



Think Again

Fall Term 2021

Class 8

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On Tap for Today

- Review
- Healthy Brains



Review from Last Week

- Last week we looked at a number of responses to brain waves and the release of neurotransmitters that we label as emotions.
- They are natural, protective, and healthy reactions that promote survival when use correctly.
- They can become harmful when they occur in the absence of appropriate stimuli, create too strong a response, or last too long.
- Thinking of them as brain chemical and electrical processes can help us use them in a healthy way.
- Even if we cannot control our feelings, we can control our behaviors.
- That goes a long way towards keeping us mentally and physically healthy.

Anger – What Is It?

- A number of you had questions about anger, particularly my statement that it was not an brain created emotion.
- The brain senses pain and threat and responds by redirecting blood flow to prepare for fight, flight, or freeze.
- Anger is directed at someone or some thing.
- Given the same brain activity, some might cry, some might feel disappointment, some might stay calm, and others might get angry.
- Anger is one response out of many to the same stimulus.
- Anger almost always requires attribution of wrongdoing to others, something the neurotransmitters do not do.
- Anger as a response can be limited by training and rational thought.



Today's Topic - Healthy Brain

There are a lot of ways to think about brain health. We will look at three of them:

Keeping the brain young

Emotionally based conditions

Physically based conditions

Science Behind Healthy Brains



- This week we will look at things that help keep our brains healthy or that may harm our brains.
- Next week we will look at some of the science that explains why some things are good for your brain and other things not so much.

The Brain Does Not Live in a Vacuum

- We will focus on the usual suspects but next week will also look at two related issues that are routinely left out of the conversation:
- The Human Microbiome
- Psychedelics



It's in the Jeans



Oops, Wrong Genes



Improving Brain Health

- Bad news is that not every bad thing can be prevented nor every good thing achieved.
- We cannot change our genes but we can influence their impact through epigenetics and processes that are modulated by other systems that we can impact.
- Good news is that there are things we can do to improve our brain health and improve the quality of our lives.
- Further good news is that most of what improves brain health also improves general health.

Aging Changes that Put Brain at Risk

- We almost never see dementia or Alzheimer's in young people.
- We produce lesser amounts of critical hormones.
- Telomeres shorten with each cell division.
- Reduced production of neural stem cells - [article](#)
- NAD+ (nicotinamide adenine dinucleotide) levels drop.
- Inflammaging
- Harm to brain caused by exposure to toxins and lack of sleep may be cumulative.
- Not all effects of aging are preventable or treatable.
- We can reverse some and slow others by lifestyle changes.

Older But Wiser

- Think of memory in terms of survival and procreation - identifying patterns and making predictions.
- Memories start with specifics but evolve into general principles or information common to multiple experiences. [Article](#) [Study](#)
- There is decline over time, but that is not the whole story.
- As we age, what appears to be memory decline may actually be a change in focus. [Article](#)
- Reading the same narrative, younger adults remember more of the details and older adults remember more of the concepts.
- Older adults often use different parts of the brain than younger adults but with the same capacity to remember. [Study Recap](#)

Superagers



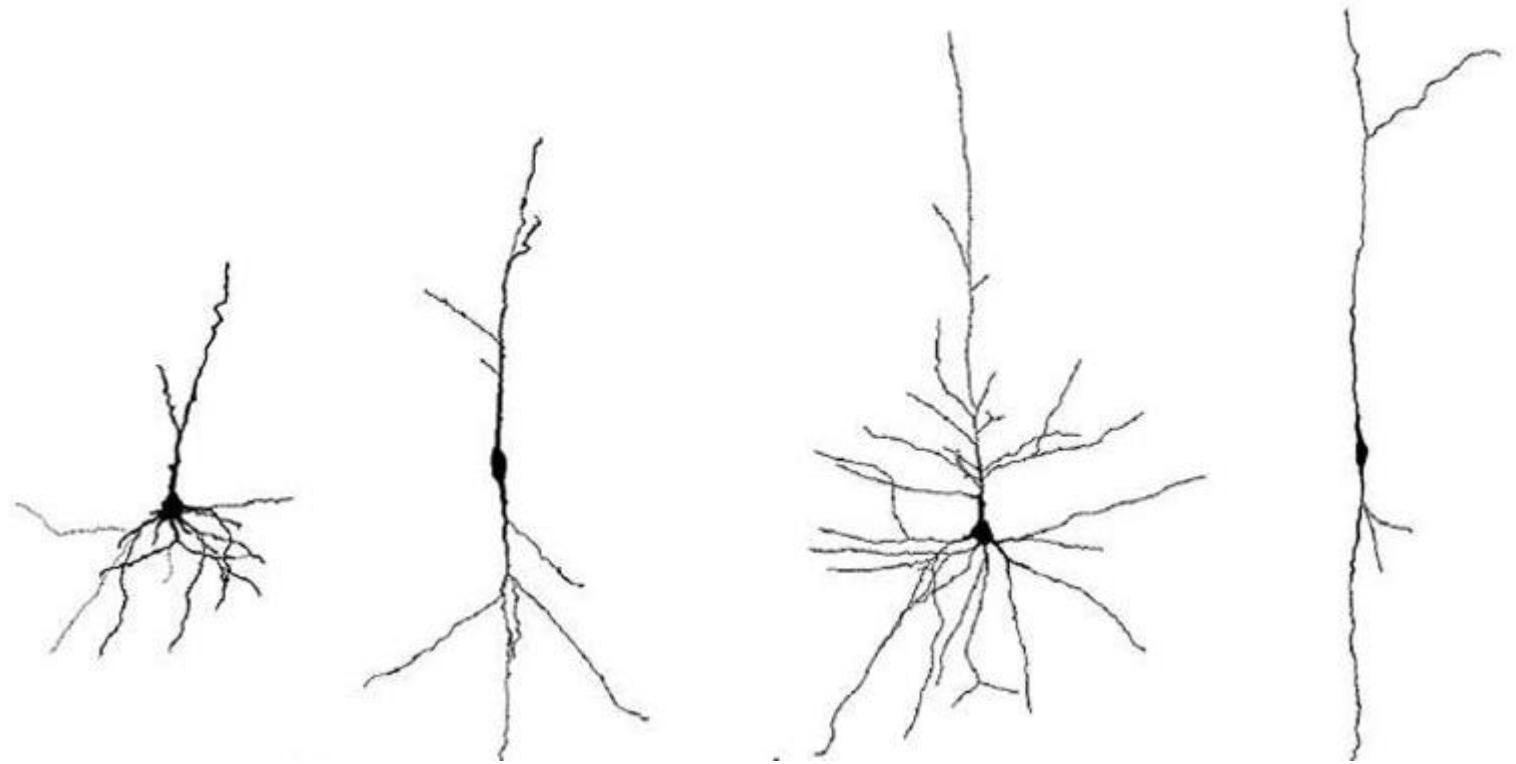
- Maintain high levels of cognitive functioning into 80's and 90's
- About 5% of population
- Differences in attitudes and lifestyles [Article](#)
- Unusually high number of spindle cells in Anterior Cingulate Cortex (ACC) - [Study](#)



Spindle Neurons

- Large neurons with spindle shaped, rather than pyramidal shaped neurons and single, rather than multiple, dendrites.
- Also called von Economo neurons after the man who discovered them.
- Find only in higher brain functioning species such as humans, great apes, and cetaceans.
- Primarily found in ACC and Fronto-Insular Cortex.

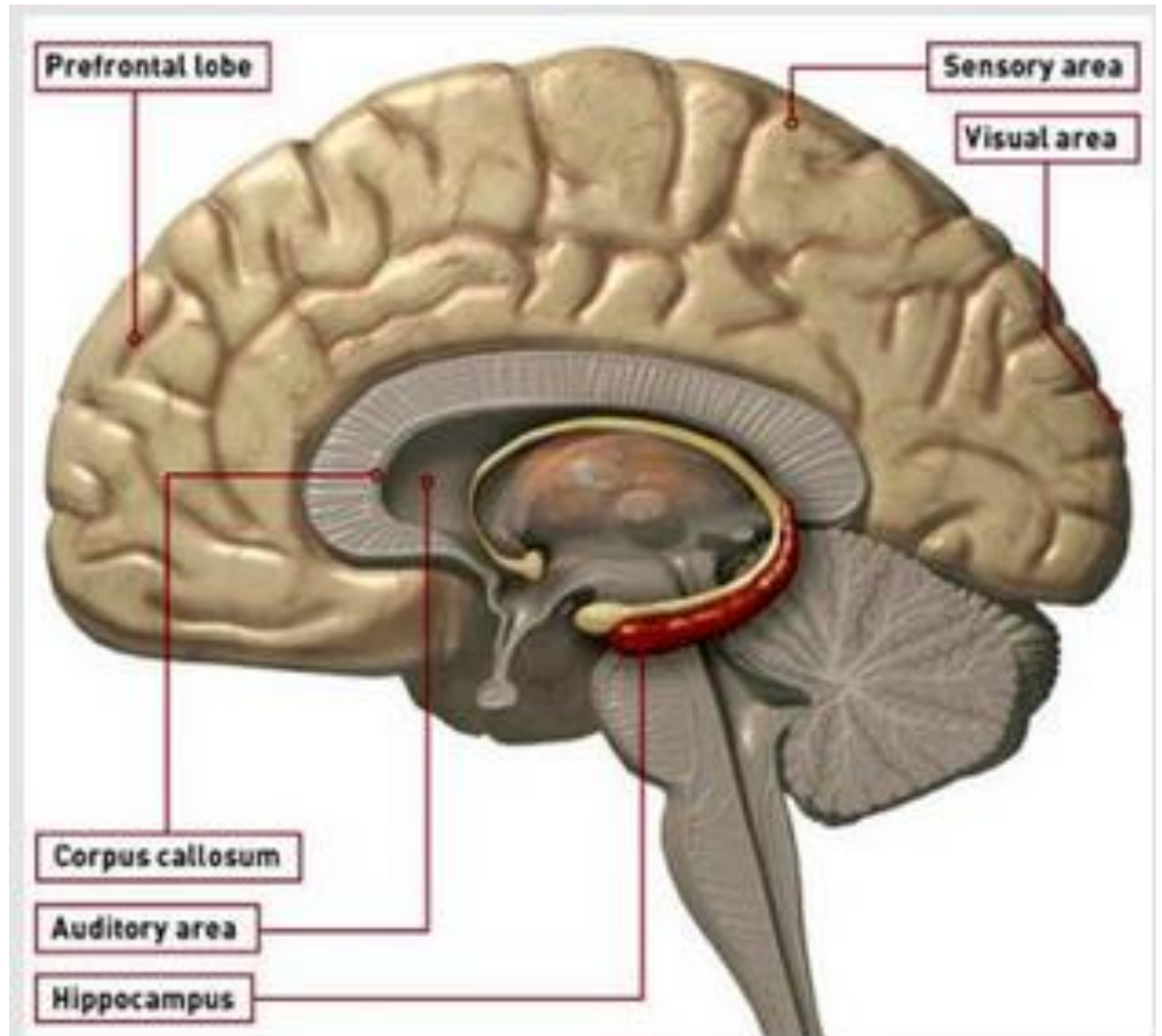
Pyramidal and Spindle Neurons





Hippocampus – Greek for Seahorse

Hippocampus Location



Hippocampus and Memory

- Hippocampus is the primary section of the brain that controls memory.
- It determines what to retain and whether to send it to the cortex for long term memory.
- The decision is based on repetition and intensity.
- Size of the hippocampus directly correlated to ability to remember.
- Hippocampus one of few areas of the brain that can grow over time.
- However, also tends to shrink with aging.

Retirement

- Retirement creates opportunities to improve relaxation, increase sleep, engage in creative activities, and many other benefits.
- Also creates risks such as declines in memory up to 38% [Study](#)
- Volunteering can maintain or even grow hippocampus. [Study](#)

The Brain is Complex

- Top scientists understand tiny percentage of how it works.
- We learn new things every day that either contradict what we thought we knew or add a different slant to it.
- The answer to the simplest question about the brain would always start with, “We do not really know”.
- What we cover in this class will be somewhat simplified.
- Virtually infinite articles and studies on brain health - must be read carefully and their limitations appreciated.
- Avoid the simplistic excuse of, “Why bother? It will just change tomorrow.”
- The limits of our knowledge, continual additions, and complexity should not justify avoiding what we believe to be positive steps.

Healthy Brain Interventions

Exercise

Try New Things

Adequate Sleep

Avoid or Eliminate Stress

Eat the Right Foods

Avoid Unhealthy Foods

Avoid Toxins

Dr. Sanjay

Video



Should We Believe It?



- A Priori – Independent of Experience
 - $2 \times 2 = 4$ (calculation)
 - Sine = Opposite/Hypotenuse (tautology)
 - $a^2 + b^2 = c^2$ (proof)
- A Posteriori – Dependent on Experience or Empirical Evidence
 - I like vanilla ice cream (personal experience)
 - Eating eggs increases cholesterol (logic)
 - Eggs do not increase cholesterol (empirical)
- Math is Deductive; Science is Inductive, always evolving



Evaluating Claims Research Gold Standard

- Human Studies
- Double Blind
- Random Assignment to Condition
- Large Number of Subjects
- High Statistical Correlation
- Effective Control of Other Variables
- Successful Replication



Lesser Value Alternatives

- Empirical but not controlled
 - Human Studies
 - Longitudinal
 - Population
- Animal Studies
- Logic
- Anecdotal

Choosing for Yourself

- Review empirical or logic model.
- Understand complexity and limits of our knowledge.
- Do no harm.
- Look for multiple benefits.
- Experiment.
- Pay attention to internal signals.





"STRESS"



Persistent Fear, Anxiety, and Stress

- Fine line distinguishes between the healthy and unhealthy versions.
- Stress and fear are responses to external triggers, fear focusing on immediate and specific harm and stress more generalized, although there are no clear lines.
- Anxiety is similar to stress except that the triggers tend to be internal rather than external.
- All are normal ways to feel when the situation warrants but become unhealthy when they persist beyond the actual triggering event.
- Considered an anxiety disorder when internalized to the point of no longer requiring a legitimate trigger or any trigger at all.

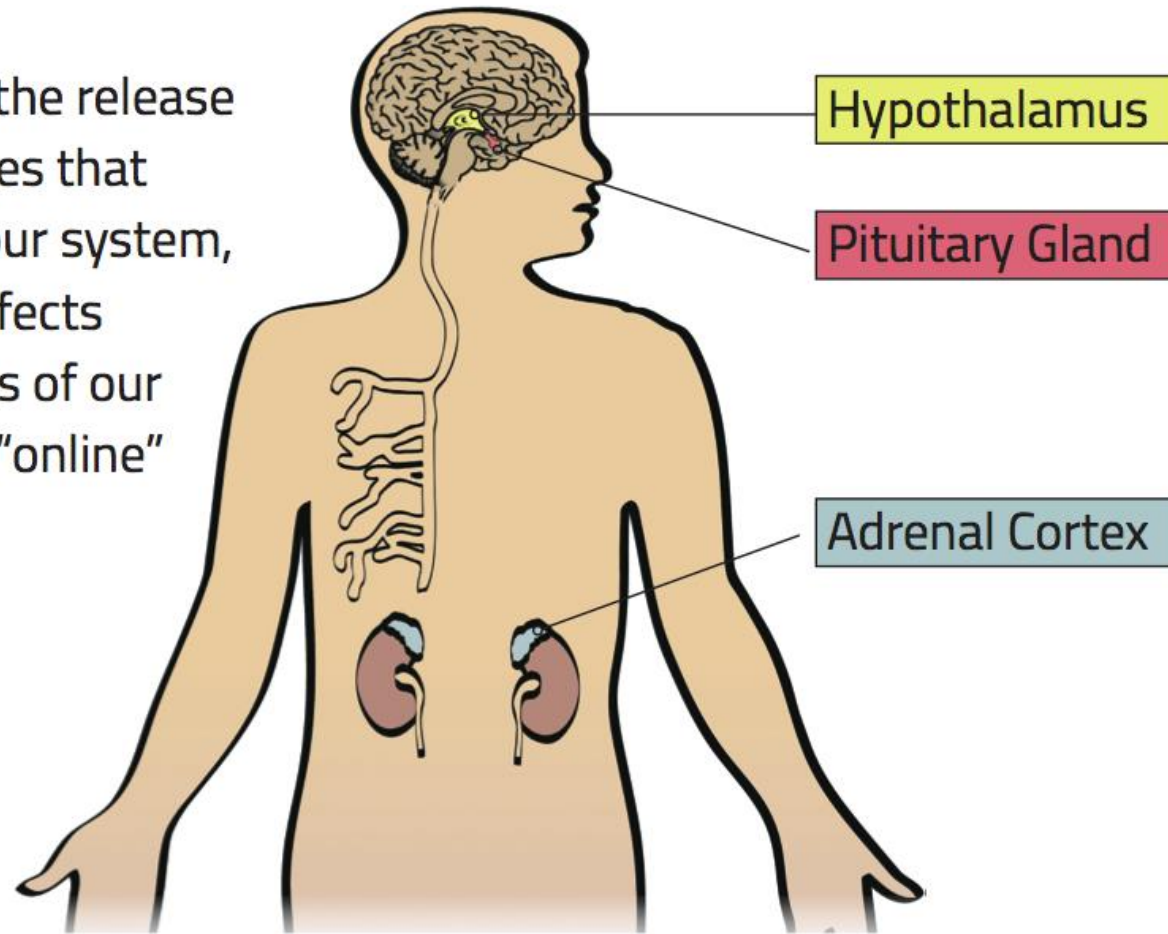
Stress Response – Necessary but



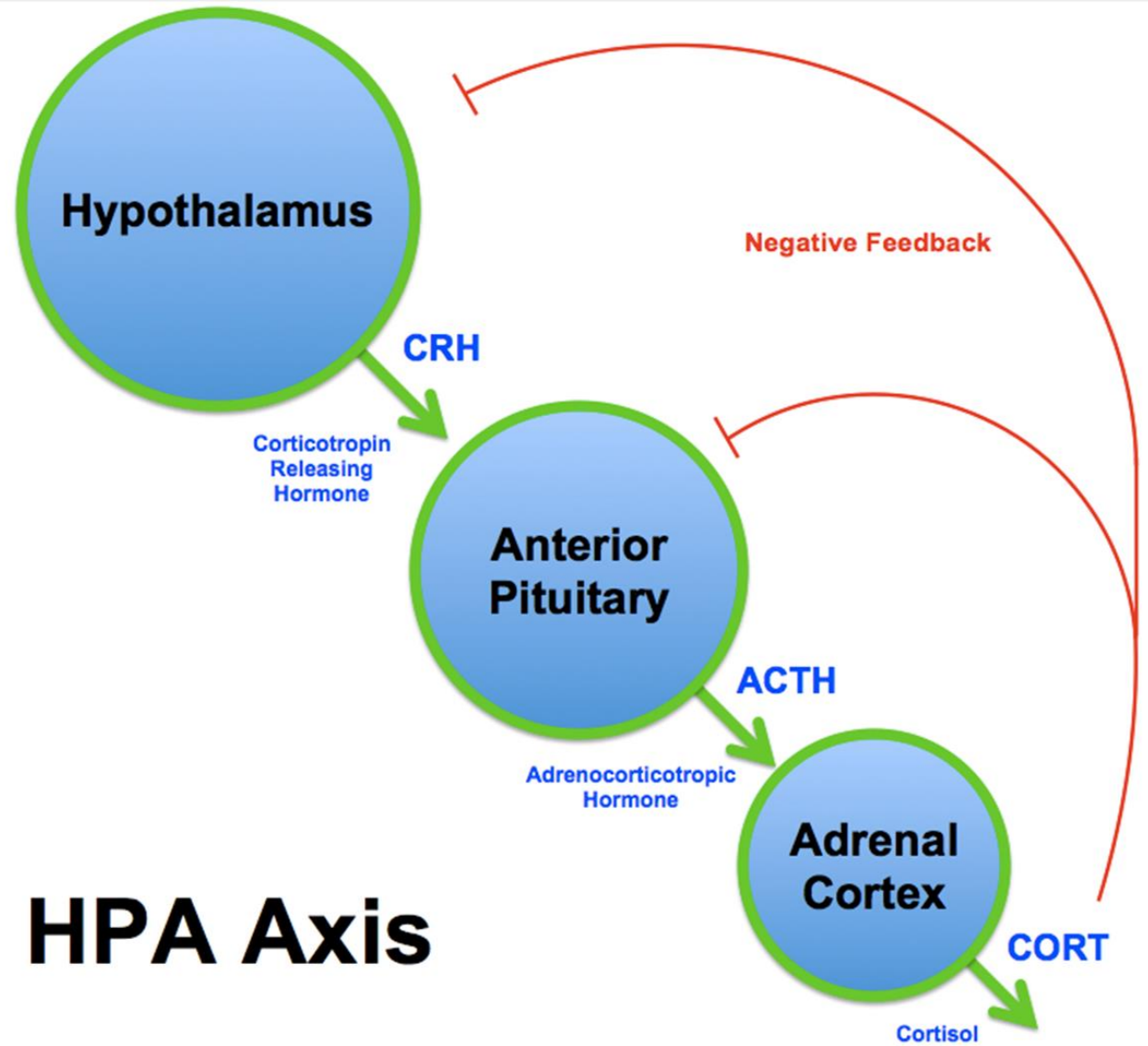
- What we call stress is a physical reaction to significant threat that allows us to respond most effectively to that threat.
- Physical reaction should be limited to what is needed for as long as it is needed.
- Excess or prolonged reaction creates harm.
- Multiple methods of restoring healthy state.

Hypothalamic-Pituitary-Adrenal (HPA) Axis

Results in the release of hormones that activates our system, but also affects which parts of our brains are "online"



HPA and Negative Feedback Loop



Cortisol

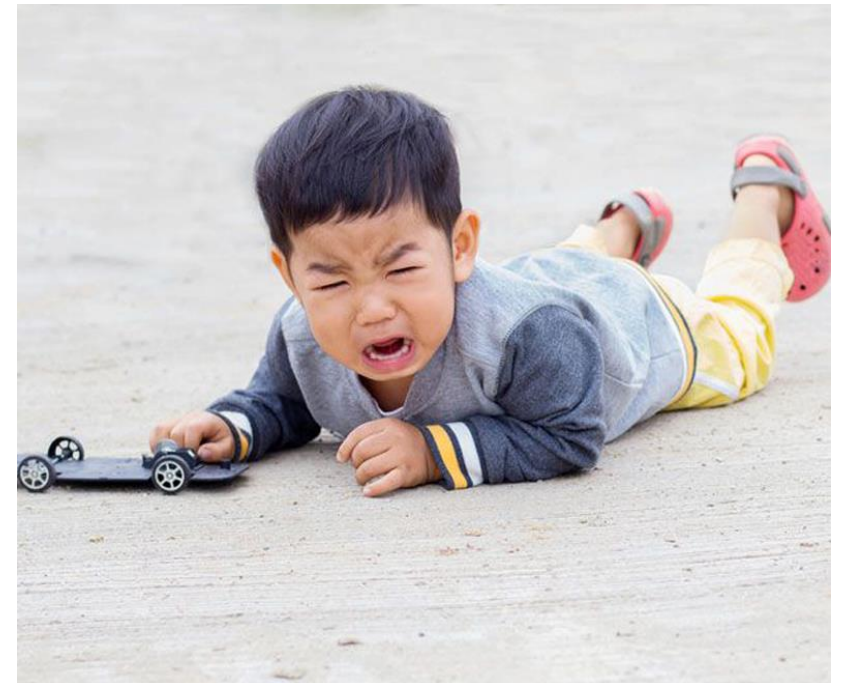
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- In healthy individuals, cortisol rises rapidly after waking, reaching a peak within 30–45 minutes. It then gradually falls over the day, rising again in late afternoon. Cortisol levels then fall in late evening, reaching a trough during the middle of the night. This corresponds to the rest-activity cycle of the organism
 - Increased production of cortisol during stress results in an increased availability of glucose in order to facilitate fighting or fleeing.
 - Cortisol also suppresses the highly demanding metabolic processes of the immune system and raises blood pressure.

Parts of Brain Affected by Stress

- Dopamine, epinephrine, and norepinephrine released
- Prefrontal cortex (executive functions) impaired – more instinctual than thought out
- Lower levels of stress enhance prefrontal cortex.
- Turns on amygdala – emotions, fear, anger
- Impacts hippocampus to facilitate instinctual memory, enhance memory related to the stress, and weaken memory of less emotional details
- Article with research cites [article](#)

The Natural Response

- Watch a dog that reacts to threat and then goes to sleep as if nothing happened seconds later.
- Or a child who falls and starts crying only to be playing happily seconds later while the parents remain scared.





**“Howl at an ambulance or fire siren every chance you get.
Run around the room in circles with a sock in your mouth.
Eat a messy meal without using your hands or utensils.
Ask a friend to scratch your belly...”**

Meditation Changes the Brain

- Slows down aging of brain [Study](#)
- Forbes Article (behind paywall) [Article](#)
 - Preserve gray matter
 - Reduces activity in Default Mode Network (less focus on self, reduced sadness)
 - As effective as medication for anxiety and depression
 - Increase Hippocampus, decrease Amygdala
 - Improves concentration and attention
- Facilitates efficiency gains in brain network – [Study](#)

Meditation Changing the Brain (2)

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- Structural connectome changes in insula – [Study](#)
 - Changes in brain waves in long time meditators (video included earlier in class on brain waves) [Video](#)
 - Meditation changes the brain – [Article](#)
 - Improving cognitive functioning – [Article](#)
 - Increase in Gamma Waves appear to be associated with intense bursts of creative insight, higher states of consciousness, peak concentration, and extremely high levels of cognitive functioning

There's no easy way to say this,
but longterm lack of sleep can cause
a variety of health problems.
Even brain damage!

YOU WOKE ME
UP TO SAY THIS?!



Sleep Like a Baby

Sleep



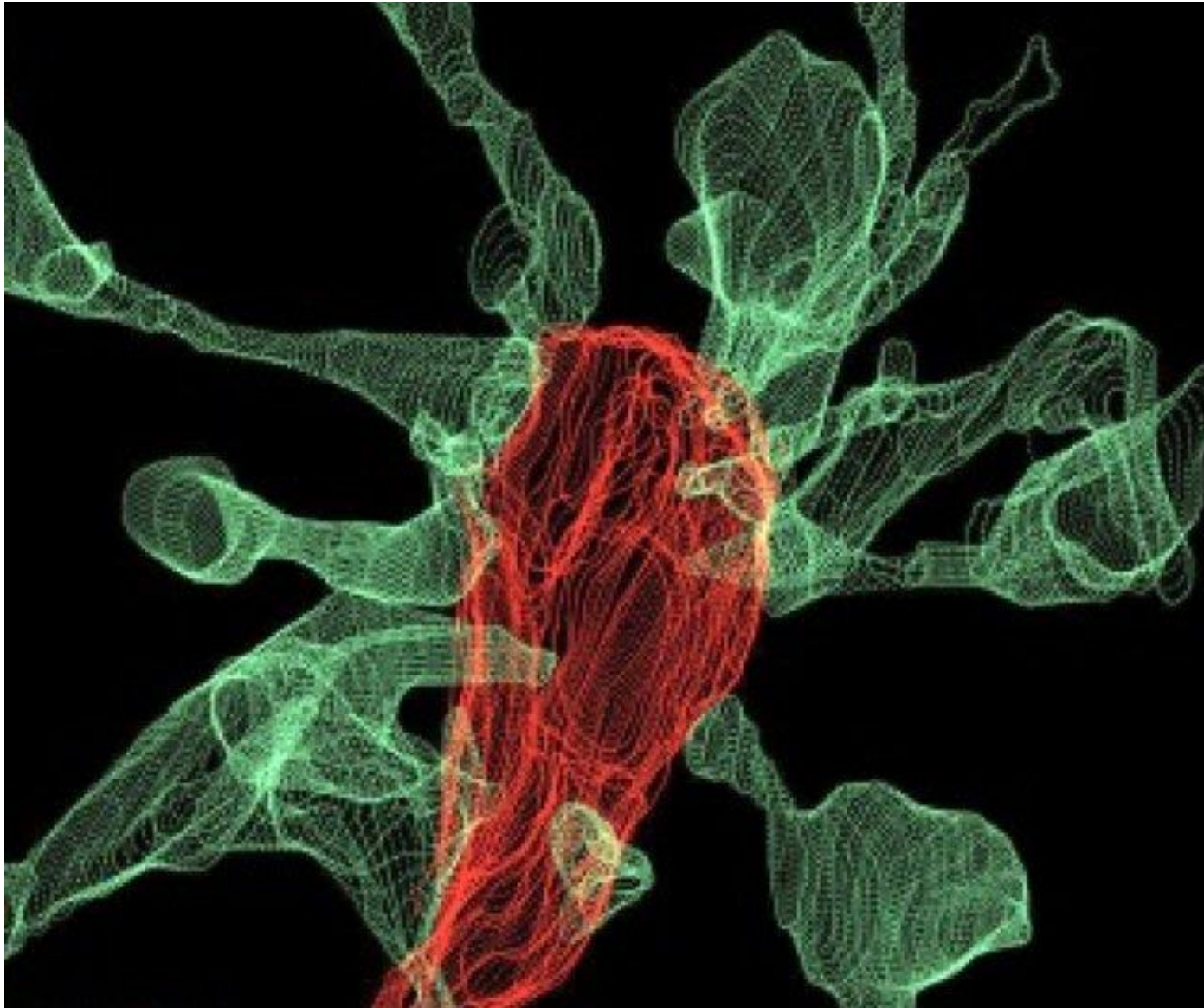
- All or almost all animals sleep.
- Importance demonstrated by dangers and vulnerabilities associated with sleep.
- Protection developed by groups, burrowing, climbing, standing up, or even half brain at a time – dolphins.
- If not absolutely necessary, species would have evolved to no longer need sleep but have not.

How Sleeps Helps our Brain

- Activates mechanism to flush out toxins that build up during day, including beta-amyloids (Alzheimer's). [Article](#) [Study](#)
- Clears out excess information and excess synapse strengthening [Article](#)
- Improves memory
- Increases creativity
- Orders the overload of input during waking hours
- Lack of sleep impairs reasoning, problem-solving, attention to detail.

Sleep Deprivation = Cognitive Lapses

- The brain will find a way to sleep whether we let it or not
- Causes slower neuron firing and longer and slower brain waves
- Results in slower thinking, cognitive lapses, and reduced reaction time
- Sleep deprived driving is similar to drunk driving - [Study](#)
- astrocytic phagocytosis – Glial cells called astrocytes clear out unnecessary synapses and pre-synapses during sleep but when sleep deprived, clear out ones that are needed. – [Article](#) [Study](#)
- Sleep deprivation linked to Alzheimer's and multiple physical illnesses.



Actual Glial Cell Growing Synapses

Multiple synapse heads
send out filopodia
(green) converging on
one microglia (red), as
seen by focused ion
beam scanning electron
microscopy

Napping and Rest Studies

- Cognitive Benefit of Napping – “These results demonstrate that motor memories are dynamically facilitated across daytime naps, enhancements that are uniquely associated with electrophysiological events expressed at local, anatomically discrete locations of the brain.” - [Study](#)
- Resting Strengthens Memory – “Human hippocampal replay during rest prioritizes weakly learned information and predicts memory performance.” – [Study](#)
- Study found improved cognition in older Chinese population napping 30-90 minutes after lunch compared with those who did not nap or napped over 90 minutes. [Study](#)
- Other studies recommend limiting naps to 45 minutes and find benefits in napping as little as 10 minutes.



Go Take
a Hike

Walking Improves Memory

- Study by National Academy of Sciences [Study](#)
- Experimental group of older adults walked 40 minutes a day for one year.
- Control group did stretching and toning for same period
- Experimental group had 2% growth in hippocampus – equivalent to reversing aging 1-2 years
- Control group had 1% shrinkage

Other Brain Benefits of Exercise

- Aerobic training increases cortical capillary supplies, the number of synaptic connections, and the development of new neurons
- Aerobic exercise increases brain volume in older adults [Study](#)
- Increases Executive Control [Study](#)
- Particular growth in Prefrontal Cortex - creativity, conscience, judgement, abstract ideas, and foresight
- And the Anterior Cingulate Cortex – monitoring and resolving conflict and adapting the brain to changing environment



Resistance Exercise and Brain Plasticity

-
- The researchers found that resistance exercise led to structural brain plasticity, specifically, a thickening of grey matter in the 'posterior cingulate' cortex, a key integrating part of the brain that is affected early in Alzheimer's disease. By contrast, the control group underwent a small shrinkage in posterior cingulate grey matter.- [Article](#)
 - Same research group - Increased muscle strength leads to improved brain function in adults with Mild Cognitive Impairment (MCI) - [Article](#)



Create New Pathways

- Try new things.
 - Learn a new language, even minimally.
 - Learn to play a musical instrument.
 - Read books you normally avoid.
- Try old things in new ways.
 - Write with your opposite hand.
 - Write your name backwards.
 - Drive using an unfamiliar route.
- Practice bilateral stimulation.

Do Brain Training Exercises Work?

- FTC fines Luminosity for unsubstantiated claims. [Article](#)
- Luminosity massaged the data to claim impact, similar to Biogen.
- Many studies fail to find benefit but studies were small, measured limited variables, and were often conducted on young people since they are readily available to researchers.
- brainHQ appears to have solid research base. - [Website](#)

Two or More Birds with One Stone

- Dancing [Study](#)
- Exercise, Creativity, Coordination, Music, and Cognition



Habla Espanol?

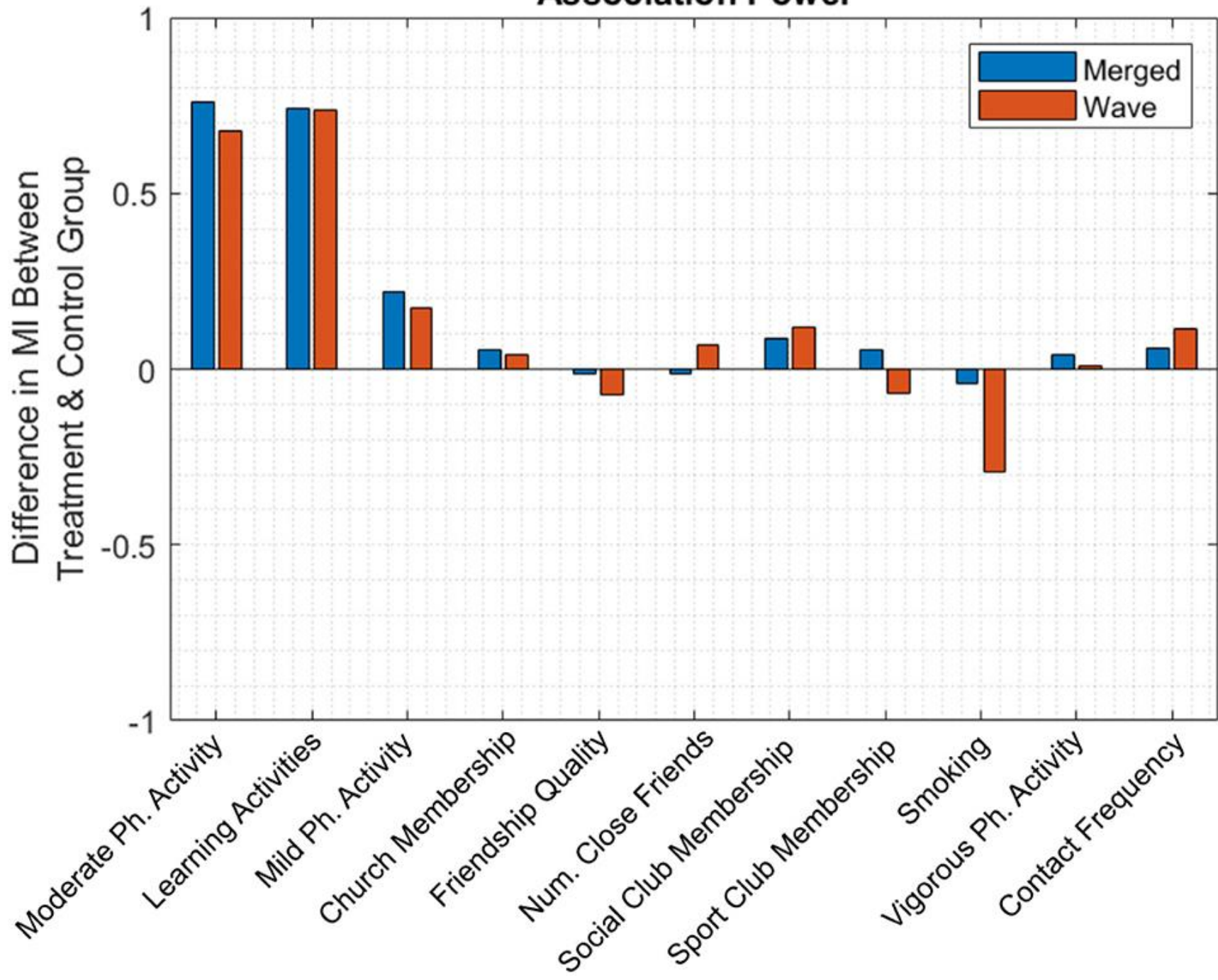


- Many studies show brain benefits of bilingualism.
- This study published October 25, 2021 compared benefits of non-fluency language learning.
- Three groups – Control, Brain Training using BrainHQ, and Spanish Lessons using Duolingo 30 minutes a day, five days a week for 16 weeks.
- Language and brain training groups similar improvements in working memory and executive function (ability to manage conflicting information, stay focused, avoid distractions).
- Language group found the experience more enjoyable than the brain training. [Article](#) [Study](#)

Lifestyle Influences on Cognitive Decline

- Study results published in late August 2021 compares the impact of different lifestyle activities on cognitive decline, primarily memory, in older adults.
- Longitudinal survey study [Study](#)
- Moderate-intensity physical exercise and learning activities correlated strongly with reduced cognitive decline.
- Other activities did not, in many cases quite contrary to the claims of many so-called experts.

Association Power



Not All Studies Agree

- Studying the human mind is complicated.
- Even well-designed and well implemented studies only present a partial picture.
- Sample size, control methods, what is measured and how lead to different conclusions.
- While that study showed little impact on cognitive decline based on the quality of social interaction, a study published last week found increased biomarkers of inflammation correlated with social isolation.
- Inflammation is one of the leading causes of cognitive decline.
[Study Recap](#)

Food as Chemical Additive

- We are primarily biochemical engines.
- Food is nothing more than chemicals we add to our bodies, hopefully to improve performance.
- Every additive has an effect – positive, negative, or mixed.
- There is direct cause and effect.



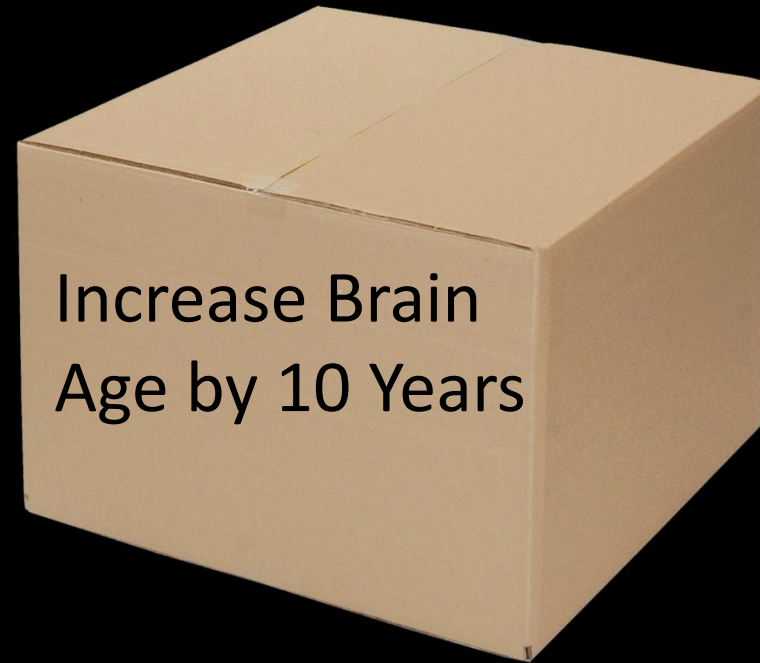
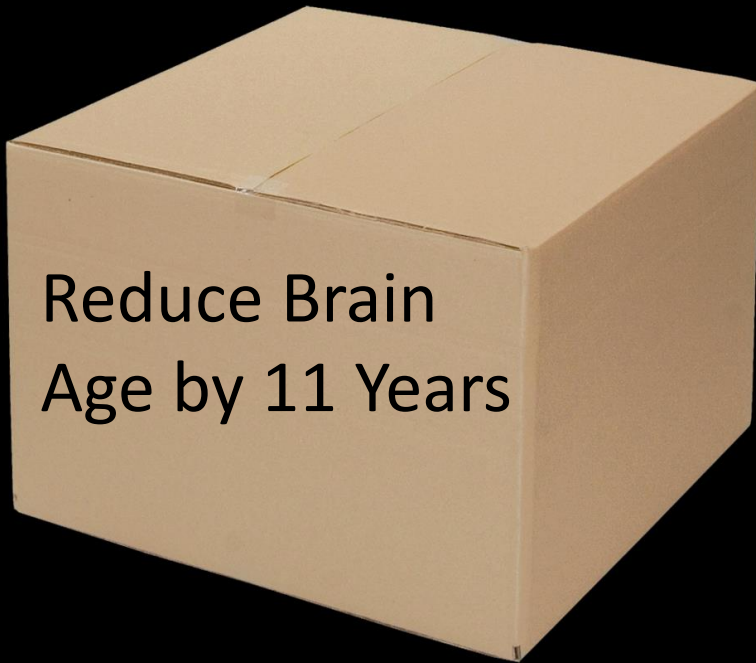
Bad Taste

- Taste has become irrelevant.
 - Especially if food not in natural form
 - Additives, colorings, sugar, salt, etc. fool our taste buds.
- Avoid choices based on habit and memories.
- Even in so-called natural state may bear little resemblance to what nature created.
- Plant foods may have herbicides, pesticides, chemical fertilizers, and may be specially bred for handling and size.
- Animal foods usually raised in unhealthy environments with added hormones or antibiotics and selectively bred for size and fast growth.

Do We Want to Act Rationally?

- Taste is an input through a combination of taste buds, the olfactory bulb, and to a lesser extent the visual system.
- Initial response is at the emotional level.
- We say something tastes good or bad or delicious or disgusting.
- It is different if we analyzing food content but is that how we make food choices?
- Our rational minds would say we are putting it in our body because it has specific desired effects on our bodies and minds.
- If we eat what tastes good, we are allowing our emotional state to dominate over our rational capacities.

Which Box Would You Choose?



Now Which Would You Choose?



Reduce Brain Age



Increase Brain Age



Can You
Think of a
Rational
Reason
to Put This
in Your
Body?



Choosing Brain Healthy Foods

- Virtually infinite number of articles making often competing claims.
- Look for solid empirical evidence and type of research (see earlier slide).
- Be more willing to add and increase foods that are generally recognized to be healthy and carry no known risks.
- Avoid risks if unnecessary and lower risk alternatives are available.

Foods May Improve Brain Functioning

Decide for Yourself (1)

- Better quality diet increases brain size - [article](#)
- Curcumin (turmeric and some gingers) - [link](#)
- Green Tea and Preventing Alzheimer's – [link](#)
- Blueberries – cognitive improvement in children – [link](#)
- Omega-3 and Alzheimer's – [link](#)
- Superfoods for Healthy Brains – [link](#)
- An apple a day. . . – [article](#)
- Raw fruits and vegetables and mental health - [article](#)

Foods May Improve Brain Functioning Decide for Yourself (2)

- Huffington Post brain food article – [link](#)
- Prevention Article - Healthy Brain Foods – [link](#)
- Green Leafy Vegetables Reduce Brain Age by 11 Years – [link](#)
- Blueberry Vinegar and Memory Loss – [link](#)
- More Blueberries – [link](#)
- Dark chocolate dampens stress and inflammation, boosts memory and mood - [article](#)
- Google Foods That Improve Brain Functioning - [link](#)

Mediterranean and DASH Diets

- Latest research shows extremely positive results on cognitive functioning, memory retention, and Alzheimer's avoidance.
- Heavy focus on colorful cruciferous and leafy vegetables, berries, nuts, beans, olive oil, and whole grains.
- If eat meat – fish and lean poultry.
- Red wine often included but more complicated.
- Mediterranean Diet – [link](#) DASH Diet – [link](#)
- MIND Diet (combo of Mediterranean and DASH) – research by Martha Clare Morris, heavy focus on data -[link](#) - [link](#) – [link](#)
- Reduces Brain age by average of 11 years.



MIND Diet May Be Most Effective

- Last few weeks the press seems to have discovered the MIND Diet and its research history.
- Mayo Clinic Report – [Article](#)
- Fitwirr – [Article](#)

Foods May Harm Brain Functioning

- Foods with high glycemic index, such as sugars and highly processed carbohydrates, create cravings and addictions. [Link](#)
- Glyphosate and Autism – [link](#)
- Salt and the Brain – [link](#)
- Canola Oil Weakens Memory (may be related to GMO's) – [link](#)
- Fried foods
- Processed or highly processed foods
- Artificial sweeteners – [Study](#)
- Processed meats

Its Reputation Precedes It

- There is an old saying that once you get the reputation of being an early riser, you can sleep until noon for a long time before anyone figures it out.
- Many of our foods are like that, reputation for being healthy but really not so much.
- Soup is a great example. If we do not make it ourselves, we are probably drinking flavored salt water.
- Some reputations, such as breakfast being the most important meal of the day, were created and promoted by cereal companies.

Foods May Both Help and Harm

- Alcohol
 - Clears Brain Waste - [link](#)
 - May Help Prevent Alzheimer's - [link](#)
 - Damages Cortex - [link](#)
 - May be Carcinogenic
- Animal Meats
- Coffee
- Eggs



Avoid Toxins

- If it kills plants or pests, it will probably harm people
- If it touches your skin, it gets into your body
- If you breathe it, it gets into your body
- Over 13,000 chemicals banned in Europe but legal in US
- Review not only food but also cosmetics and household cleaners

GMO's

- Never required to establish safety.
- Limited research both supports safety and raised serious concerns.
- No such thing as GMOitis so no meaningful way to measure affect on humans.
- Monsanto and other producers use tactics similar to tobacco companies.
- Even if GMO's prove not to be dangerous, they do allow direct application of Glyphosate which is extremely toxic and probably carcinogenic.
- GMO wheat shuts down certain DNA.
- GMO's and health – survey – includes multiple brain conditions - [link](#) - [link](#)

GRAS, Try at Your Own Risk

- Generally Recognized As Safe (GRAS), a provision of the Food, Drug, and Cosmetics Act that effectively grandfathers in any food additives in use at the time of the Act.
- In theory there is a review panel and a process for removing substances from the list.
- However, the determination is made by the manufacturer for its own products.
- The concept is logical in theory, but almost comical as applied, if killing people for profit tickles your funny bone.
- The industry-friendly drafting of the Act and the more industry-friendly interpretation by the FDA makes removal difficult even when toxicity is clear.
- GMO's and artificial sweeteners were self-determined, and accepted by the FDA as GRAS.

Glyphosate (Roundup)

- Never proven safe. Rationale was that it is in the ground and does not reach plants and that it works on the shikimate pathway which animals do not have.
- With GMO's, applied directly onto plants in heavy doses. Evidence shows it is found in significant residues on plants and found in significant concentrations in human urine.
- Shikimate pathway exists in gut bacteria critical to health and survival.
- Mimics glycine, an amino acid, and since blood brain barrier does not recognize glyphosate, it treats it like glycine and allows it to cross. [Article](#)

Monsanto - Dark Power Creates the Dark Act

- Monsanto produced both GMO seeds and RoundUp.
- One of the most corrupt corporations in history, rivaling tobacco companies, used its political and advertising clout to defend glyphosate.
- Actually got Congress to pass and Obama to sign what was known as the Dark Act, prohibiting states from requiring GMO labeling.
- WHO labeled glyphosate a probable carcinogen but US regulatory agencies never looked into it.



The Truth Comes Out

- Monsanto lost multiple suits for hundreds of millions of dollars by those who contracted cancers based on exposure to glyphosate.
- Juries were furious when discovery uncovered the techniques and lies Monsanto used to keep the truth from the public.
- Monsanto was purchased by Bayer, not the greatest of companies but no Monsanto.
- Bayer has since discontinued selling glyphosate residential use, but it is still available for industrial and agricultural use where the exposure is far greater. [Article](#)
- Possible Bayer will just change the name.

Number of children (6-21yrs) with autism served by IDEA

plotted against glyphosate use on corn & soy ($R = 0.9893$, $p \leq 3.629e-07$)

Sources: USDA:NASS; USDE:IDEA

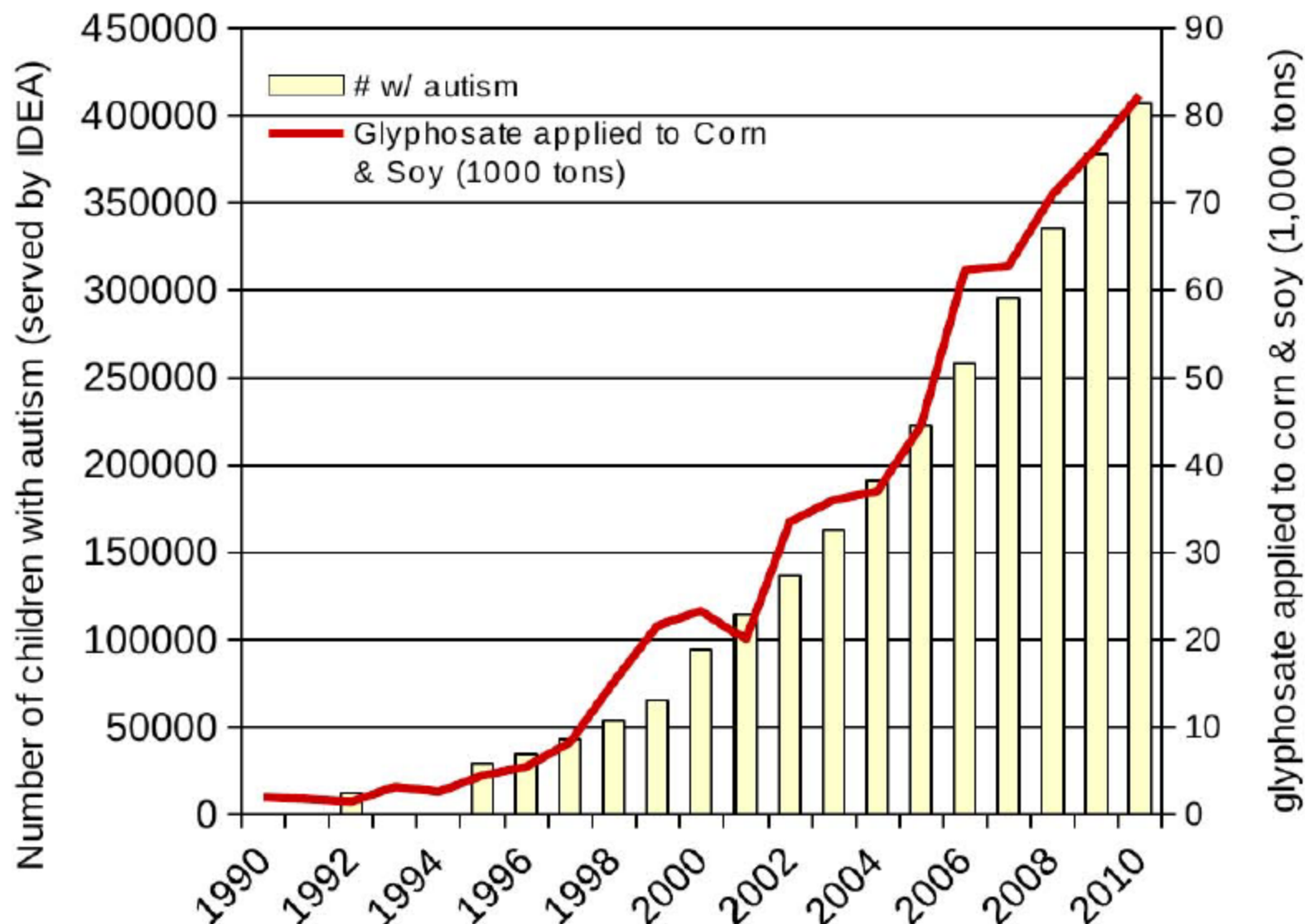


Figure 23. Correlation between children with autism and glyphosate applications.

Age Adjusted Deaths from Alzheimer's (ICD G30.9 & 331.0)

Plotted against glyphosate use ($R = 0.917$, $p \leq 2.205e-07$) &

%GE crops planted ($R = 0.9373$, $p \leq 9.604e-06$)

sources: USDA:NASS; CDC

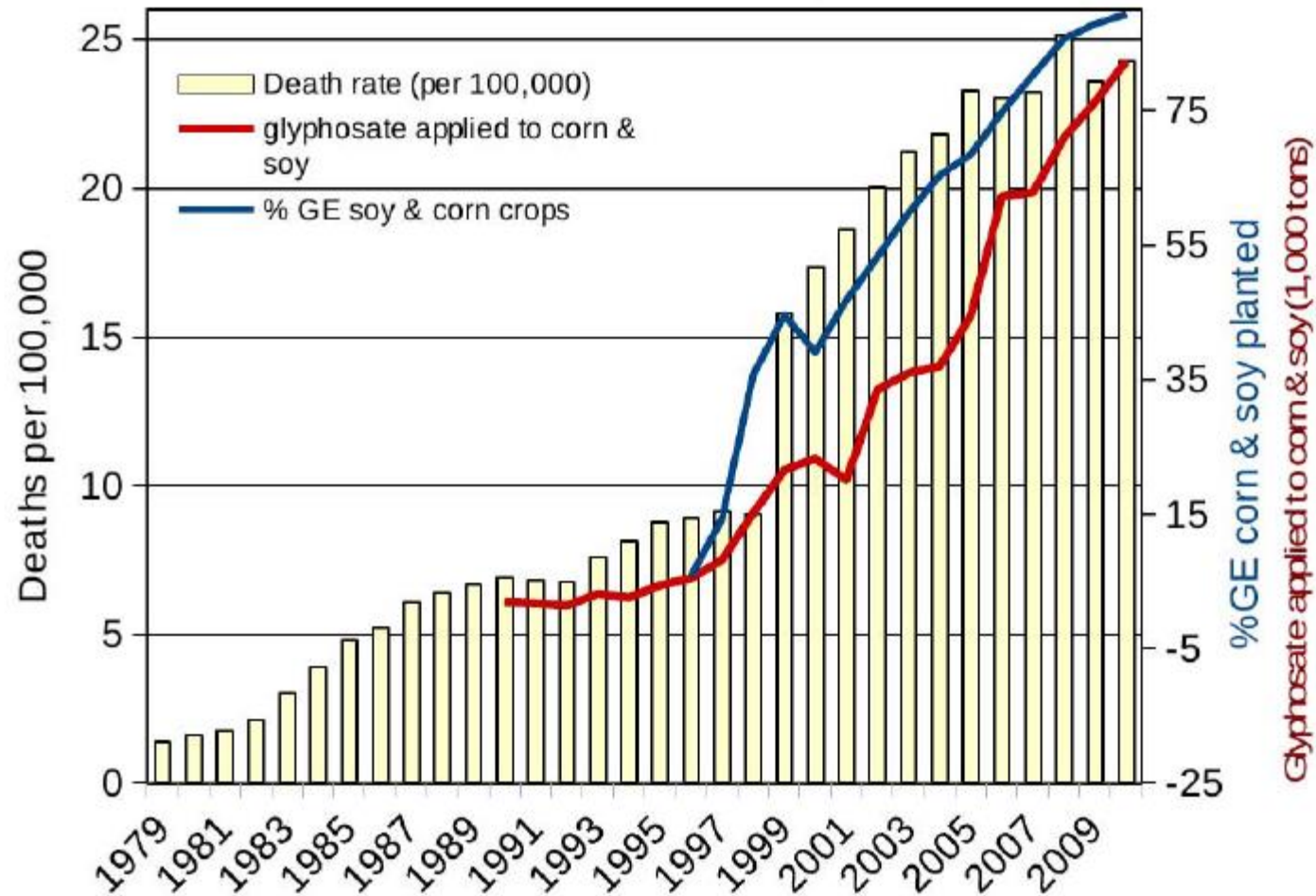


Figure 25. Correlation between age-adjusted Alzheimer's disease deaths and glyphosate applications and percentage of US corn and soy crops that are GE.

Environmental Working Group

- Website - <https://www.ewg.org/>
- Dirty Dozen – <https://www.ewg.org/foodnews/list.php>
- Food Scores - <https://www.ewg.org/foodscores?inlist=Y&sdh=1>
- Cosmetics - <https://www.ewg.org/skindeep/?inlist=Y>