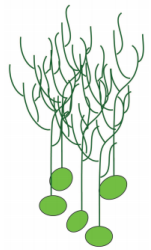
- Learning
  Dupret et al., 2007
- Alcohol
  Crews and Nixon, 2004
- Dietary Restriction
  Kitamura et al., 2006
- Enriching Environments
  Tashiro et al., 2007



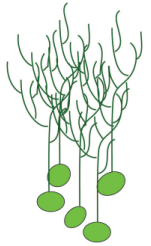
decreases



increases



increases



increases

	**How Babies Think* *(*EC Prereading quiz: opens on TritonEd Wednesday, May 1 @ 4pm – Tuesday, May 2 @ 10am.*	Dr. **Deak** (5/2) How do we become socially skilled?	
6 May 7 – 9	*TBA*	Dr. **Kirsh** (5/7) TBA	Quiz E in section
	What Profanity Teaches Us About Ourselves	Dr. **Bergen** (5/9) Your Brain on Swearing	**REVISED** **10:46 pm, Apr 24, 2019**

Continued on next page

7 May 14 – 16	**For Dummies — The Introduction to Neural Networks we all need!* *(*EC Prereading quiz: opens on TritonEd Monday, May 13 @ 4pm – Tuesday, May 14 @ 10:00am)* *#A Six Unit Network is All You Need to Discover Happiness* *(#Optional reading)*	Dr. **Cottrell** (5/14) Introduction to Neural Networks Dr. **Boyle** (5/16) Midterm-2 Review	Quiz F in section Next week: Midterm 2 – May 21st in class- scantron provided ☺

note: EC QUIZZES are before lecture

**How Babies Think* *(*EC Prereading quiz: opens on TritonEd Wednesday, May 1 @ 4pm – Tuesday, May 2 @ 10am.*	Dr. **Deak** (5/2) How do we become socially skilled?

⊛ THE PURPOSE IS TO PREPARE YOU FOR LECTURE!! ☺

REFRESH YOUR BROWSER.

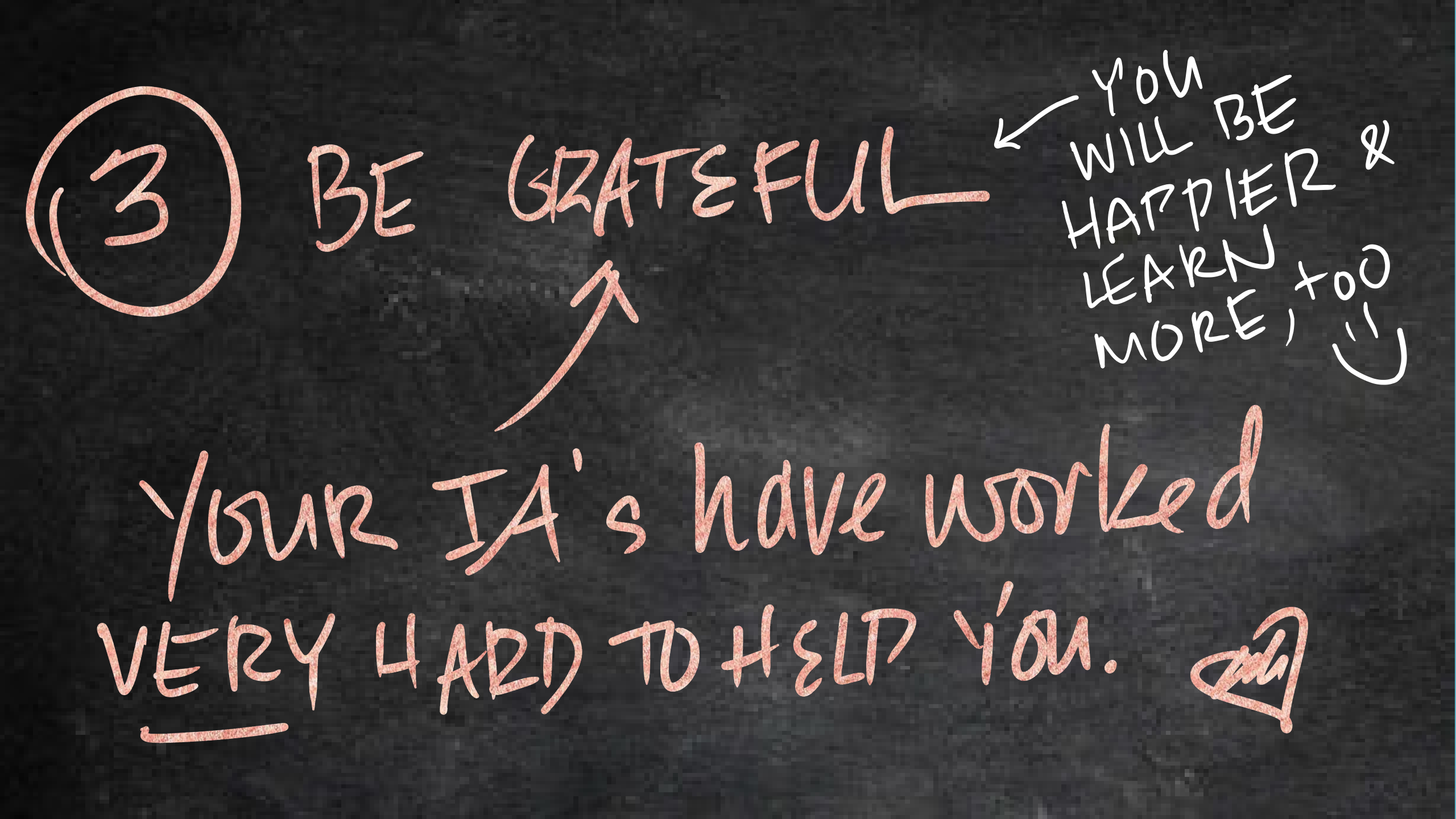
(OFTEN.!)

COMMENTS ON —

① BEING PROFESSIONAL

&

② KINDNESS


3
BE GRATEFUL
YOU WILL BE HAPPIER & LEARN MORE, TOO
YOUR IA's have worked VERY HARD TO HELP YOU.