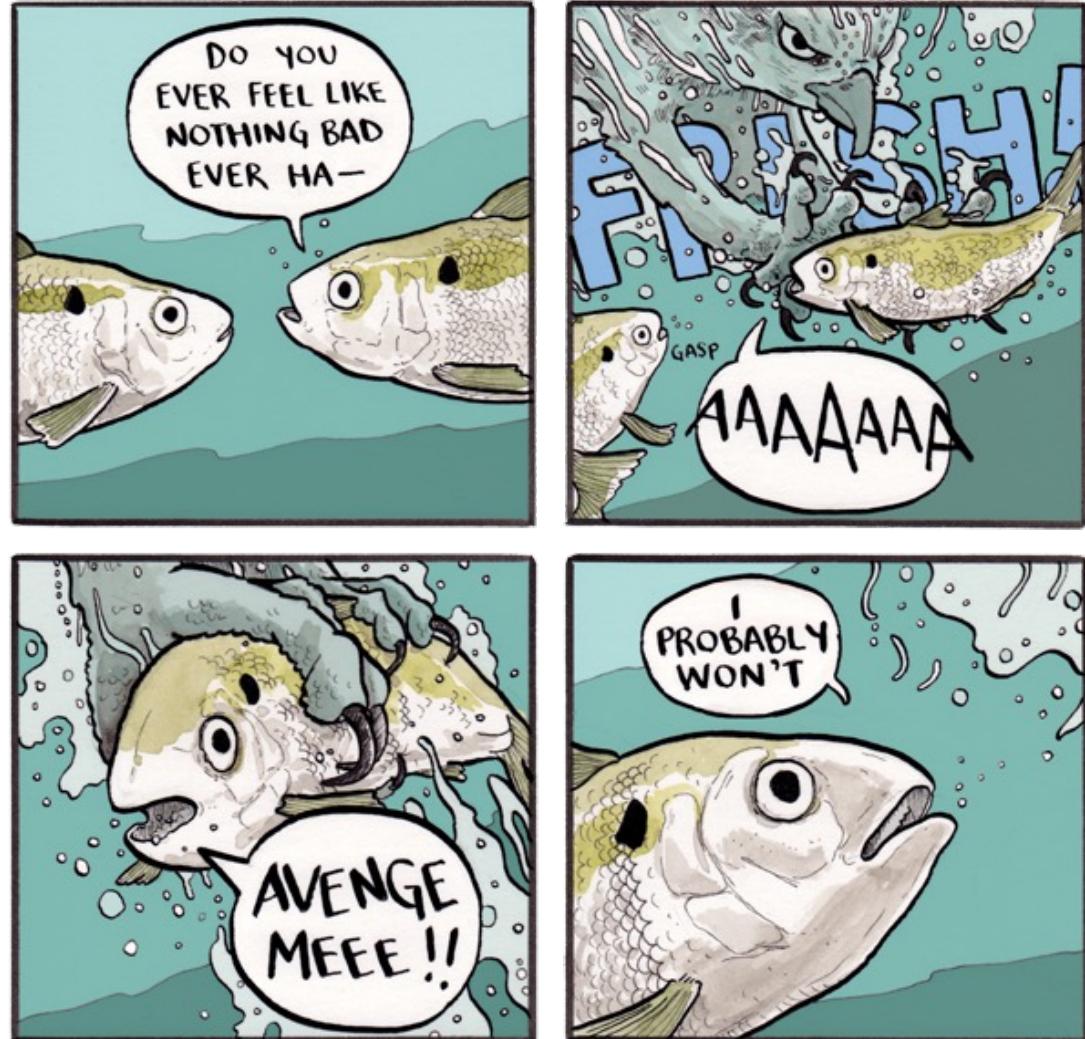


PSYC301: (Some) Causes of brain dysfunction

Jay Hosking, PhD



Lecture overview: part I

Brain tumours

Strokes

Head injuries

Phew



Learning objectives part I

1. Describe these terms as related to tumours:
encapsulated vs. infiltrating, benign vs. malignant, metastatic.
2. Identify and describe one encapsulated and one infiltrating tumour we discussed.
3. What should the doctor be trying to save in a stroke?
4. Identify regions in stroke, types of stroke, and causes of stroke.
5. Describe and compare two methods of dealing with an aneurysm.
6. What is excitotoxicity? What causes it? How is it related to this lecture?
(For the future:) How is it related to other topics?
7. Describe these terms in head injuries: closed vs. open, contusion vs. mTBI, concussive vs. subconcussive mTBI.
8. What is CTE? What causes it? What is one marker of CTE? How does this marker relate to other diseases? Why is diagnosis currently a problem in CTE?



FALSEKNEES.COM ©2018

#expRx

Encapsulated tumours

Tumours, aka neoplasms

Here: meningioma

Grow between the meninges

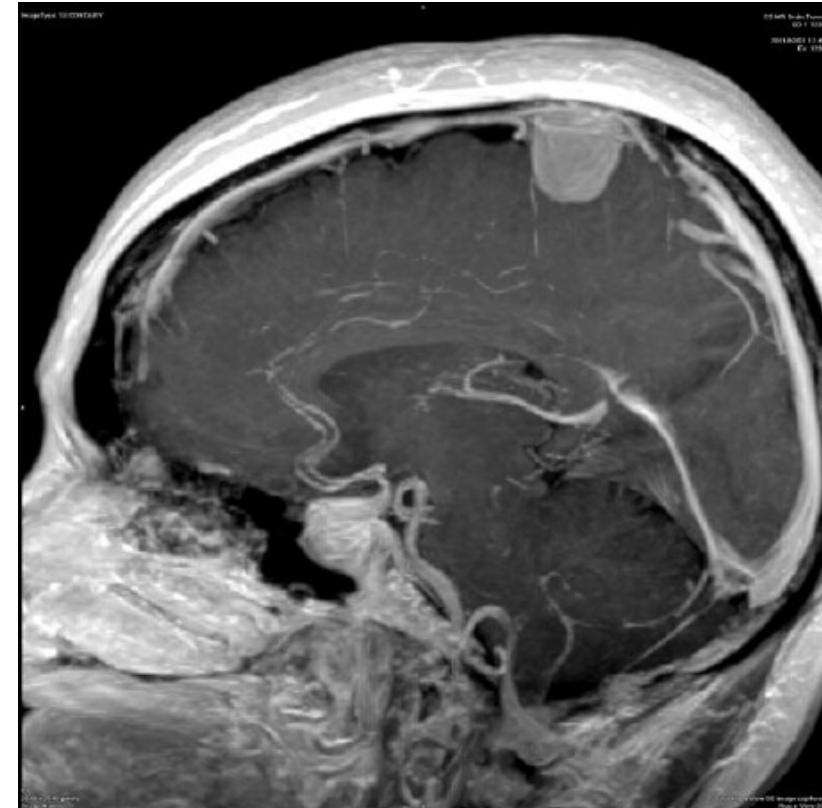
Encapsulated

Benign "not cancer"
and 2 be ↑ prob won't grow
back

#not in my head
↑
manifestation

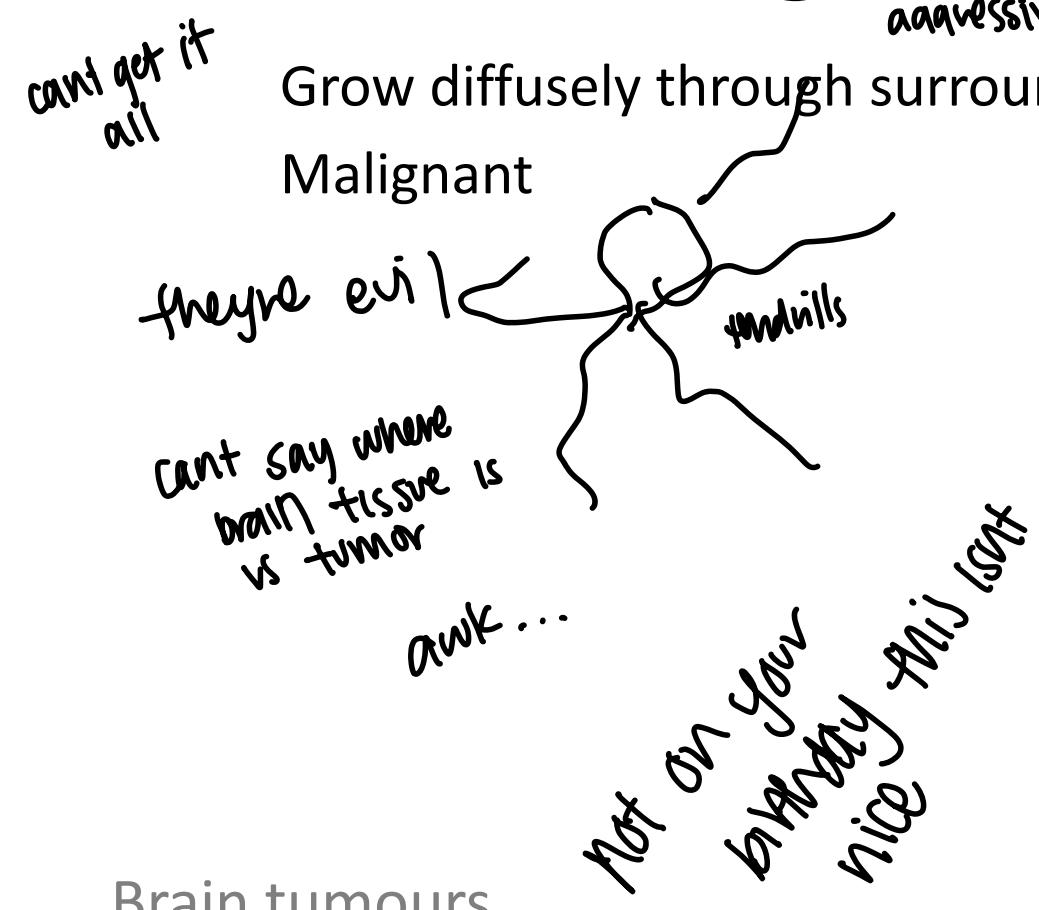
20%
have
own
little
membrane

oh ik abt
brain surgery jay
ive seen the
PICTURES
↑, was so
bad



Brain tumours

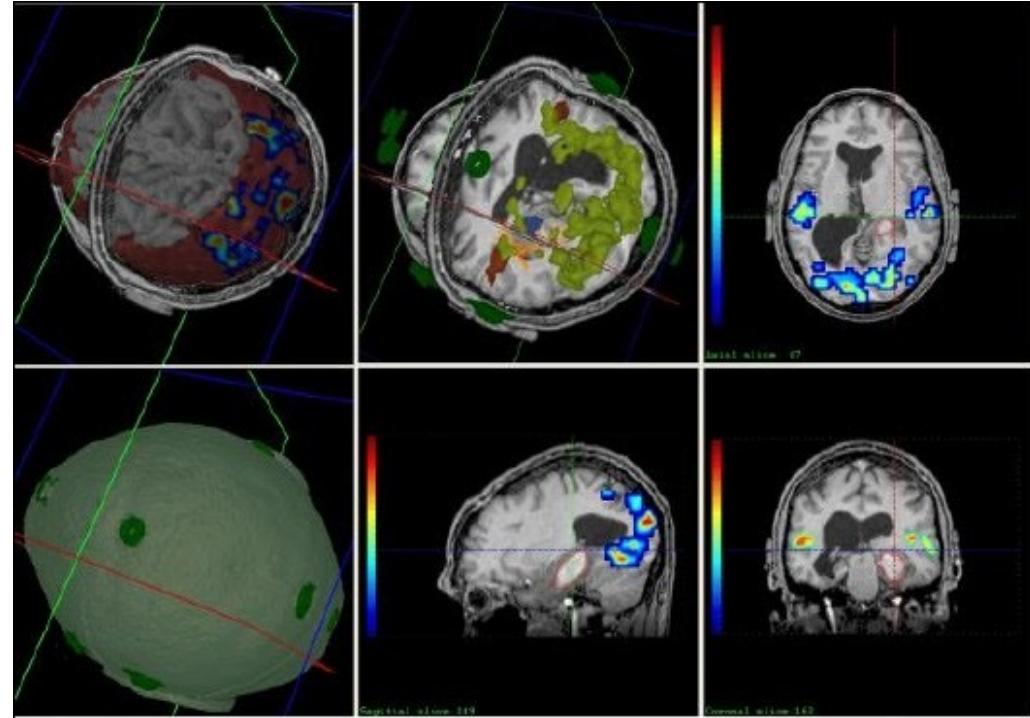
Infiltrating tumours



aggressive

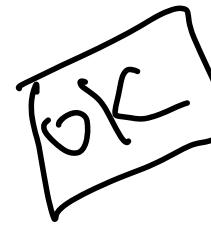
healthy

Grow diffusely through surrounding brain tissue



Want
him to ask
all if we're

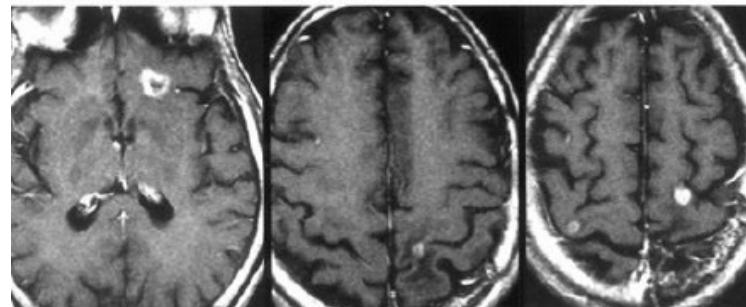
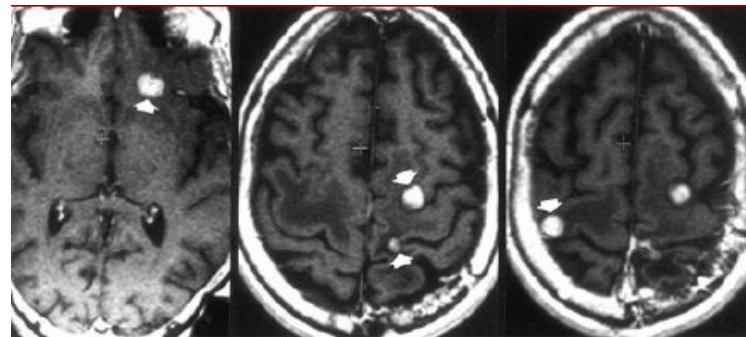
Metastatic tumours



It of
can
work

Some infiltrating brain tumours grow from tumour fragments carried to the brain from another body part via the bloodstream

Commonly originate from a breast cancer or a lung cancer



What if it
isn't
a brain
tumour
but actually
beyond the
brain?



Den
orthodox
share

Brain tumours

deep sigh...
can a send me
what
woman pos

Glioblastoma



Gord Downie



Bob Moog

Brain tumours

Box 1 | WHO classification of brain tumours

Astrocytic tumours

- Diffuse astrocytoma (grade II)
- Anaplastic astrocytoma (grade III)
- Glioblastoma (grade IV)

Oligodendroglial tumours

- Oligodendrogloma

Mixed gliomas

- Oligoastrocytoma

Ependymal tumours

- Ependymoma

Neuronal and mixed tumours

- Gangliocytoma

Neuronal/glial tumours

- Dysembryoplastic neuroepithelial tumour
- Ganglioglioma

Embryonal tumours

- Medullobepithelioma
- Ependymoblastoma
- Neuroblastoma

Primitive neuroectodermal tumours

- Medulloblastoma

oh...

DEATHS

most common type
of malignant brain
tumour in adults
(aka: glioma)

Most malignant
Short survival rate

~~Strokes~~ are sudden-onset cerebrovascular disorders that cause brain damage

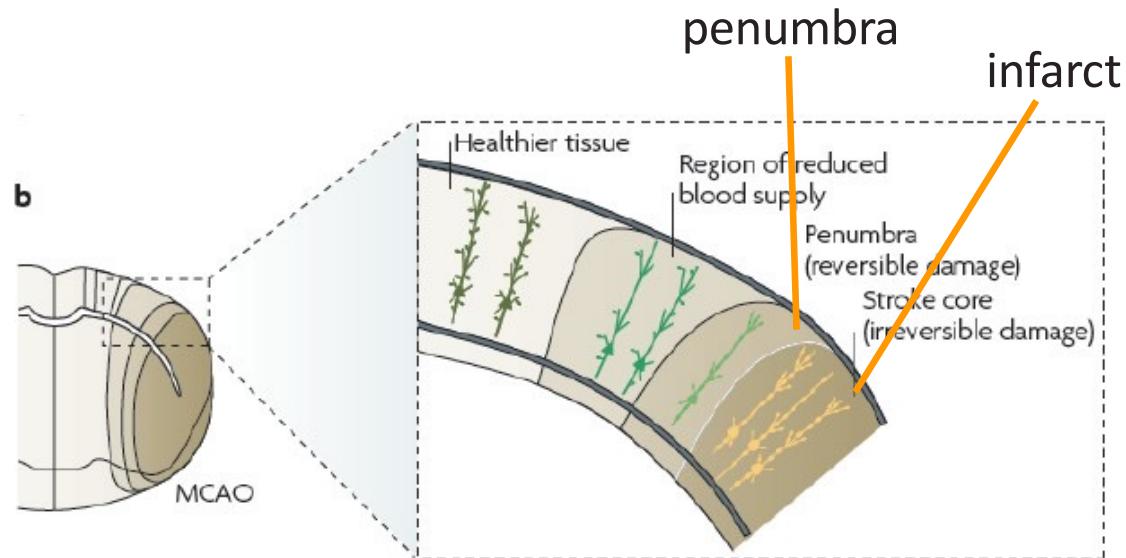
what if this class is SCAM

Infarct: area of dead/dying tissue

Penumbra: dysfunctional area surrounding the infarct; tissue in penumbra may either recover or die

save this = good

oxygenated blood cut off



Strokes

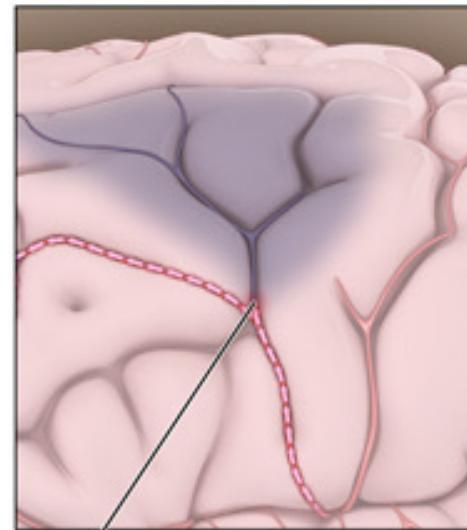
not on ur
special day (3) Types of stroke

Ischemic, i.e. resulting from cerebral ischemia

Hemorrhagic, i.e. resulting from cerebral hemorrhage

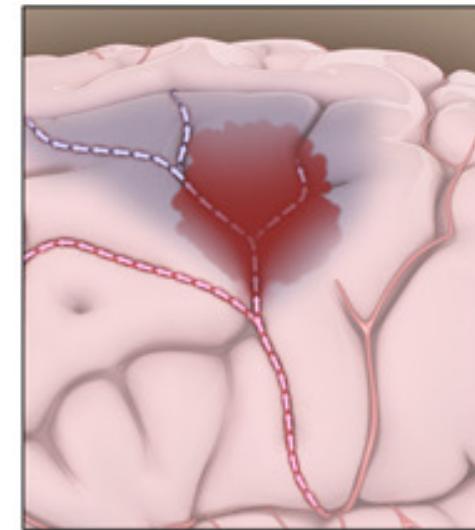
↓
Additional
prob. Blood =
toxic to cells
in brain

Ischemic stroke



A clot blocking blood flow
to an area of the brain

Hemorrhagic stroke



Bleeding inside or around
brain tissue

Strokes

Cerebral hemorrhage: aneurysm

20-40 40-60 60-80
~0% ~3-4% 5-7%

Can be congenital or develop later

Commonly at base of brain
(e.g. Circle of Willis) ^{mainstem}

Risk factors: diabetes, hypertension,
smoking cigarettes, alcoholism, **aging**

Usually artery

Two common treatments:

massive amt of hemorrhaging @ one
pressure of
fluid of
water balloon...
rupture...
next slides



Strokes

not dangerous when growing 10



deep sigh

Cerebral hemorrhage: aneurysm

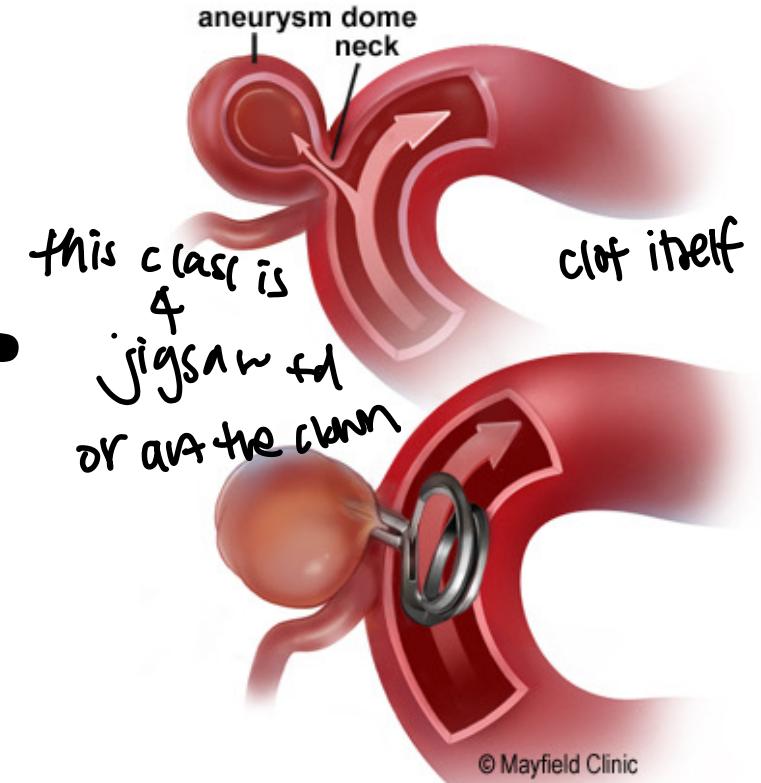
Treatment option 1:

Clipping - ~~afterly~~ clip it

clipping

yuck...

Requires craniotomy, but slightly lower rate of recurrence than option 2



age group that needs it →
can't tolerate it

what did
discover
name

Cerebral hemorrhage: aneurysm

Treatment option 2:

Endovascular coiling

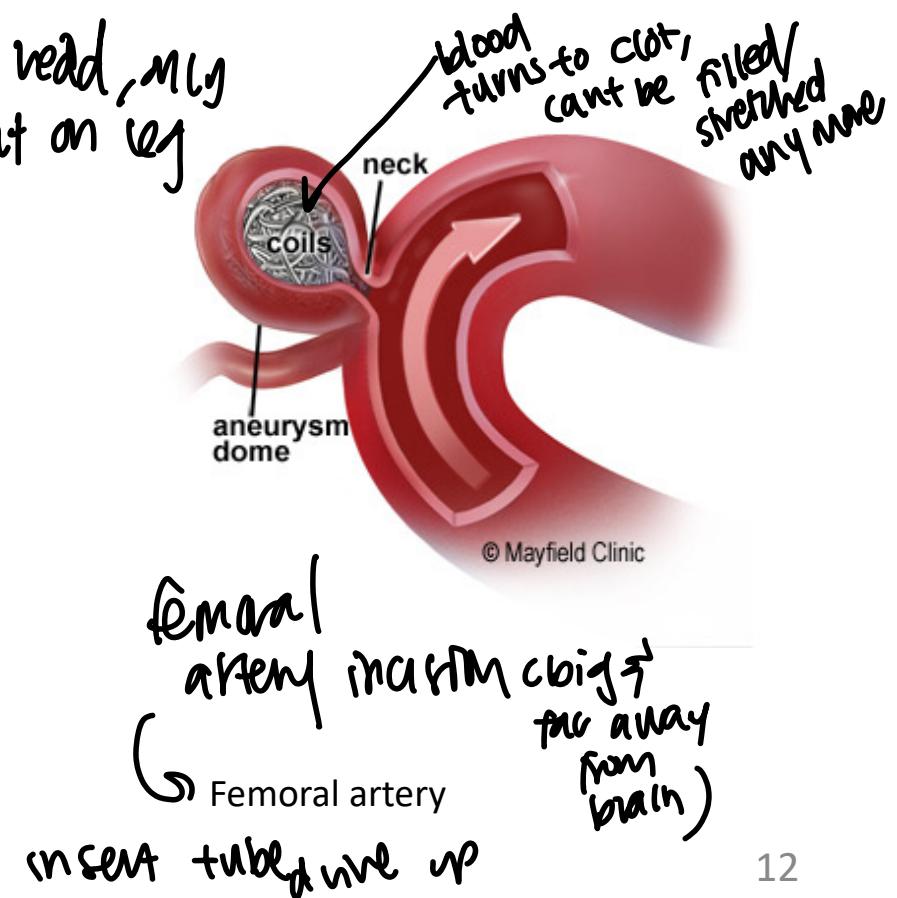
Ph  Much less invasive, but slightly higher rate of recurrence than option 1



Strokes

I feel so squeamish too

nothing done to read, my
cut on very
tly higher



insert tube & tie up

1 hour 2
see...

Cerebral ischemia

blockage

task
out 22 20min

A disruption of blood supply to some area of the brain

*Three main causes:

1. Thrombosis: a plug *blood clot blocking the flow*
2. Embolism: a moving thrombosis *air bubble, fat, tumor tissue*
3. Arteriosclerosis *narrowing of arteries cholesterol*

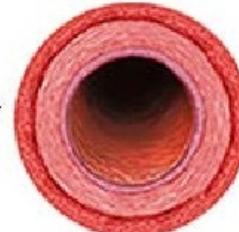
3 can interact with 1 or 2!

This class made my stomach hurt and we are sick

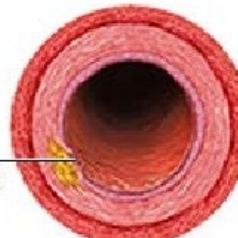
Strokes

create a narrow tube, now small can plug it

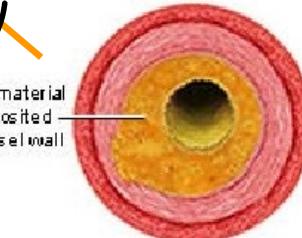
Normal cut-section of artery



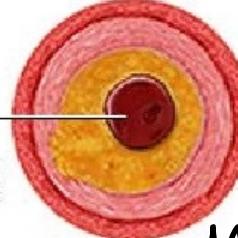
Tear in artery wall



Fatty material is deposited in vessel wall



Narrowed artery becomes blocked by a blood clot



★ epilepsy too
not just stroke

Cerebral ischemia

Ischemia-produced brain damage has three important properties:

- 1. It takes a while to develop (can be days) starts as imperfect blockage, can't build up
- 2. Damage is more likely in some parts of the brain (e.g. hippocampus) *some areas of brain are more sensitive than others*
- 3. The mechanisms of ischemia-induced damage vary between brain structures (one example: excitotoxicity and apoptosis)

resting membrane potential - need Na^+ pump to start working again

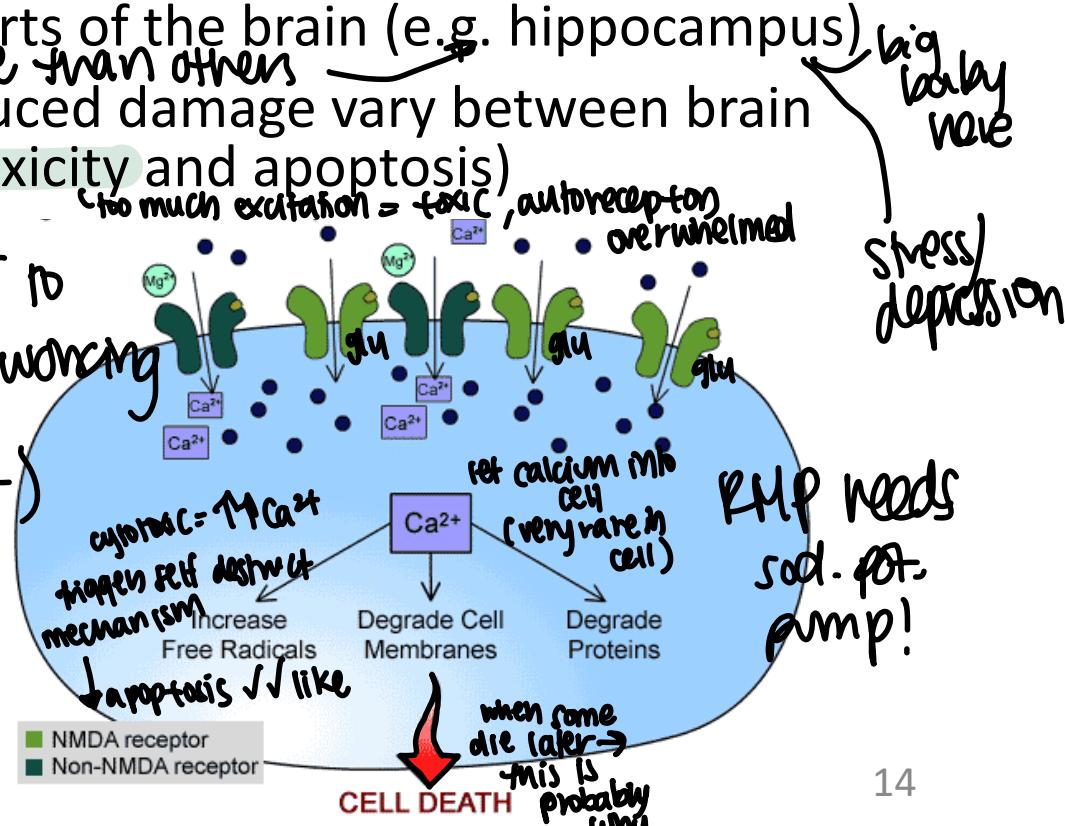
Target NMDARs for stroke?
(Unfortunately not yet)

block Ca^{2+} from getting into cell
 Ca^{2+} get into cell by axon terminal

✓ becomes easier to have image good channels (block to rest)
Hang on to excitotoxicity and NMDARs, we'll keep seeing them

renormalized
area affected
Strokes

lack of blood (is what kills it)



Open-head injuries

aka Penetrating or perforating head injuries

Typically very severe

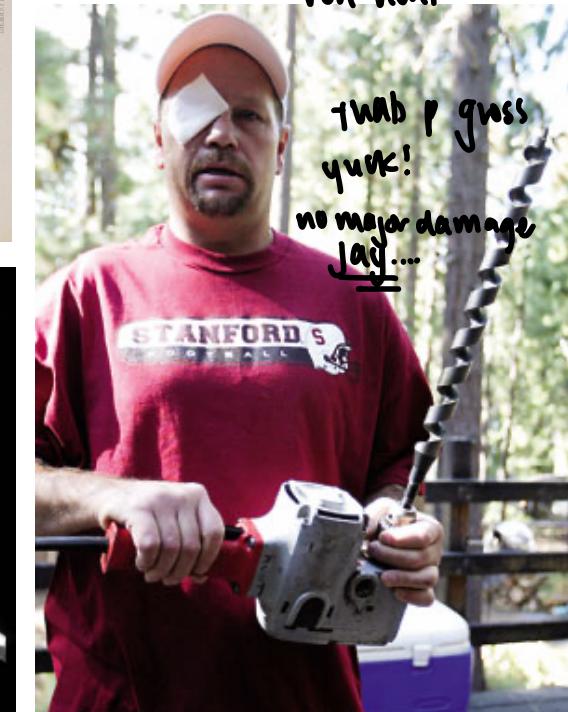
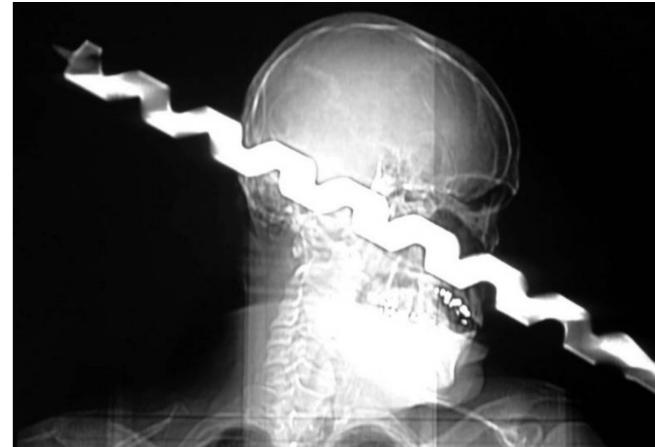
High risk of infection, complications
~~blood brain barrier = "~~

High velocity worse than low

phineas gage



Head injuries



we're giving the wrong TWS
mostly fatal
(90% of ppl shot in the
head die right away/
right after)

ron hunt

that's p guss
yuck!
no major damage
Jay....

TBI
trauma
brain
injury

Closed-head injuries: contusion

brain can slam into

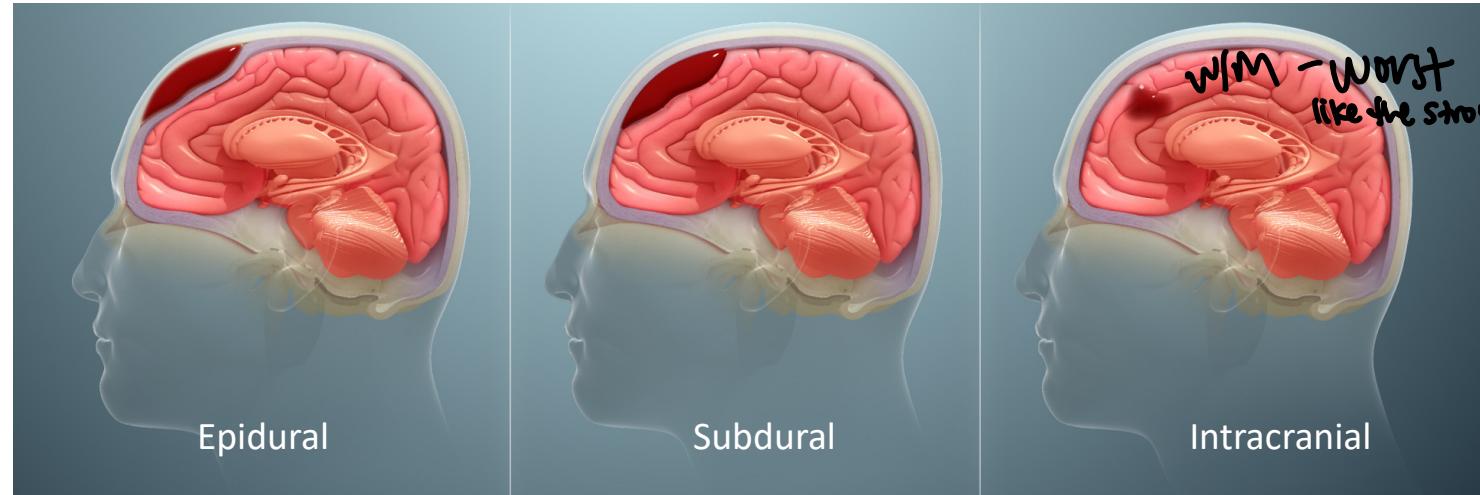
Well, contusion essentially just means “bruise”

Closed-head injuries that involve damage to the cerebral circulatory system, producing internal hemorrhaging and a resultant hematoma

Occurs where the brain slams against the skull

solid swelling of
blood

Many types of
hematomas, e.g.:



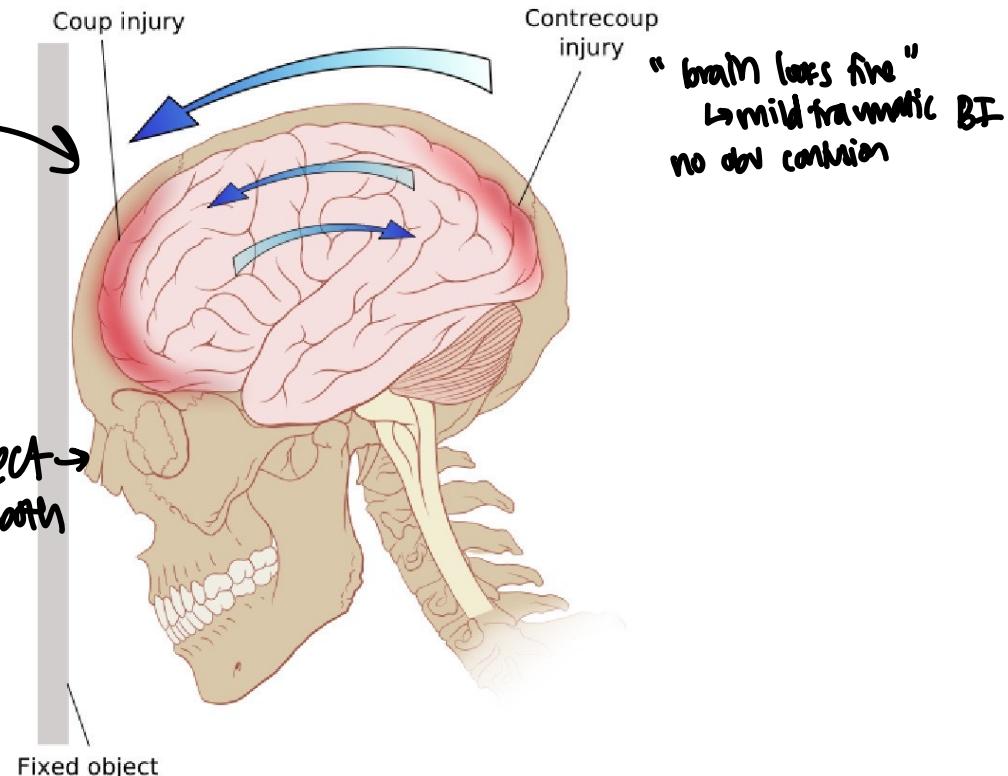
Closed-head injuries

Contusions (and closed-head injuries in general) are frequently **coup contrecoup** injuries

Smith
hits
your
head -

directly under where
obj hits - coup injury

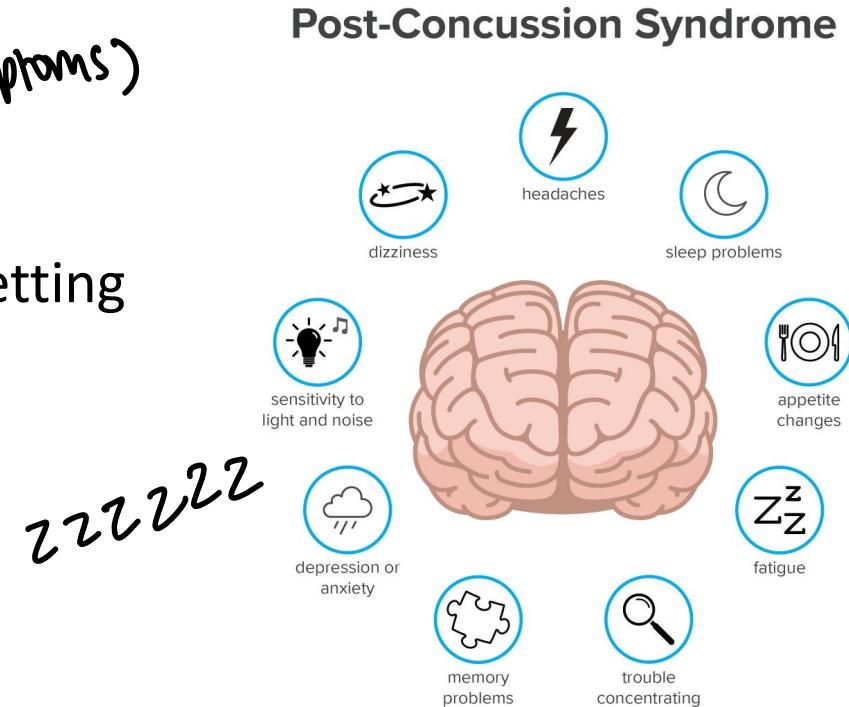
If you are the object →
bounce back & hit both
sides ☹



“Mild” traumatic brain injury (mTBI)

- When there is a blow to the head but no evidence of contusion or other structural damage

Typically synonymous with concussion,
which is a syndrome,
(checklist of symptoms)
but you can injure your brain without getting
a concussion (**subconcussive mTBIs**)



Chronic traumatic encephalopathy (CTE)

aka Dementia pugilistica, punch-drunk syndrome

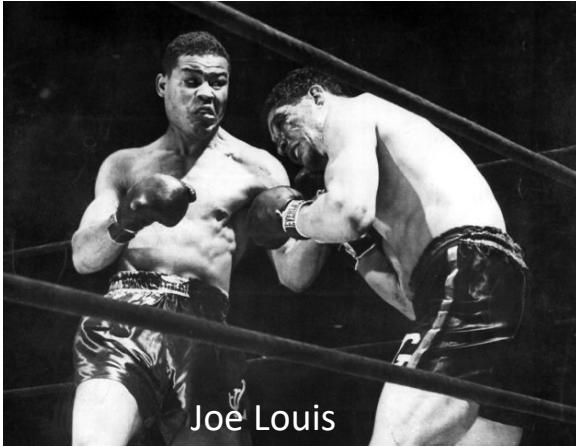
'amakair
A progressive, irreversible neurodegenerative disease

Caused by repeated blows to the head

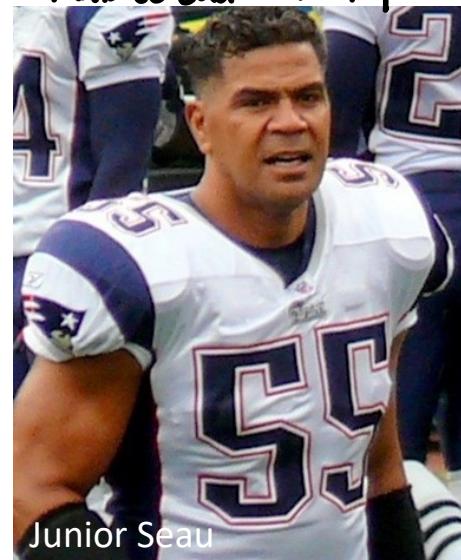
III football
players
↳ 110 もも

Not just professional athletes!

that so sad oh my god

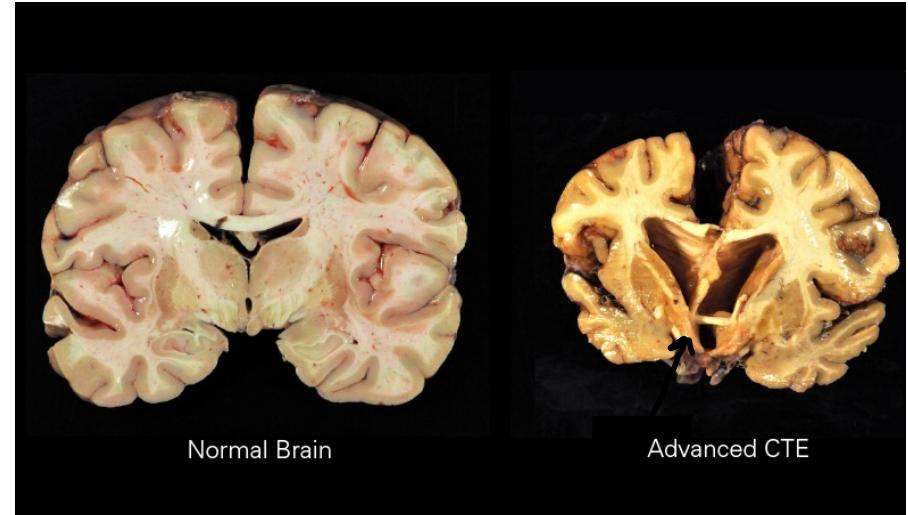


Head injuries



Junior Seau

<https://www.youtube.com/watch?v=d9Vlc7kBUW8>



Normal Brain

Advanced CTE

*that insane
this has been such a tough
yuck!*

CTE

Stage 1: confusion, disorientation, headaches

Stage 2: lapses in memory, social norms, impulsivity, judgement exel.fu

Stage 3/4: progressive dementia, movement disorders **cognitive & motor symptoms**
(esp. Parkinsonism), speech disorders, depression, suicidality

spontaneous movement
trouble w/ speech
cognition

I'm so
sad
say...

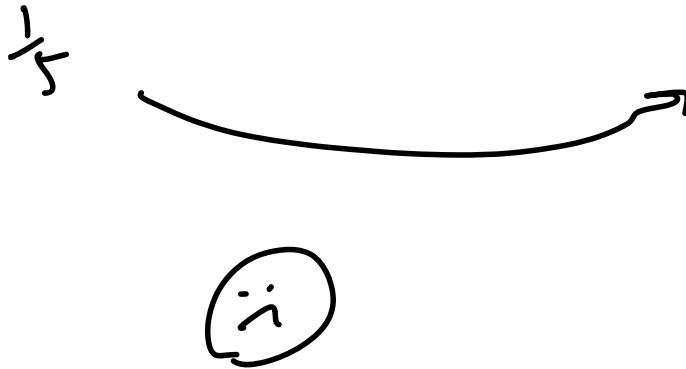
<https://www.youtube.com/watch?v=NsZ1kYv6hXw>

<https://www.youtube.com/watch?v=HZy8xGOzsUA>



★ Pathological aggression, jealousy, and paranoia are common

Not just concussion *repeated blows*
Not just professional athletes



<https://www.youtube.com/watch?v=St3dzliCWS4>

CTE *can't diagnose while someone is alive*

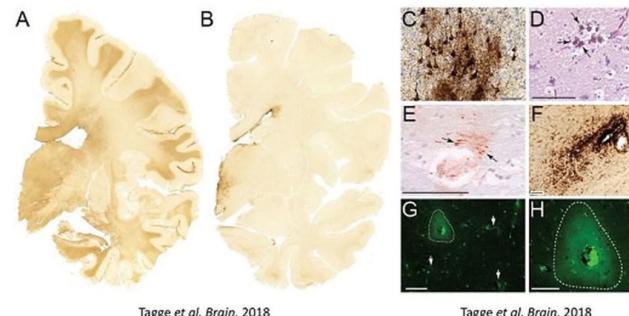
Early Lead

A new study shows that hits to the head, not concussions, cause CTE

By Cindy Boren January 18 Email the author

TBI-CTE Pathology in Teenage Athletes After Mild Head Injury

Rare brains from teenagers in acute-subacute period after sports-related TBI



Tagge et al. *Brain*, 2018

Tagge et al. *Brain*, 2018

Most Read

1 Perspi
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2 2018
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4 At All
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5 The E
hard
call fr

Head injuries

From https://www.washingtonpost.com/news/early-lead/wp/2018/01/18/a-new-study-shows-that-hits-to-the-head-not-concussions-cause-cte/?utm_term=.e603dc4dd10f

CTE: Tau & neurofibrillary tangles

that
guy made
me so
sad

Tau stabilizes cytoskeleton
binds & stabilizes

reverted from
cytoskel with
needs to move

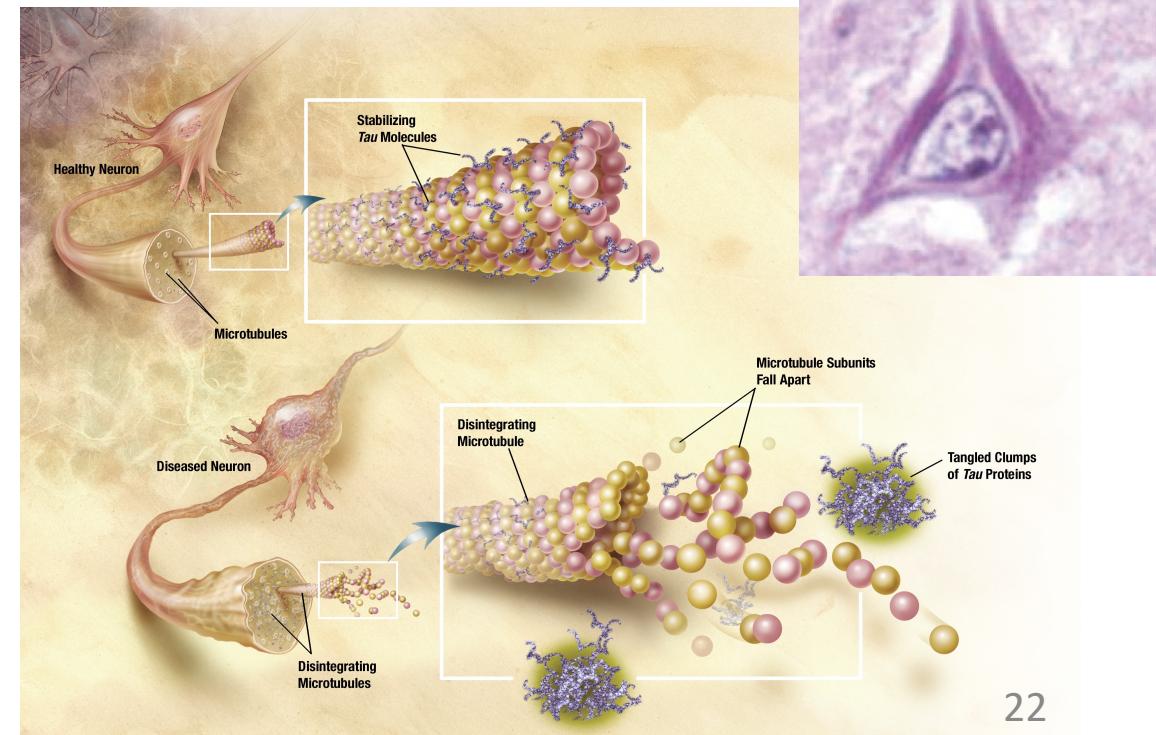
When tau is hyperphosphorylated, it aggregates and
cytoskeleton becomes unstable
tagged

Not necessarily cause of CTE
curl, but may be byproduct

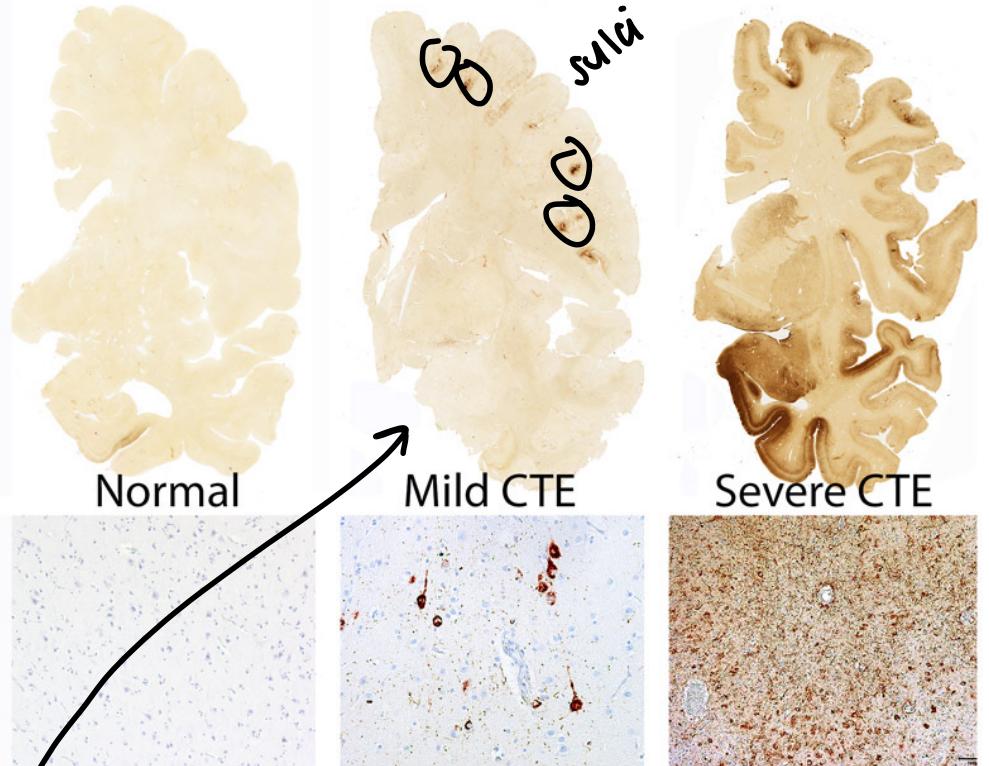
Also seen in AD, PD

A clear marker of CTE, but
relies on postmortem staining *

Head injuries



Tau progression



Sulci first (?): iron deposits from hemorrhage?

Tau progression is different for CTE vs. AD
Head injuries

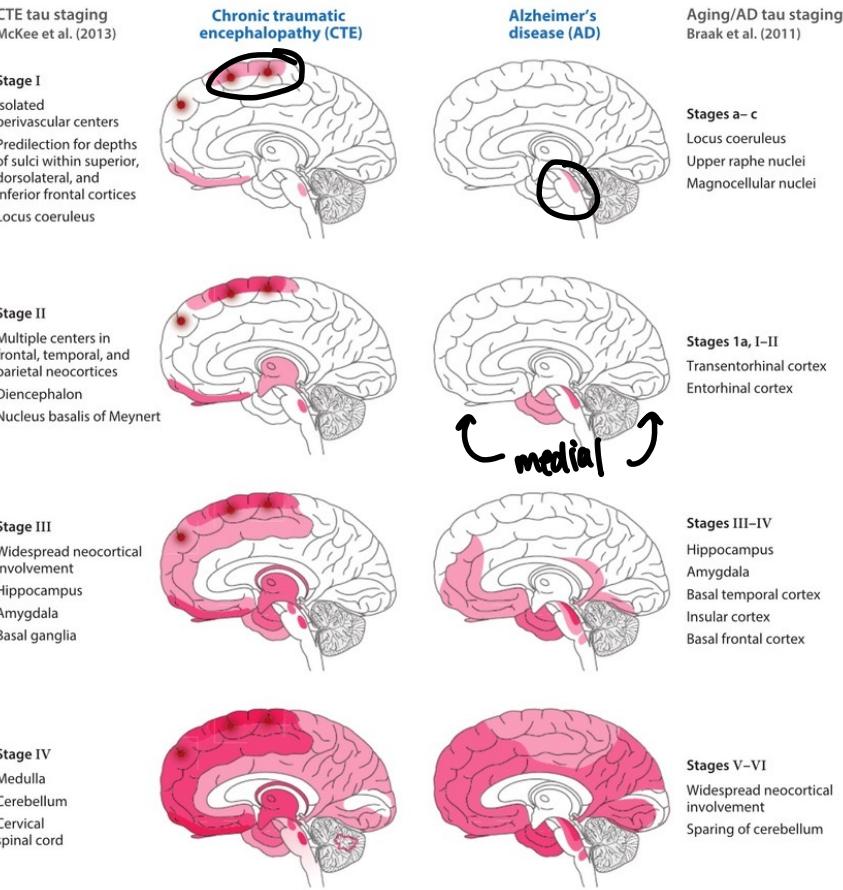
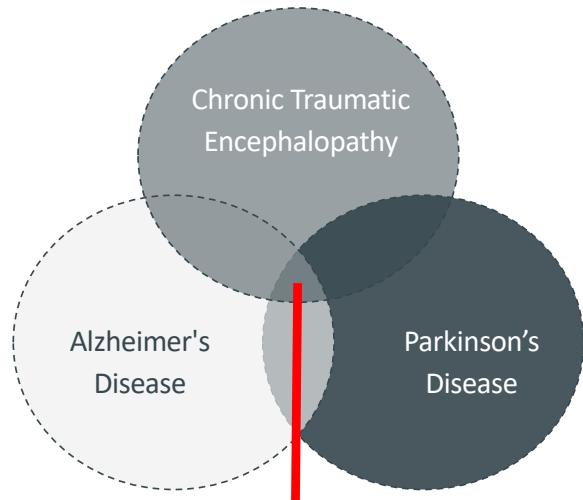


Figure 3

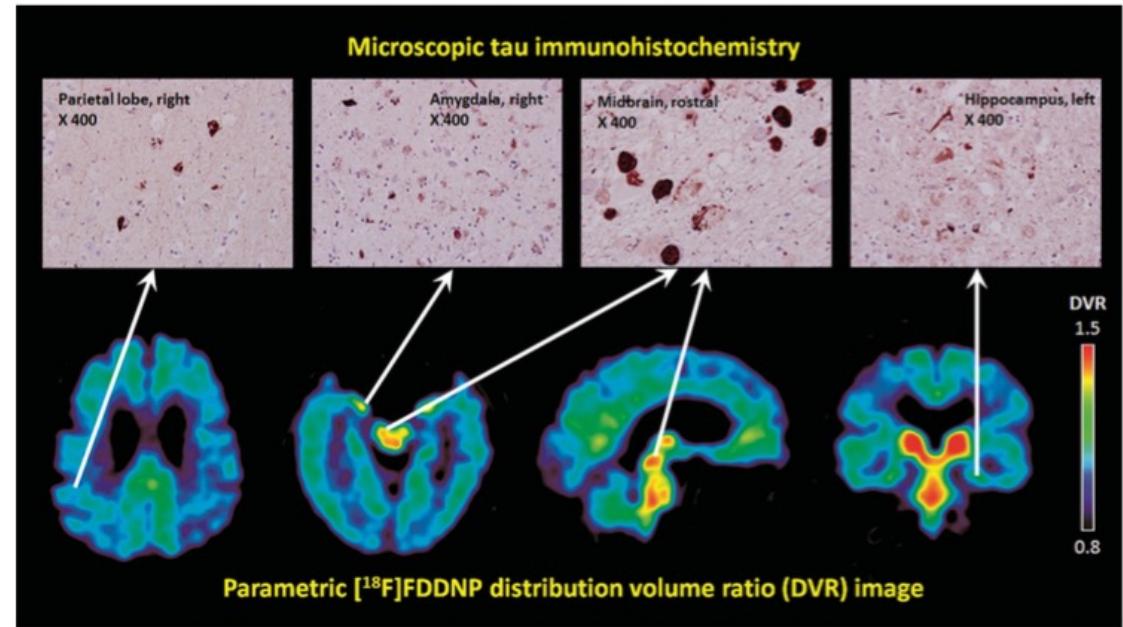
Comparison of hyperphosphorylated tau progression. In chronic traumatic encephalopathy (CTE) the abnormal accumulation of hyperphosphorylated tau first appears in the neocortex and locus coeruleus (CTE stage I), then involves the diencephalon (CTE stage II), next the medial temporal lobe (CTE stage III), and finally is widespread throughout the neocortical, brainstem, and cerebellar regions (CTE stage IV). This is in contrast to Alzheimer's disease (AD), where the tau pathology first occurs in the brainstem (Braak stages a-c), next involves the entorhinal cortex (stages 1a, 1b, I-II), then more widespread involvement of the medial temporal lobe (stages III-IV), and finally widespread involvement of the neocortex (stages V-VI). This schematic figure is based on information reported in Braak et al. (2011), McKee et al. (2013), and Stein et al. (2014).

literally no no no

Taupathies



- “Taupathy”
 - Result: neurofibrillary tangles
- evidence of cellular stress/dmg?*



Omalu et al. 2017

Trying to develop PET tracer for CTE diagnosis in the living, but not there yet

works very good in brainstem but not in cortex

Head injuries



<https://www.cbc.ca/sports/hockey/nhl/henri-richard-cte-1.6876247>

Knowledge changes you (well, me)

Preliminary results (Mez, 2022):

- 74 post-mortem hockey players
- (7 youth, 25 high school, 22 junior or college, 19 professional)
- 54% of their brains showed signs of CTE
- “We found each year of ice hockey play may increase the odds of developing CTE by 23%.”

<https://www.bumc.bu.edu/camed/2022/03/04/additional-years-of-ice-hockey-play-may-be-linked-to-greater-chance-of-cte/>

I'M SO
SAD TD

never been
happier 2 v
baseball
(no head injuries)



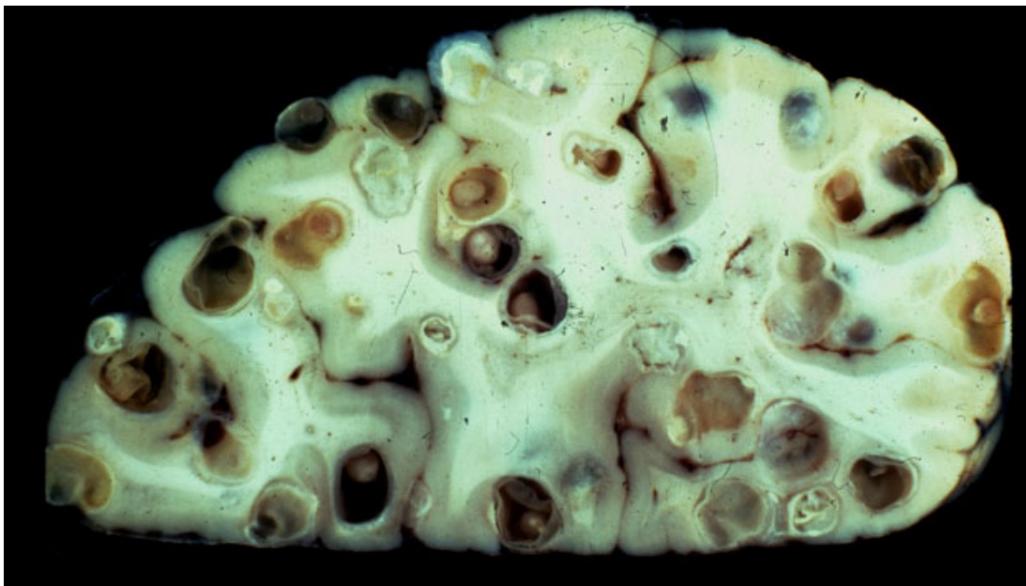
Head injuries

???

25

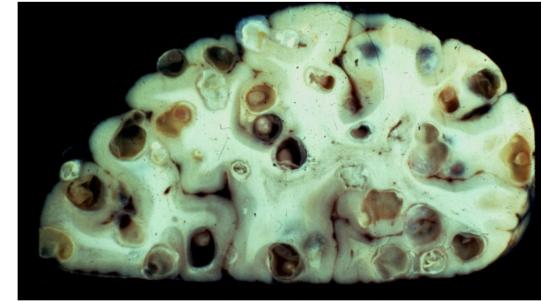
Lecture overview: part II

- A. Infections of the brain
- B. Neurotoxins
- C. Multiple sclerosis



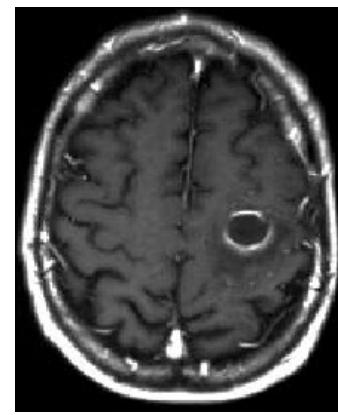
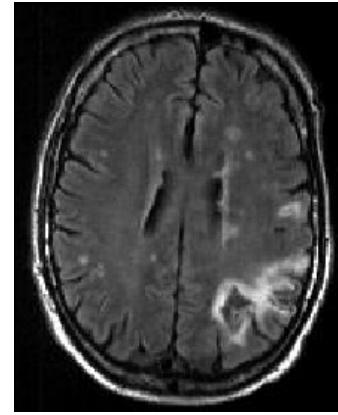
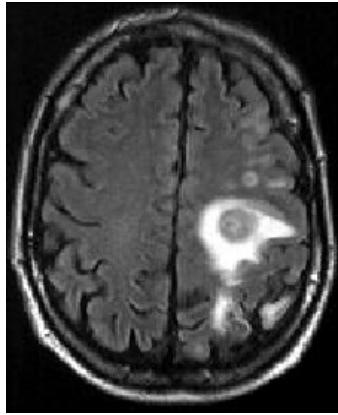
Learning objectives part II

1. Discuss three types of brain infections, including their cause and severity.
2. Discuss two types of neurotoxin-induced brain dysfunction.
3. Are vaccines dangerous? Describe their relationship to toxicity and to autism.
4. Describe the symptoms of multiple sclerosis (MS).
5. Discuss the two theories of MS.
What evidence is there to suggest that
MS is not simply an auto-immune disorder?
6. Read the paper by Bjornevik *et al.* 2022. Some of the molecular details will be outside of your knowledge base, so don't worry about them as much. Instead, focus on the longitudinal design of the study, and why it is particularly convincing in seeing Epstein-Barr virus as causal to MS. Be sure to also know the general results, e.g. time course of EBV and MS.



Bacterial infections

bacteria avert
mean
@@



Can cause inflammation of the brain (encephalitis).

LOL

When bacteria attack the brain they often lead to the formation of cerebral **abscesses** (pus pockets).

Yucky

not as
bad

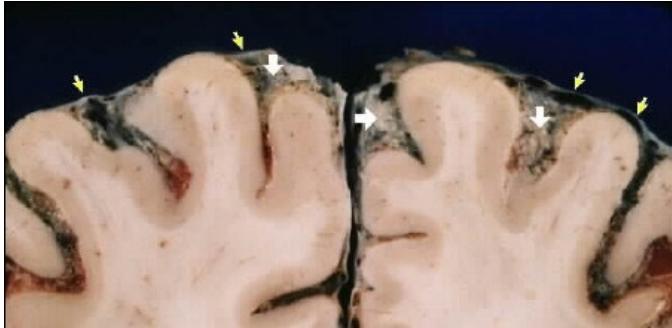
Bacterial infections (or viral)

challenge =
identifying it

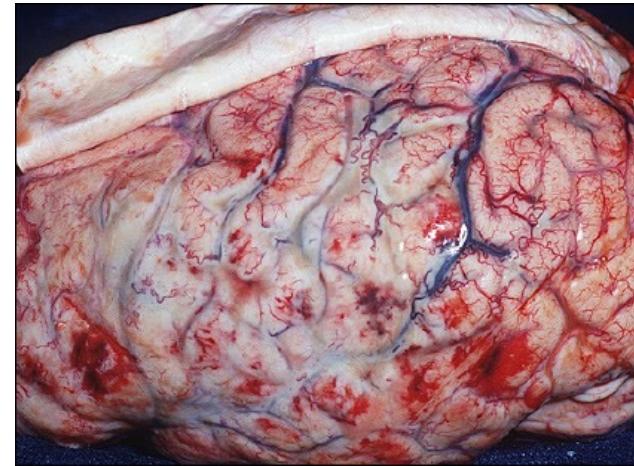
1/4 die

→ Bacteria often attack the meninges, producing an inflammation known as meningitis.

not noticed
at first
symptoms like a
cold/flu



headache
fever
etc



what if
this
class
makes
me
worse as
a
person

I never could
summe med
school

Bacterial infections

In the news:

Convicted for using natural remedies to treat dying son, father back promoting alternative medicine

GRAEME HAMILTON 01.11.2017 |



“haters”
I ~~hate~~
we hates theequus

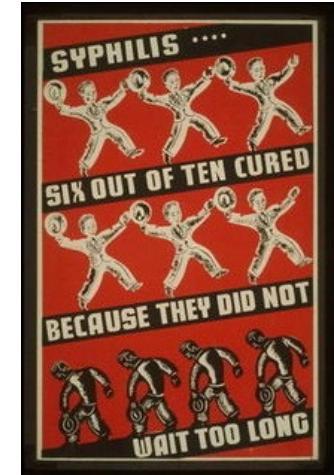
Bacterial infections: syphilis

round of antibiotics
can prevent
this

A type of bacteria that can attack the brain.

#awesome

General paresis: The syndrome of psychosis/dementia that results from a syphilitic infection of the brain.



Viral Infections

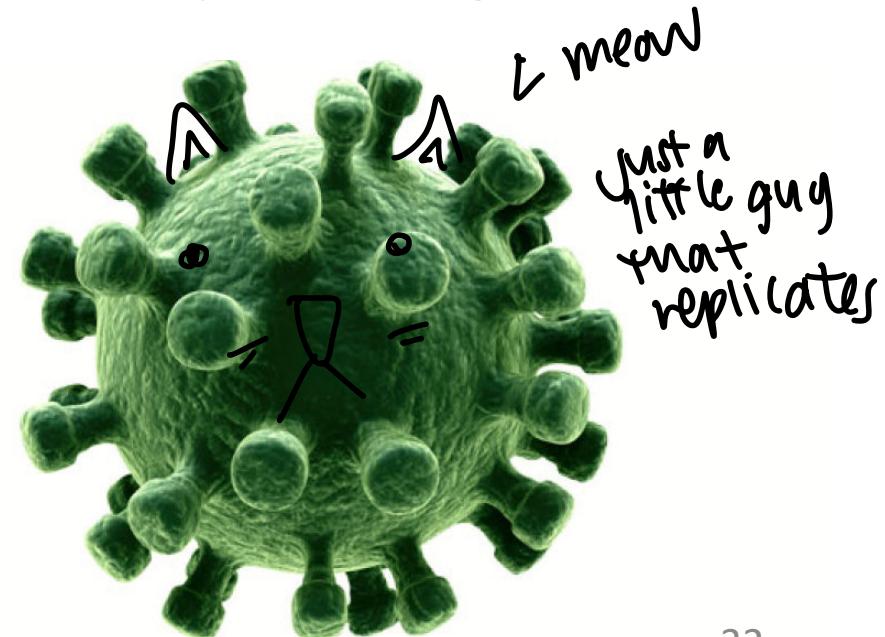
Jay...

smaller
X alive??X

Two types:

1. Those that have a particular affinity for neural tissue (e.g. rabies)
2. Those that attack all tissues indiscriminately, including nervous tissue (e.g. herpes simplex)

Viral infections of the brain can cause encephalitis and meningitis.



Viral Infections: Rabies

hydrophobia aggressive foamy mouth

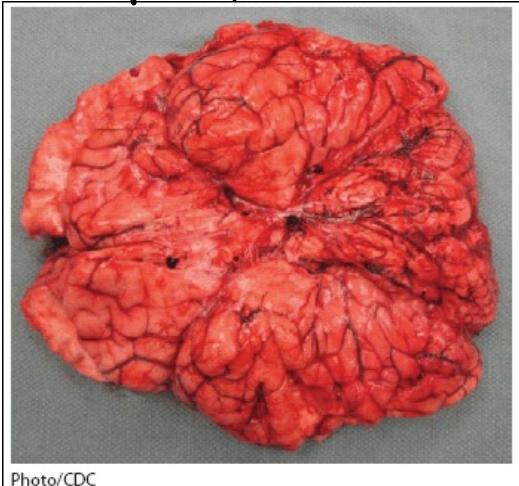
100% fatal

almost never happens

retrograde transport - backwards along the axon

The rabies virus has an affinity for the nervous system.

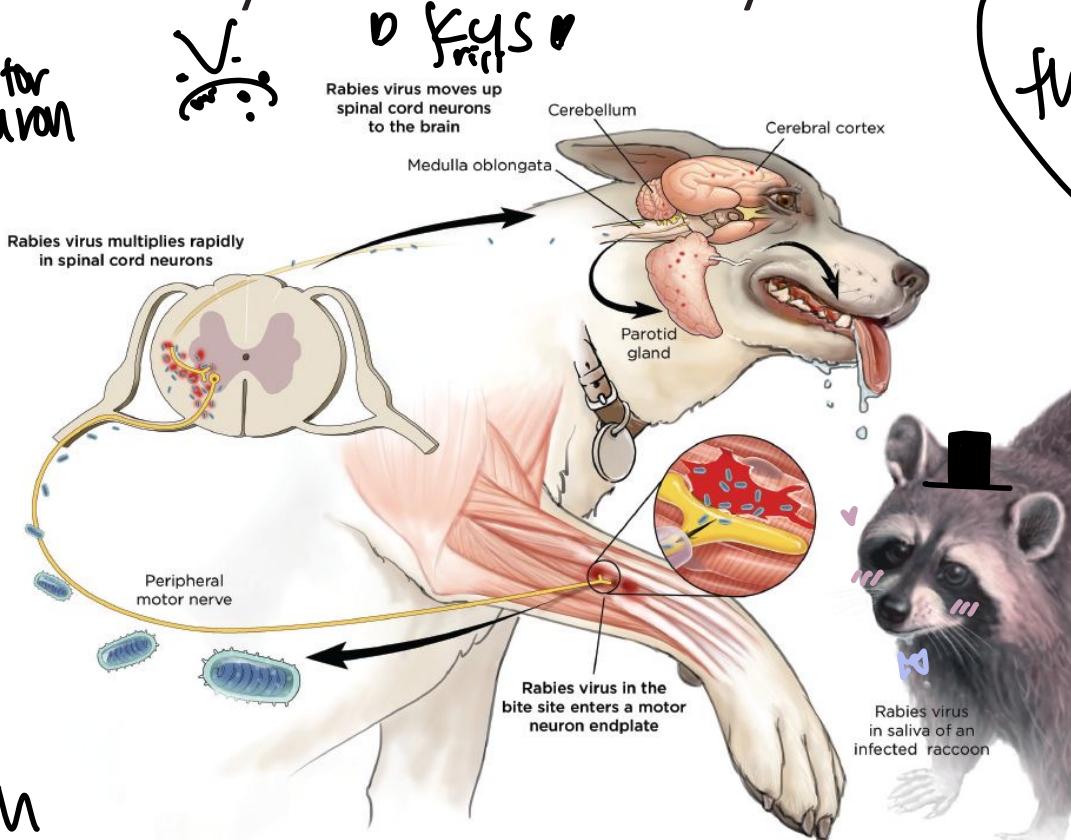
requires that it makes it into the axon of a motor neuron



This is a human brain!

Infections

rahhh



hes kinda cure though

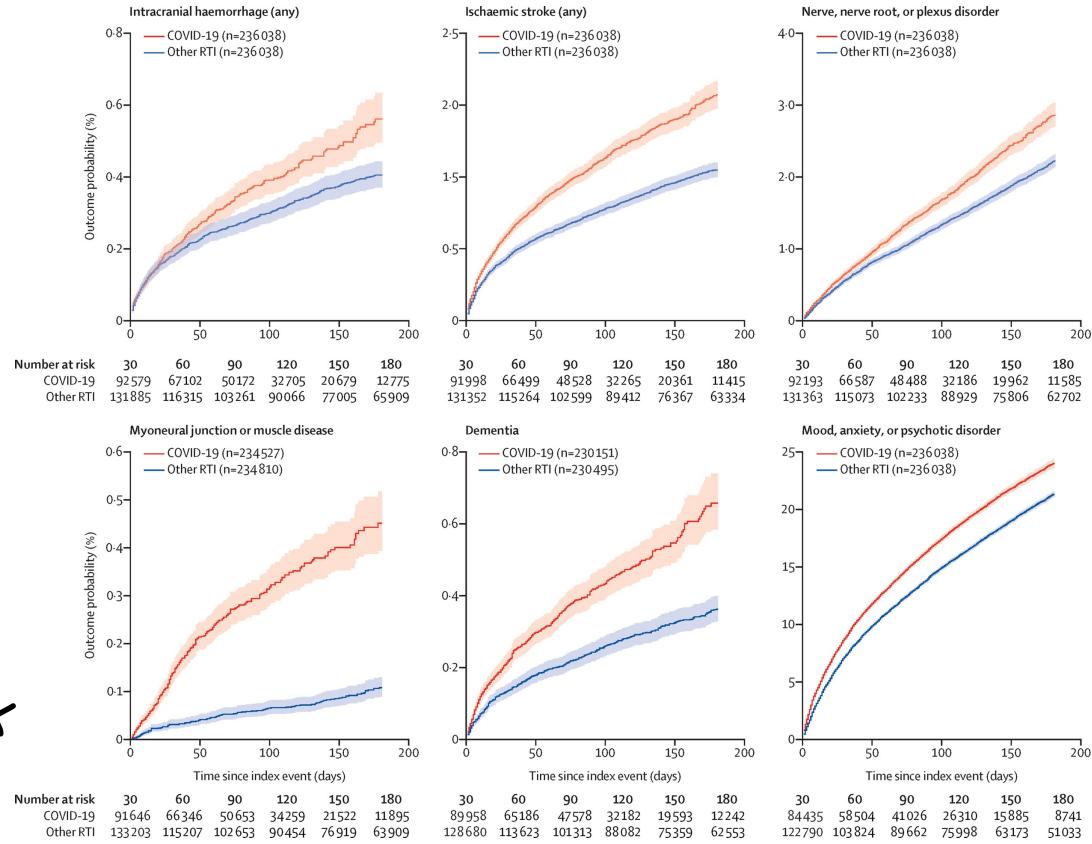
#SHAPE been longer guys
i dont have rabies, jay said so

What about COVID-19?



- Caveat: not all of us symptomatic, new topic, other complications to studying
- ~35% of those symptomatic have neurological symptoms (Koralnik & Tyler 2020, Mukerji & Solomon 2021)
- Often detected in olfactory neurons, likely rare in CNS (Soung *et al.* 2022)
- Often markers of inflammation
- Most dangerous issue seems to be cerebrovascular (i.e. blood flow) leading to hypoxia

Prob not by directly
getting inside it



Taquet *et al.* 2021

What about COVID-19?

- Douaud *et al.* 2022: longitudinal design, 401 people's brains, before and after COVID-19
- Effects on brain small but significant: decreased grey matter in OFC and parahippocampal gyrus, global reductions in brain size
- Also saw greater cognitive decline vs. controls
- Effects largest on oldest participants

SCAM ...

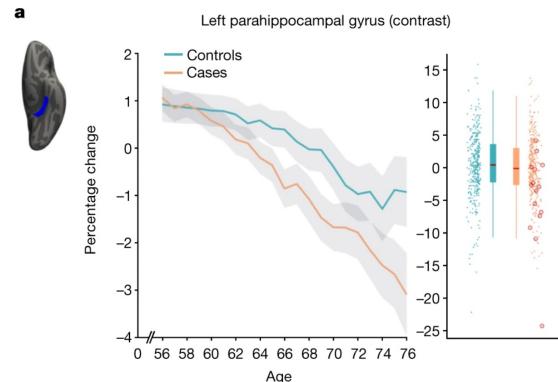


Fig. 3: Significant longitudinal differences in cognition.

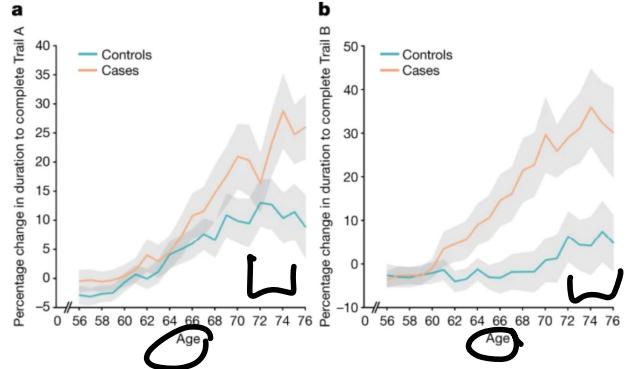
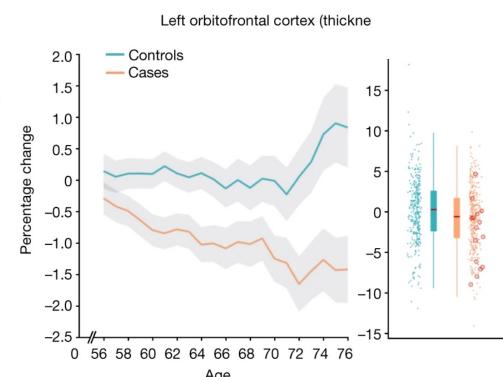
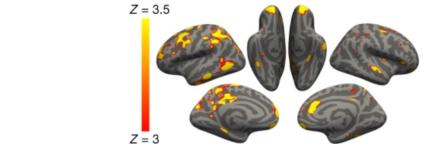
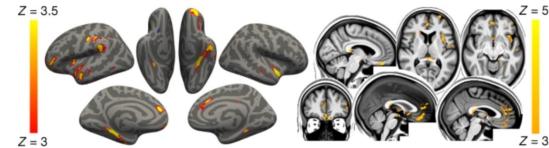


Fig. 2: Vertex-wise and voxel-wise longitudinal group differences in grey matter thickness and mean diffusivity changes.



Douaud *et al.* 2022

COL
don't be around cats while pregnant

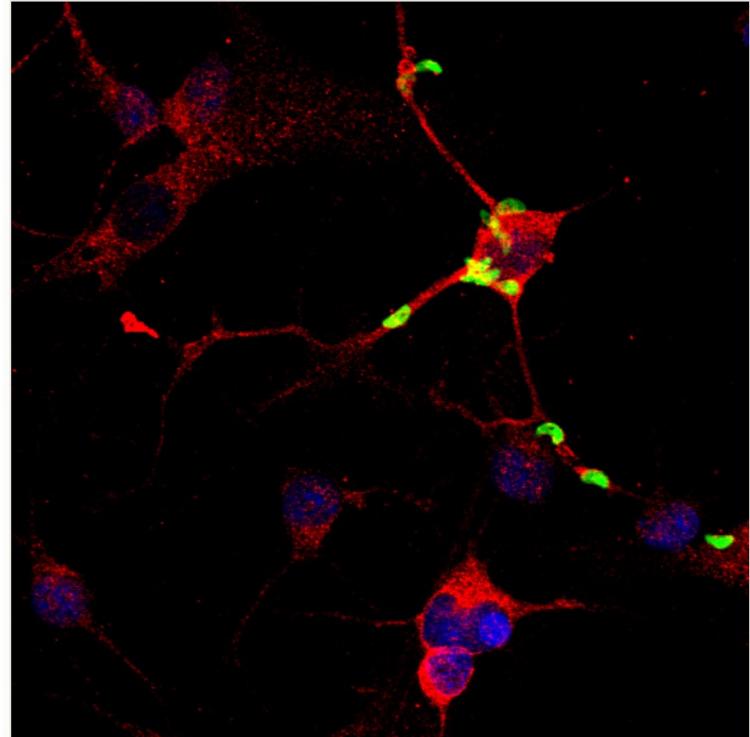
Toxoplasma gondii: eukaryotic parasite



Selectively
affects
just some
areas of the
brain
in cats (no long-term
effects)

needs to
host in
life span

Parasite infections



Individual Toxoplasma parasites (green) are shown invading neurons (red) grown in a petri dish in the lab. The blue areas are fluorescently tagged cell nuclei.

Stanford Report, August 17, 2011
Parasite uses the power of sexual attraction
to trick rats into becoming cat food

<https://news.stanford.edu/news/2011/august/catrat-081711.html>

Infections
barely any differences
in pop-

not claiming

In the news



NBC News

@NBCNews

Follow

A mind-controlling parasite found in cat feces may give people the courage they need to become entrepreneurs, researchers reported.



A mind-controlling parasite found in cat feces may give people the courage they need to become entrepreneurs, researchers reported Tuesday.

They found that people who have been infected with the *Toxoplasma gondii* parasite are more likely to major in business and to have started their own businesses than non-infected people.

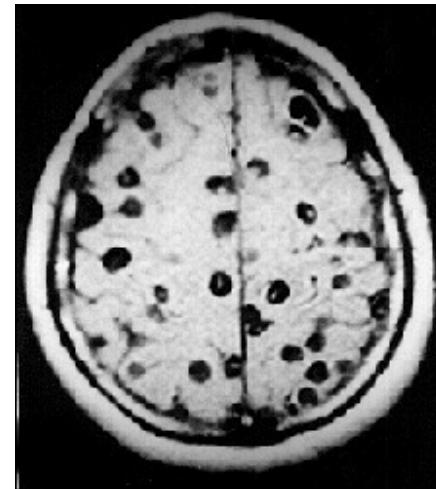
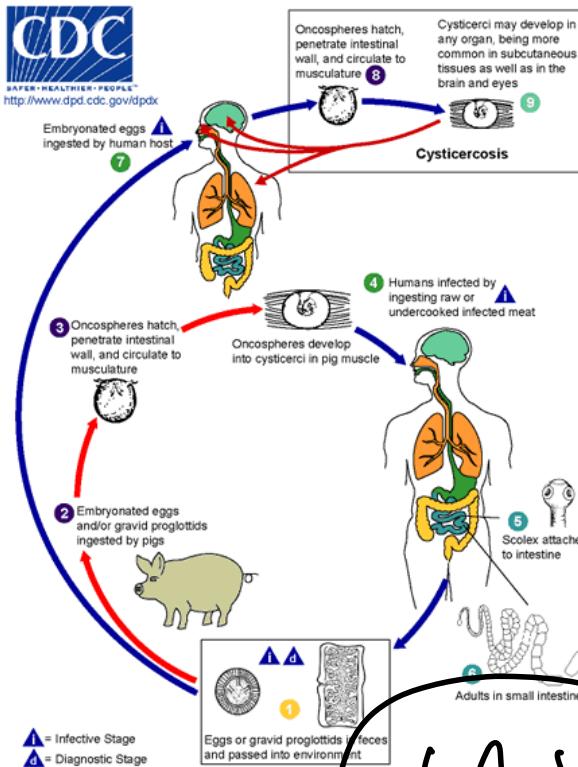
The parasite, which makes rodents unafraid of cats, may be reducing the fear of failure in people, Stefanie Johnson of the University of Colorado and colleagues said.

They haven't actually shown that. But toxoplasma does get into the brain, and it's been linked to a variety of mental effects in mice and people alike. And fear of failure could be a good thing, Johnson said.

Parasite infections

Neurocysticercosis: Tape worm in the brain.

It's ok
we can
get them
out 4
me



EW

CT scan normal
that's not a brain tumor...

STOP
STOPPPPPPP

this wk is tough in 301

<https://www.youtube.com/watch?v=kNP3JlnUcxg>
guys you have worms in LA

LA is
female

Heavy Metals

Mercury can accumulate in the brain and permanently damage it--producing a **toxic psychosis**.



Lor

deep sigh

Heavy Metals

Minamata disease: caused by severe methylmercury poisoning;
ataxia, numbness, muscle weakness, damage to
vision/hearing/speech, paralysis, coma, death; congenital effects



first 10 min here

Neurotoxins

Heavy Metals

Methylmercury poisoning is thankfully rare in North America, now, but still sometimes occurs

using for years b4

CNN health Food Fitness Wellness Parenting Vital Signs • LIVE TV Edition ▾ Q

A woman was permanently injured from a skin-lightening cream tainted with an extremely toxic form of mercury - the first such case in the US

By Scottie Andrew, CNN

Updated 11:01 AM ET, Thu December 26, 2019



Heavy Metals

Small amounts of ethylmercury are present in vaccines as a preservative, BUT no evidence whatsoever to suggest harmful neurological effects.

Aside:

Relationship between vaccines and autism?

NO

12 children sample
100% corr.

no control group
(everyone was exposed
to MMR vaccine)

Neurotoxins



Wakefield - *celebrity*

no side effects for
nervous system

WORLD NEWS DECEMBER 5, 2019 / 10:08 AM / 2 MONTHS AGO

WHO decries 'collective failure' as measles kills 140,000

Kate Kelland

4 MIN READ

LONDON (Reuters) - Measles infected nearly 10 million people in 2018 and killed 140,000, mostly children, as devastating outbreaks of the viral disease hit every region of the world, the World Health Organization said on Thursday.



World Canada Local Politics Smart Living Money Entertainment Health Video Podcast

February 9, 2019 5:12 pm

Updated: February 9, 8:37 pm

Health officials confirm measles case in Vancouver area

By Simon Little
Online Journalist Global News



status as anti-vaxx guy
one study had such a profound
effect

Heavy Metals

Lead can also lead to toxic psychosis (origin of “crackpots”). lead lined teapots



↳ drinking
from cracked
tea pot, absorbed

Neurotoxins ~~in~~ USA

Free time: *Cosmos* episode 7

Comparing Canadian water to Flint, Michigan and lead pipes

Prince Rupert

Prince Rupert (no LSLs) versus Flint (including 12% that have LSLs)

Samples first drawn after 6 hours of stagnation

	Median (ppb)	Average (ppb)	% above 5 ppb
Prince Rupert (15 samples)	9.9	14.1	80%
Flint (277 samples)	3.5	10.5	40.4%

Samples include 1-minute flush from Flint and 45 second flush from Prince Rupert after 6 hours of stagnation

	Median (ppb)	Average (ppb)	% above 5 ppb
Prince Rupert (15 samples)	3.9	4.0	26.7%
Flint (277 samples)	1.4	10.2	24.9%

Samples include 3-minute flush from Flint and 2-minute flush from Prince Rupert after 6 hours of stagnation

	Median (ppb)	Average (ppb)	% above 5 ppb
Prince Rupert (15 samples)	2.3	2.8	13.3%
Flint (277 samples)	0.5	3.7	12.6%

Credit: Data obtained and analyzed by the Institute for Investigative Journalism

Heavy Metals

However, lead is toxic at much lower levels as well. Lead poisoning is especially deleterious to children, where it impairs physical and mental development. It can also cause a variety of neurological problems in adults.

Tainted Water

INVESTIGATIONS

Is Canada's tap water safe? Thousands of test results show high lead levels across the country

BY GLOBAL NEWS, TORONTO

Posted November 4, 2019 6

Updated November 5, 2019

INVESTIGATIONS

In Metro Vancouver, you may not know if you have lead in your water. Here's why



By **Ainslie Cruickshank** Star Vancouver
Thu., Nov. 21, 2019 | 7 min. read

unregulated in house

Cant wait to
go drink some
CA water

Progressive disorder that primarily attacks the myelin of axons in the CNS, but there is also cell loss.

Common symptoms in advanced cases:
visual disturbances, muscular weakness, numbness, tremor, and loss of motor, usually sensory & motor coordination. later stages can be cognitive

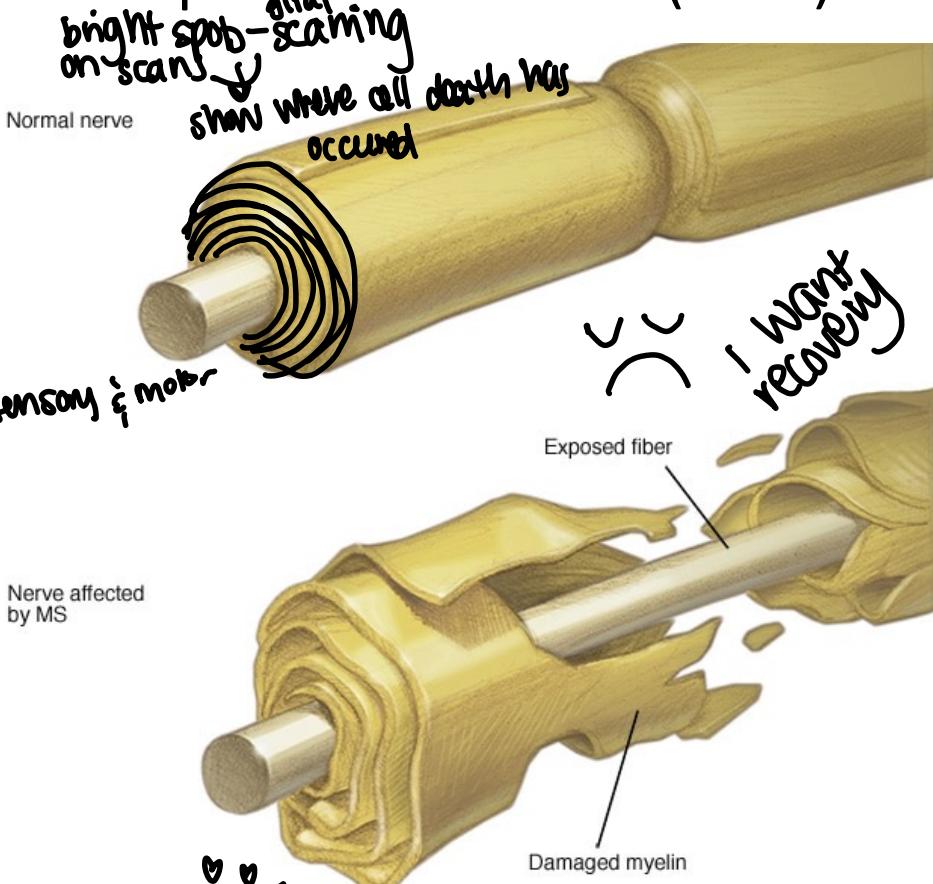
The immune system often appears to attack the CNS myelin as if it were a foreign substance.

autoimmune disorder

Multiple forms: e.g. relapsing-remitting, secondary progressive, primary progressive

Multiple Sclerosis

Multiple Sclerosis (MS)



prim dugs = straight symptoms all the time
immunosuppressant/
immunomodulator

Theories of Pathogenesis

1. Primarily an autoimmune disease ("outside-in" theory).

main theory

immune syst. wrongly targeted
normal cells

↳ cells being attacked from outside

2. Primarily a neurodegenerative disease, with inflammation in some patients ("inside-out" theory).

immune syst reaching, but
not primary differ → cells from inside

Evidence to suggest that it isn't simply an autoimmune disease (3)

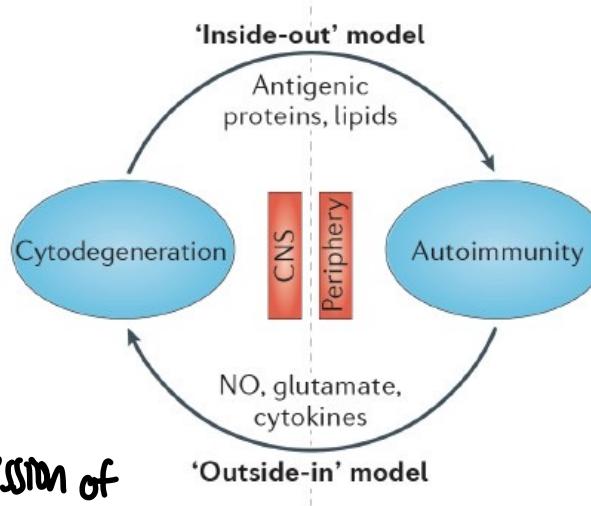
we're not sick we just
smokes a lot

↳

Multiple Sclerosis

1. block immune syst should
block prog of disease
↓
drugs help w/ symptoms
but don't change progression of
disease

2. some indivs w/ MS don't have
inflam (diff w/ of immune response)



from Stys et al., 2012

3. Immune system - should be attacking myelin, acting on outside first BUT → innermost layer dysfn first ??

46

I hate u jay

Progression: relapsing-remitting form

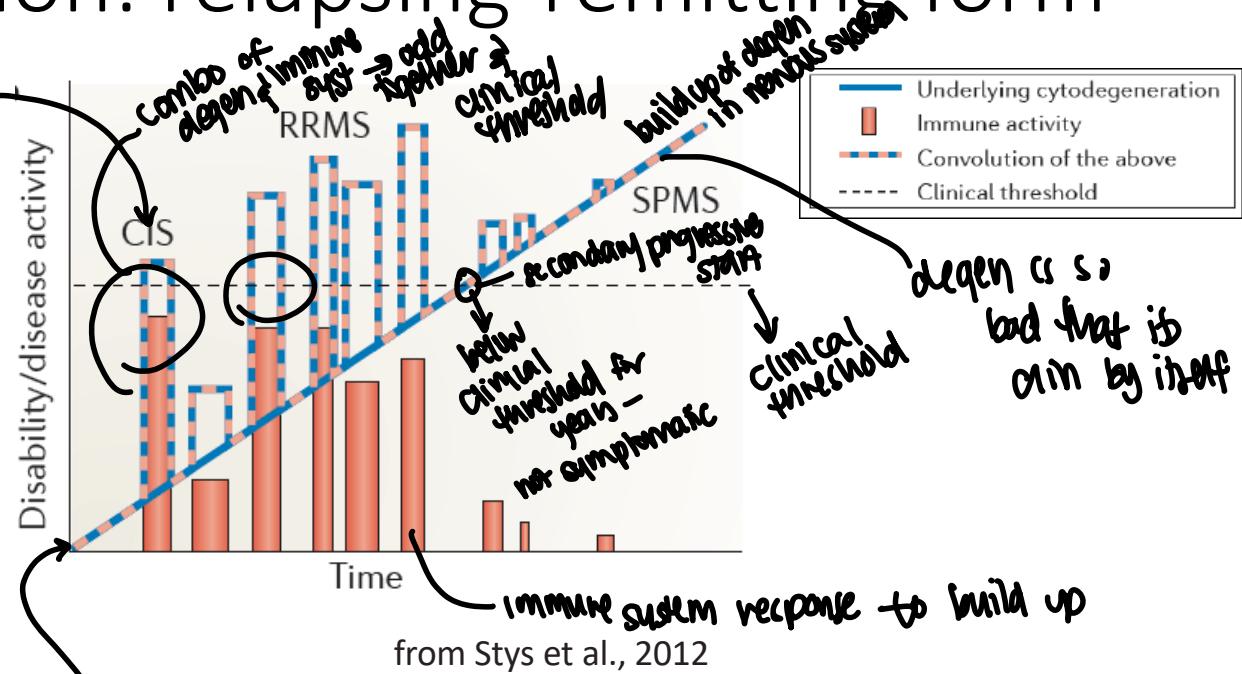
CIS = clinically isolated syndrome
something happens for a few days & then goes away

RRMS = Relapsing-remitting MS

SPMS = Secondary progressive MS

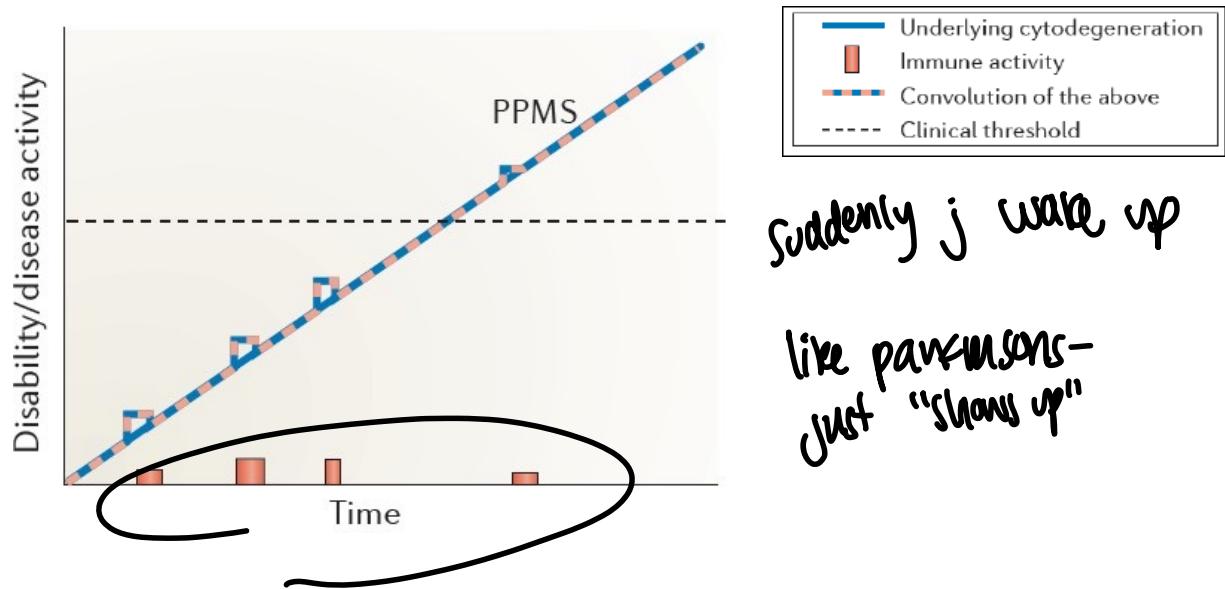
San pasadena
middle school

inside out
building up
progressive
degeneration



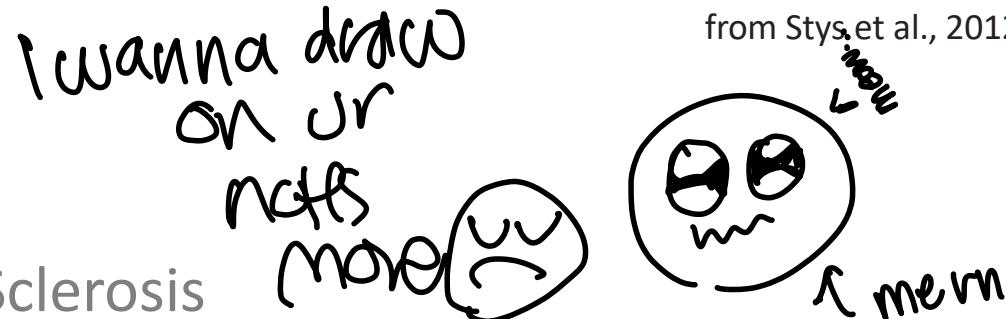
Progression: primary progressive form

PPMS = Primary progressive MS

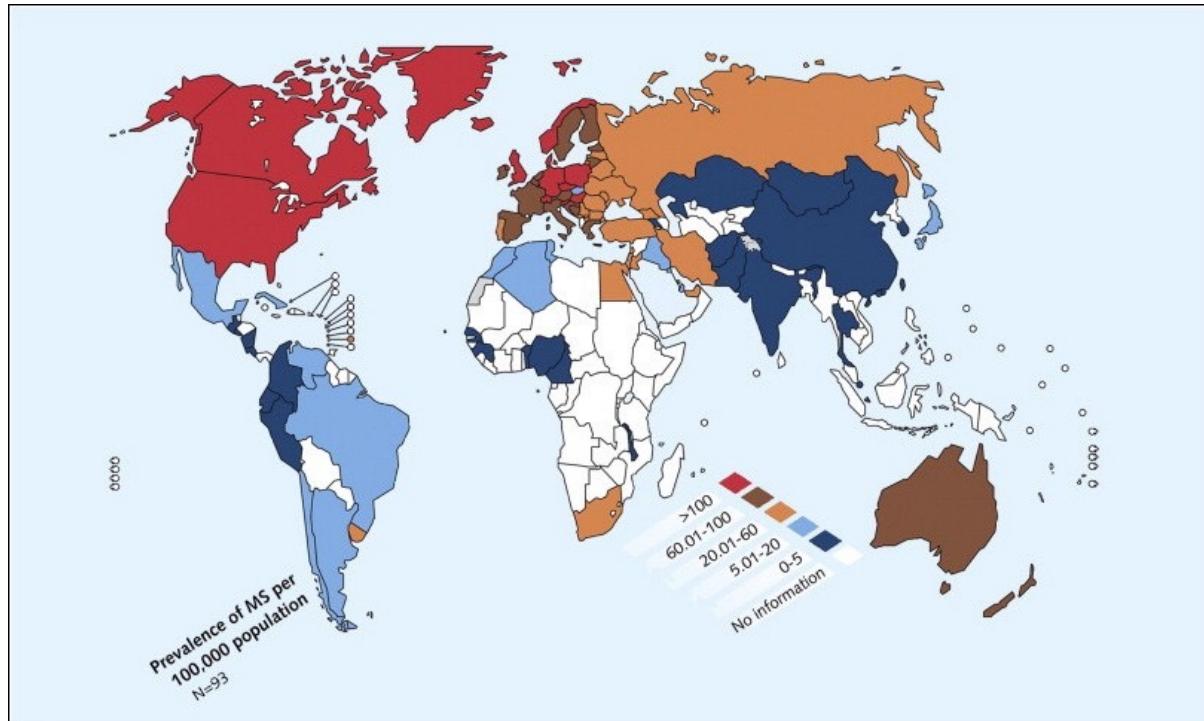


Suddenly j wake up

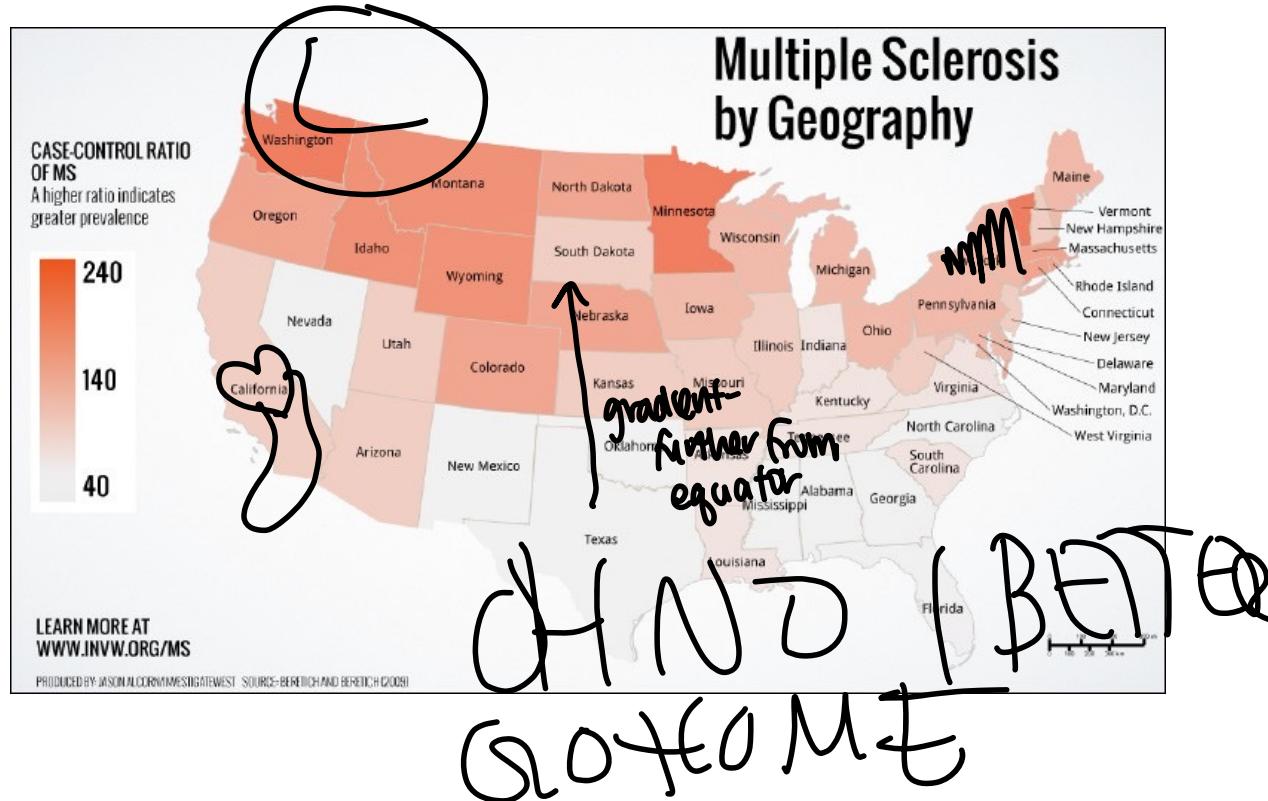
like parkinsons-
just "shows up"



Geography of MS

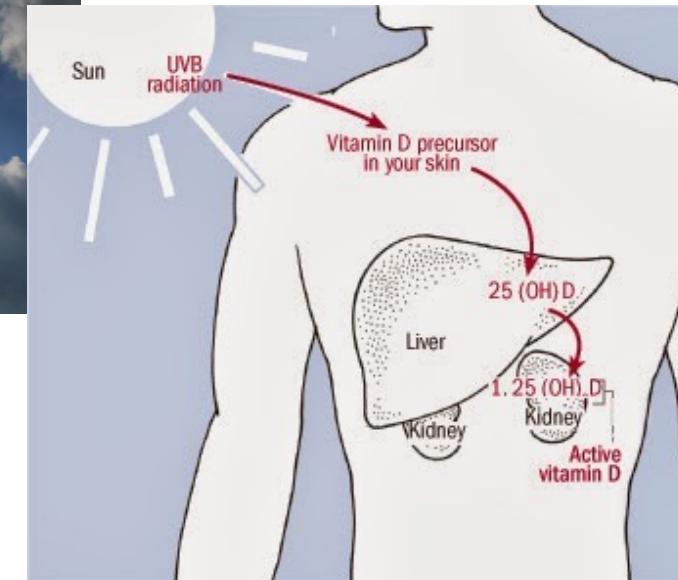


Geography of MS





$\sim 1:30$ \rightarrow watch
 \rightarrow 20 min



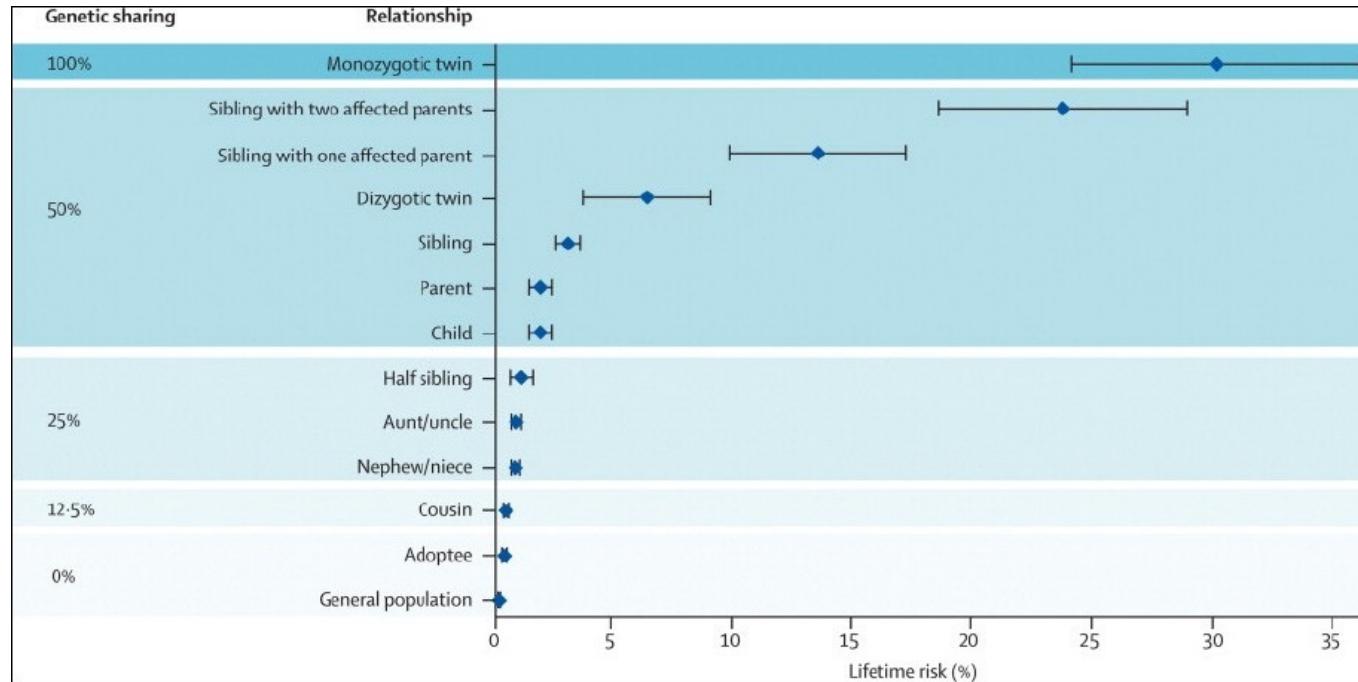
Vitamin D

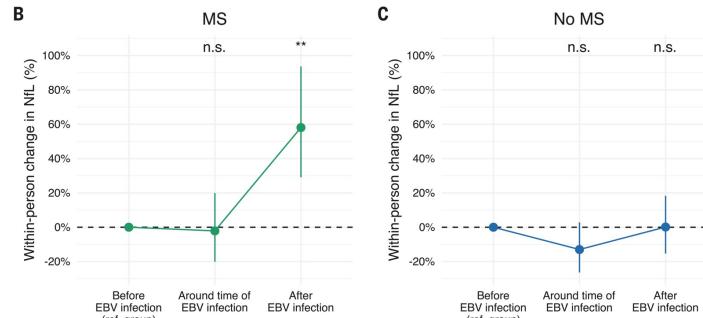
Multiple Sclerosis

OH NO $\ddot{\text{o}}$ $\ddot{\text{o}}$ $\ddot{\text{o}}$ $\ddot{\text{o}}$ $\ddot{\text{o}}$

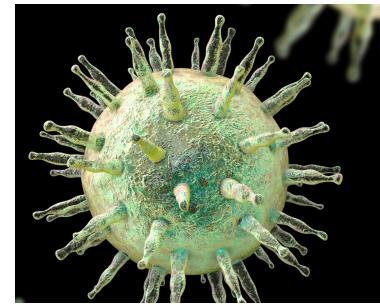
Some evidence for relationship between vitamin D and MS.

Genetics





Strong link to **Epstein-Barr virus (EBV, Herpes virus 4)**
 Same virus that causes “mono”
 Also associated with various cancers



Bjornevik *et al.* 2022: 10 million participants in the military!

All have blood sampled (HIV screening)

They selected EBV-negative participants and followed them

Can see screenings over time, plus onset of MS years later

i.e. longitudinal design

Findings: Epstein-Barr Virus increases risk of MS by 32x!

Only 1 of 801 new MS patients did not have EBV!

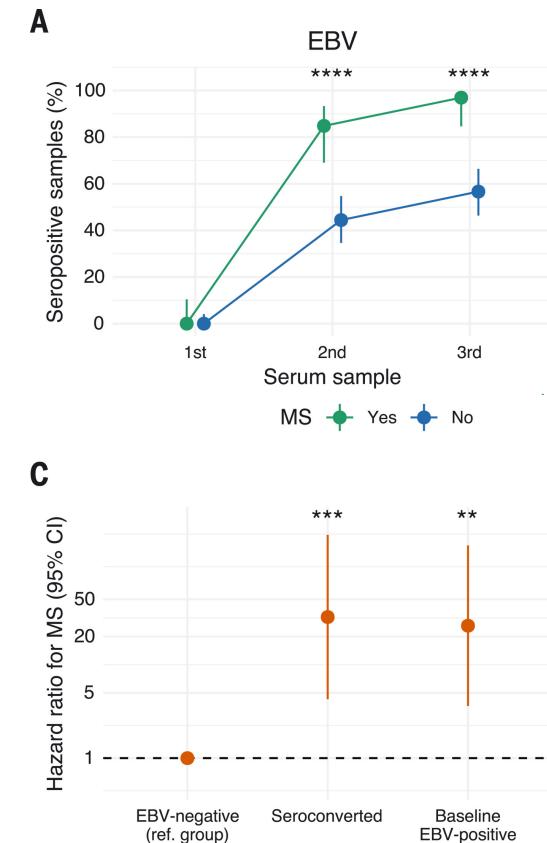
EBV preceded increase in markers of MS

Other virus exposure did not increase MS risk

Complication: most of us have EBV

Implication for MS prevention?:

What's causing MS?



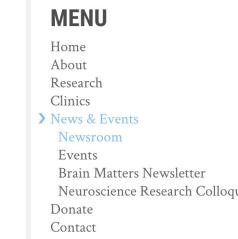
Bjornevik *et al.* 2022

Treatment / prevention?

1. Vitamin D supplements? (lack of is more a risk factor)
2. Corticosteroids
3. Immune system modulators
4. Cannabis (Sativex)
5. Physical therapy
6. Muscle relaxants
7. “Liberation treatment” of the veins? (No)
8. High-dose biotin? (Modest)
9. Hematopoietic stem cell transplantation? (Maybe)
10. Hopefully more/better soon
11. Hopefully EBV vaccine soon
(not treatment, though)



WORKING TOGETHER TO ADVANCE BRAIN HEALTH
THROUGH RESEARCH AND TREATMENT



**CLINICAL TRIAL RESULTS PUT
LIBERATION THERAPY
CONTROVERSY TO REST**

