EPSIG Symposium 22nd March 2019

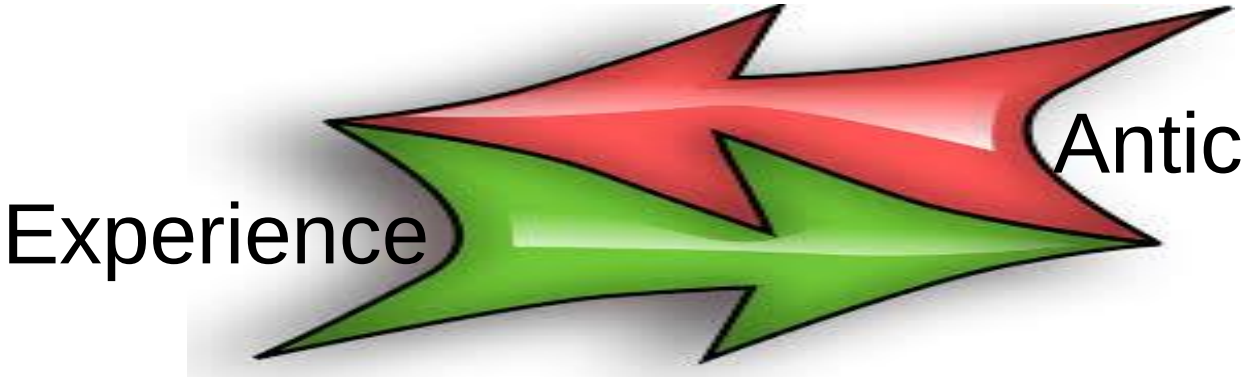
Surviving at the cost of suffering:

The mixed blessings of our evolved neuroplastic brains

Haley Peckham Ph.D.

The brain is the organ of adaptation

We **adapt** to, and **learn** from, past experiences so we can better **anticipate** and **survive** future experiences



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Neuroplasticity: The capacity for neural systems to adapt to experience

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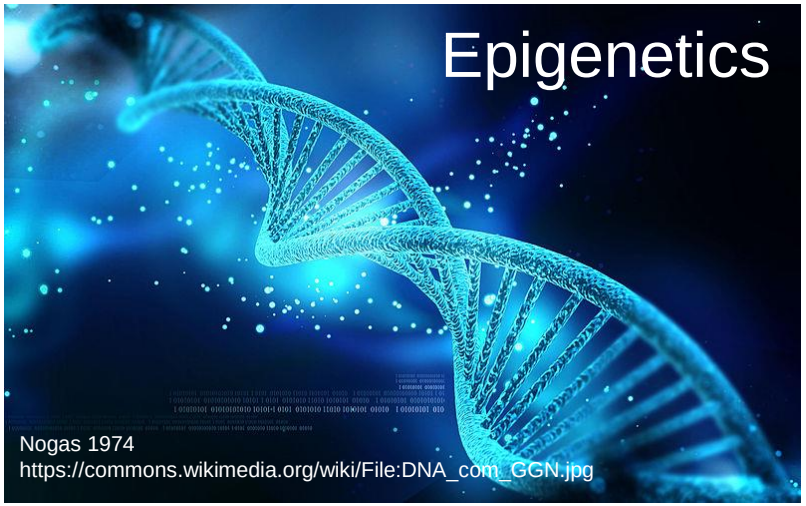
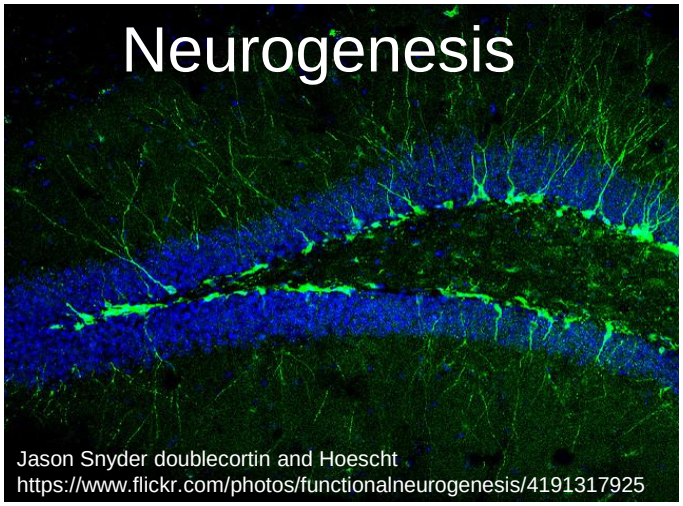
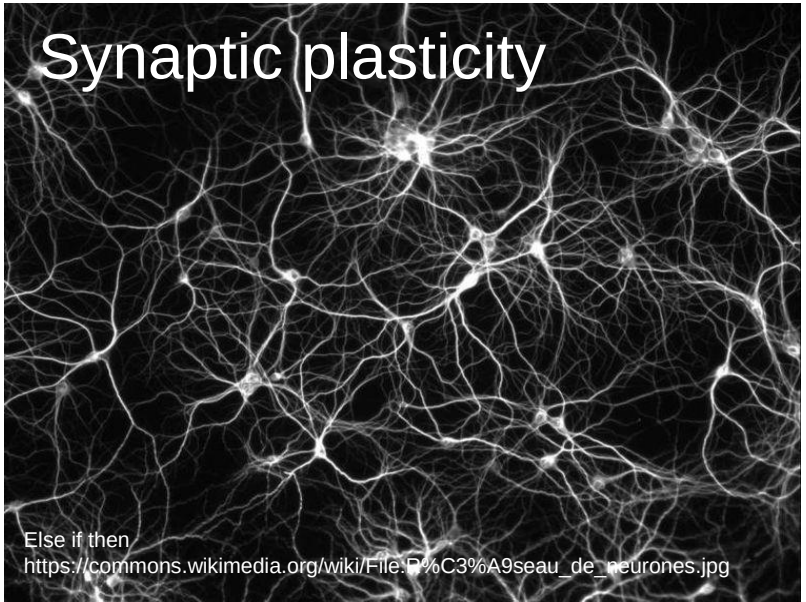


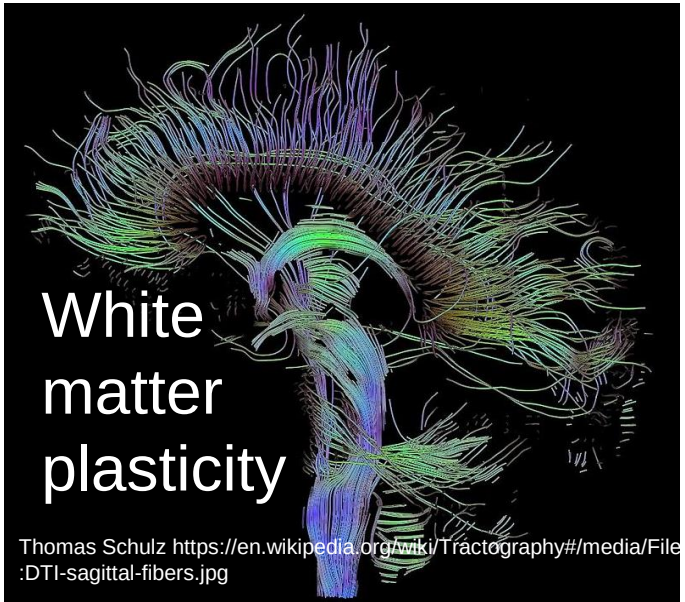
Nogas 1974
https://commons.wikimedia.org/wiki/File:DNA_com_GGN.jpg



Jason Snyder doublecortin and Hoescht
https://www.flickr.com/photos/functionalneurogenesis/4191317925



Else if then
https://commons.wikimedia.org/wiki/File:R%C3%A9seau_de_neurones.jpg



Thomas Schulz https://en.wikipedia.org/wiki/Tractography#/media/File:DTI-sagittal-fibers.jpg

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Epigenetics: Genes learning from experience

- ‘Epi’ genetics – above the gene
- Small chemical groups attach to DNA or histones
- Makes genes more or less accessible to transcription machinery, acts as volume control
- Changes in gene expression may persist from minutes to a life time / transgenerational


Nogas 1974 https://commons.wikimedia.org/wiki/File:DNA_com_GGN.jpg

DNA

↓

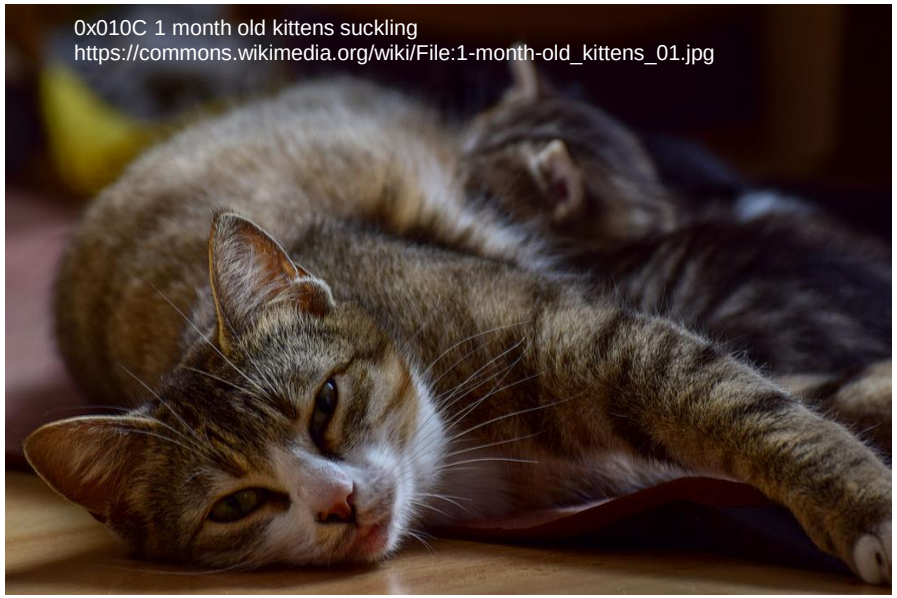
RNA

↓

PROTEIN

Feil, R. and M. F. Fraga (2012). "Epigenetics and the environment: emerging patterns and implications." Nat Rev Genet **13**(2): 97-109.

Calibrating the stress axis



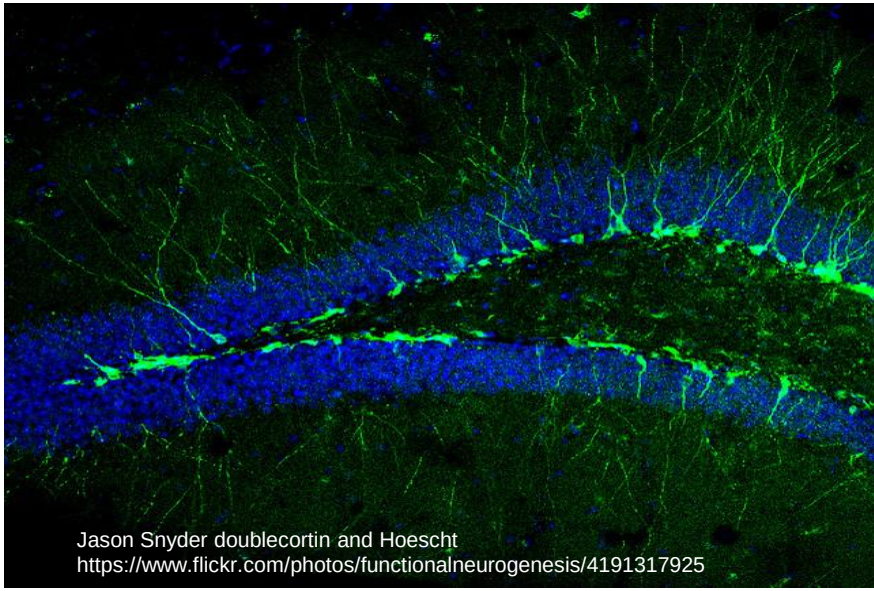
- The glucocorticoid receptor gene is epigenetically regulated by early maternal care
- This early maternal care calibrates the stress axis
- Changes are adaptive

Weaver, I. C., et al. (2004). "Epigenetic programming by maternal behavior." Nat Neurosci **7**(8): 847-854.

Neurogenesis

- The growth of new neurons and their successful integration into the existing network

- Thought to underlie processes of new memory formation and subtle changes to existing memories



Jason Snyder doublecortin and Hoescht
https://www.flickr.com/photos/functionalneurogenesis/4191317925

When you need to remember

By Minette Layne (Flickr: Rain) [CC BY-SA 2.0 (http://creativecommons.org/licenses/by-sa/2.0)], via Wikimedia Commons

- Food hoarding birds have higher levels of neurogenesis in autumn
- Neurogenesis increases in harsher environments
- And reduces when birds are in captivity
- Changes are adaptive

Sherry, D. F. and J. S. Hoshooley (2010). "Seasonal hippocampal plasticity in food-storing birds." Philos Trans R Soc Lond B Biol Sci **365**(1542): 933-943.

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Early Stress Evokes Age-Dependent Biphasic Changes in Hippocampal Neurogenesis, BDNF Expression &Cognition

Separation stress:

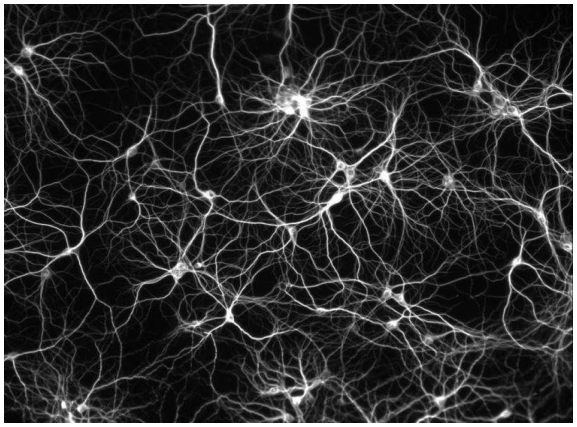
- Reduces epigenetic repression of the BDNF gene
- more BDNF is produced
- Increases neurogenesis
- And improves memory in 8 week old rat pups

BUT

These effects are reversed when the rats reach middle age

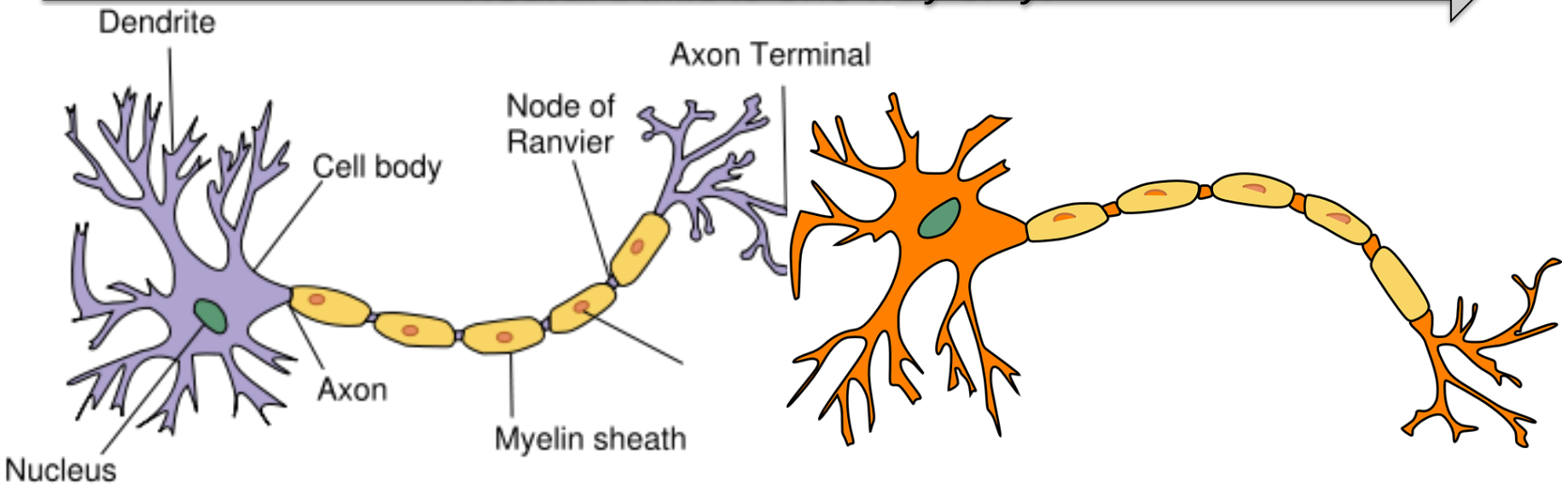
"Early stress may transiently endow animals with a potential adaptive advantage in stressful environments but across a life span is associated with long-term deleterious effects."

Synaptic plasticity: Experience alters synapses



"Neurons that fire together wire together"
Donald Hebb

Neural traffic is one way only!



https://commons.wikimedia.org/wiki/File:Neuron.svg

https://pixabay.com/en/neuron-nerve-cell-axon-dendrite-296581/

Learning to drive a taxi in London changes your brain

James Barrett Black London Cab https://www.flickr.com/photos/jtbarrett/2220601538

- 'The Knowledge'

25 000 streets within a 6 mile radius of Charing Cross

- MRI showed increased grey matter volume in the hippocampi of taxi drivers who passed the exam!

"It seems that there is a capacity for local plastic change in the structure of the healthy adult human brain in response to environmental demands."

Maguire, E. A., et al. (2000). "Navigation-related structural change in the hippocampi of taxi drivers." Proc Natl Acad Sci U S A **97**(8): 4398-4403.

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A lot of flow down a neural pathway makes it worthwhile building a pipe

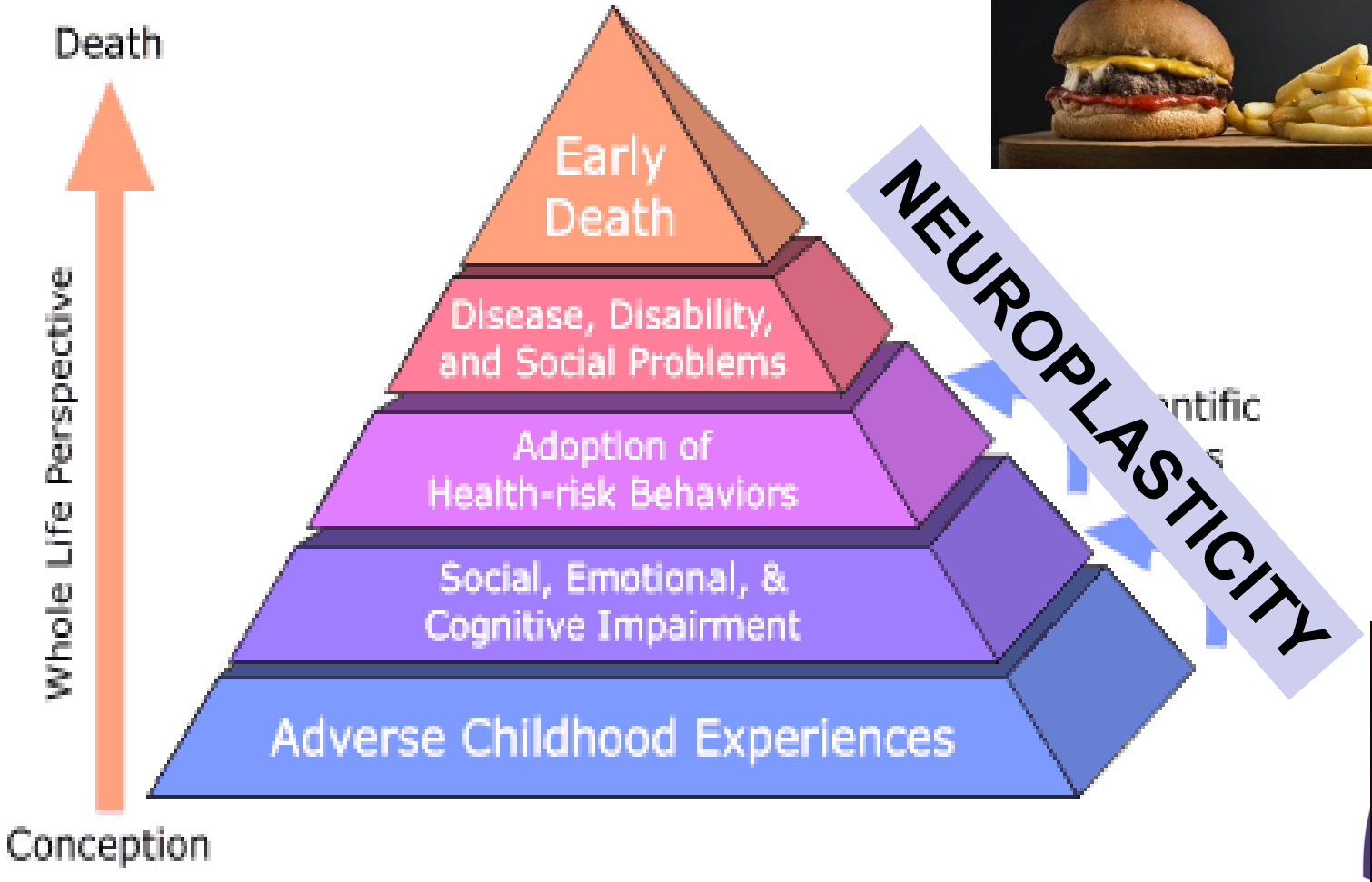
White matter plasticity: Experience alters myelination

https://pixabay.com/en/p

Brenkee https://pixabay.com/en/meditation-calm-above-the-city-1287207/

James Heilman
https://commons.wikimedia.org/wiki/File:5_ball_juggling.jpg

Adapting to our environment is survival positive… but…



[Nadine Burke Harris: How childhood trauma affects health TED.com]

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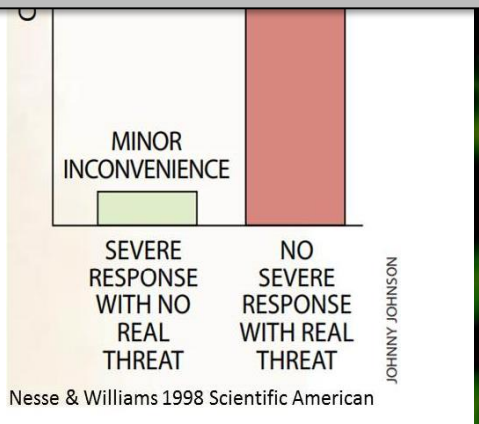
“Nothing in biology makes sense, except in the light of evolution”

Theodosius Dobzhansky

Suffering ≠ Pathology



Nesse & Williams 1998 Scientific American

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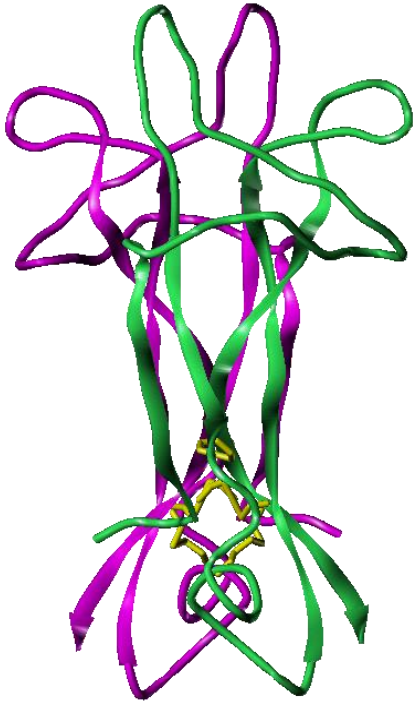
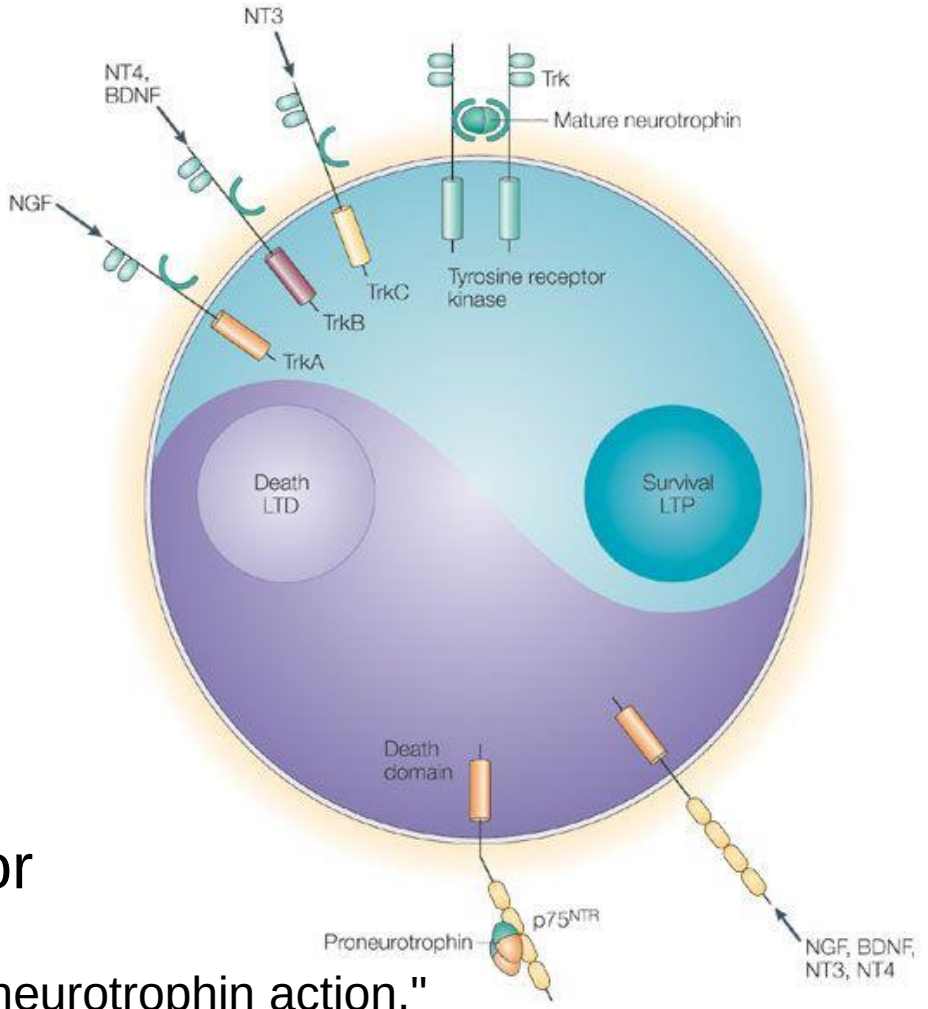
"*Why we get sick*"
An Evolutionary Perspective

Evolution is a process of attrition of those less able to survive and reproduce that leaves those more able to survive and reproduce here to do so.

Any heritable trait that supports survival to reproductive age and reproduction WILL be selected for ***even if it causes suffering or shortens our life expectancy***

An Evolutionary Perspective: Pleiotropic genes





Brain-derived neurotrophic factor

Lu, B., et al. (2005). "The yin and yang of neurotrophin action." Nature Reviews Neuroscience **6**: 603.

Baba Brinkman: Gene's eye view

Survive long enough to reproduce

Anything that helps us ‘survive to reproduce’ will be selected for, even if it causes us to suffer, or harms us later in life

https://commons.wikimedia.org/wiki/File:MorrisWaterMaze.jpg

Separation stress:

- improved memory in 3 week old rat pups

BUT

- The same rats had impaired memory in middle age

Tradeoff:

pre-reproductive cognitive advantage
in exchange for a
post-reproductive cognitive disadvantage

An Evolutionary Perspective: Life History Theory

BABA Brinkman
“peer-reviewed rap”

Longer life is better when predators are scarce
‘Cause you can invest in care
But when the dangers of death surround you
Reproduce faster when hazards hound you
This is how our bodies got built
To achieve just one thing, and it’s not health

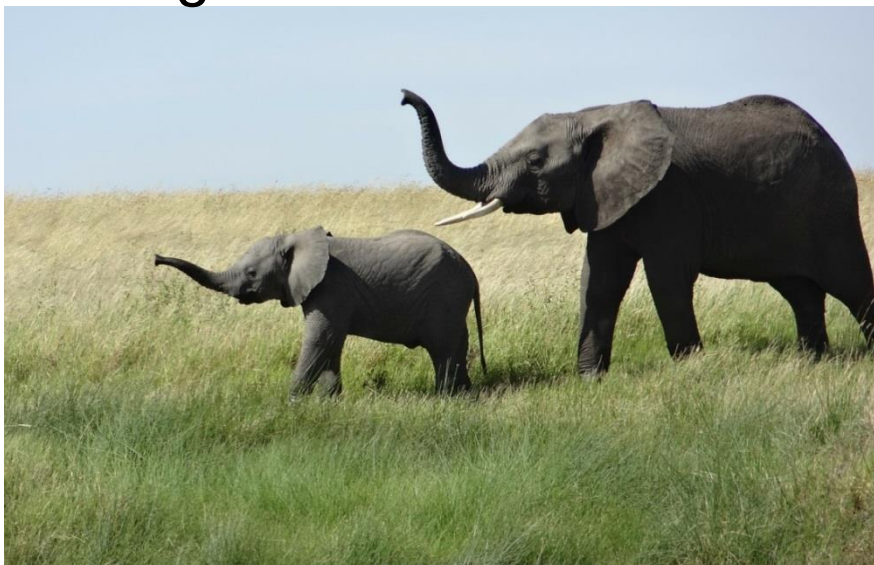
Life History Theory: ***Across*** species differences

Fast Life History

- More generations
- Quick to mature
- Reproduce at a younger age
- Litters
- Lower parental investment
- Shorter life

Slow Life History

- Fewer generations
- Longer to mature
- Reproduce at a older age
- 1 / 2 births per pregnancy
- Higher parental investment
- Longer life



Life History Theory: ***Within*** species differences

Fast and furious	**Slow and easy**
• Assume life will be short	• Assume life will be long
• Don't delay gratification!	• Gratification can be delayed
• Discount future prospects	• Start saving for retirement
• Early sexual development	• Later sexual development
• More, and more sexually intense relationships	• Fewer relationships with more trust
• STRATEGY: More kids	• Fewer, highly competitive kids

Life History Theory: Die young, so live fast…

- Fast and furious

Baba Brinkman
Survival of the fittest

- Slow and easy

By Pete Souza - http://www.whitehouse.gov/sites/default/files/image/1215201-family-portrait-high-res.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=17779257

"From the perspective of evolution neither the fast or the slow reproductive pattern is better than the other, neither is 'biologically normal'… what is normal and adaptive depends on the environment" Chisholm

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A healthy brain is a brain that can adapt.

Neuroplastic mechanisms function to biologically embed our experience regardless of the quality of that experience.

Neuroplastic mechanisms may cause suffering even as they support the survival of the genetic line.

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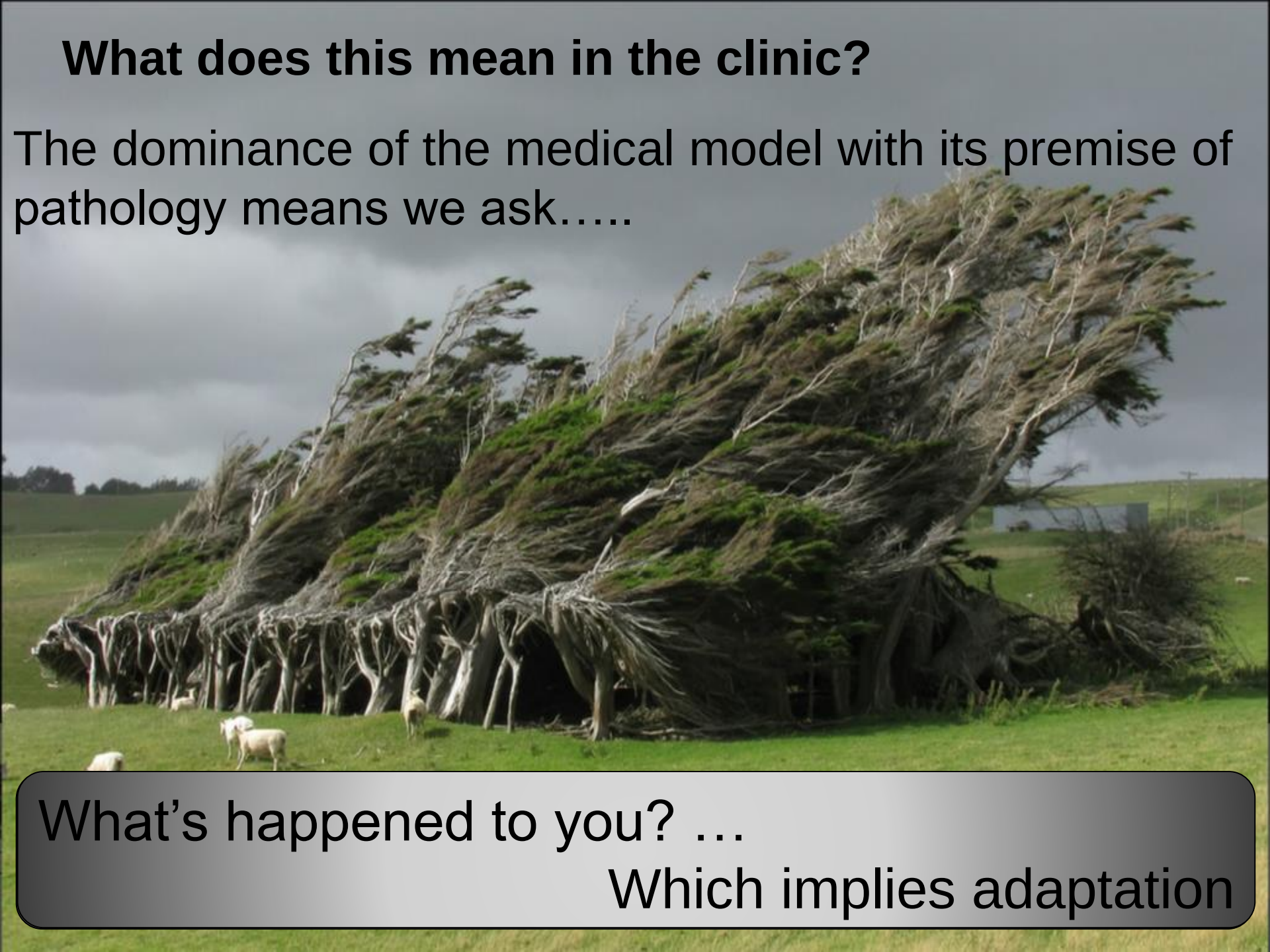
What does this mean in the clinic?

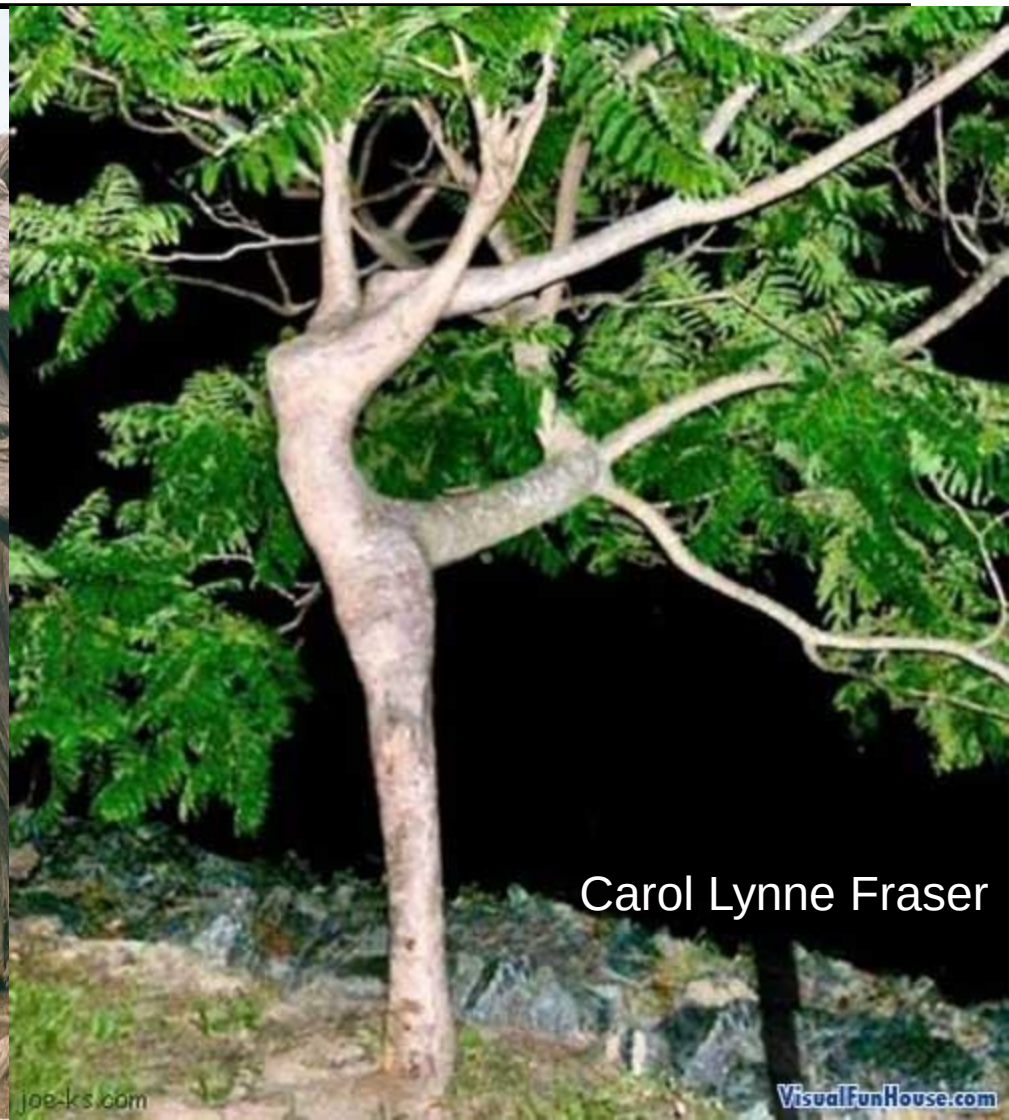
The dominance of the medical model with its premise of pathology means we ask…..



What's happened to you? …

Which implies adaptation

Responding to survivors of complex trauma



Reconciling the medical model and the neuroplastic narrative

We tend to assume pathology
If we don't consider there is another explanation
Then we are never open to see it

Adaptive change
Neuroplastic narrative
What's happened to you?

True pathology
Medical model
What's wrong with you?

Huntington's is genetically determined ….
BUT environmental enrichment delays onset

van Dellen, A. *et al.* (2000). "Delaying the onset of Huntington's in mice." Nature **404** 721-722.

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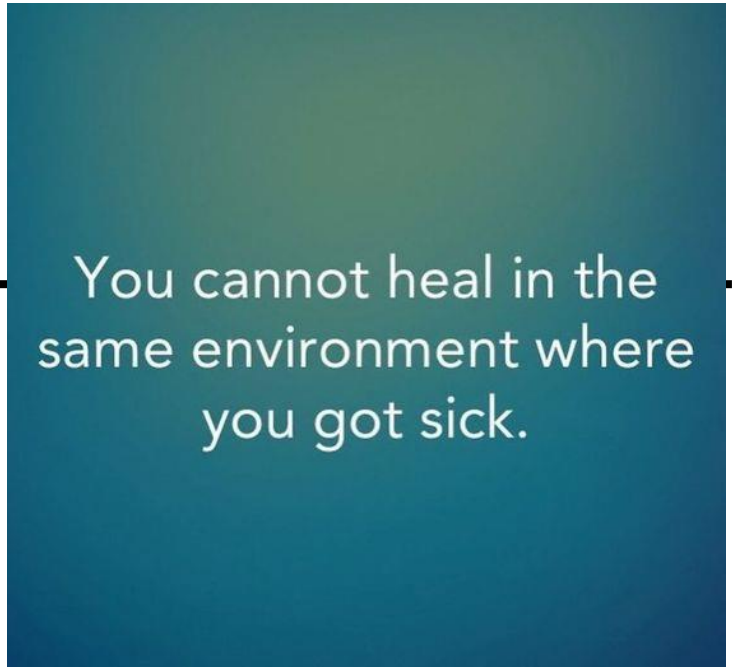
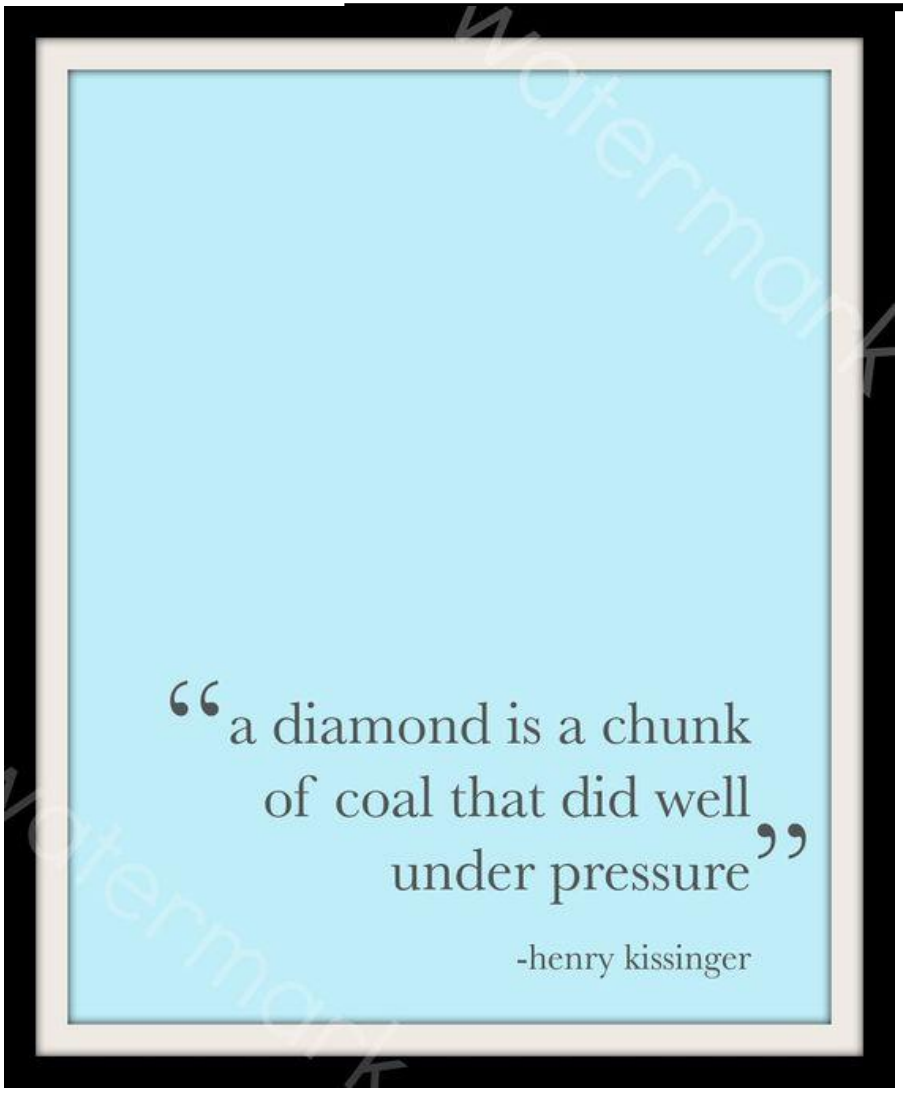
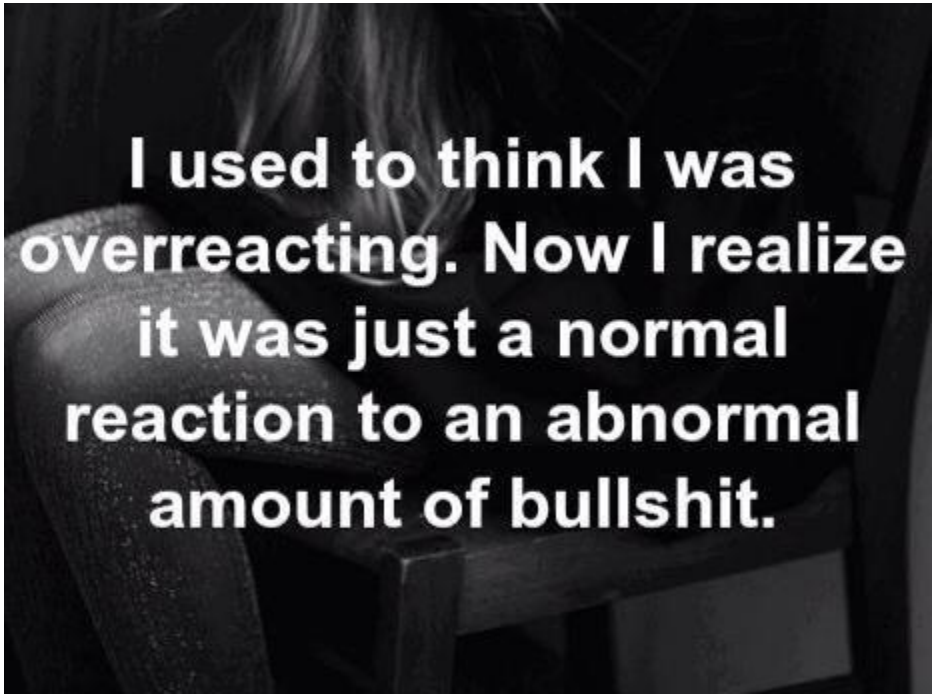
Sick or suffering?







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The Neuroplastic Narrative

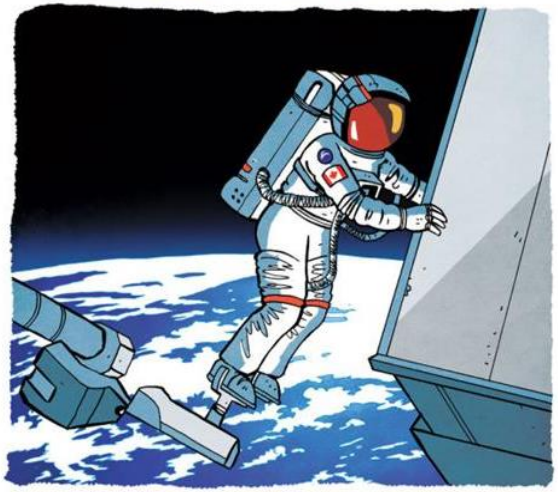
Choose your experiences to change your brain

DECIDE IN YOUR HEART OF HEARTS WHAT REALLY EXCITES AND CHALLENGES YOU...

LOOK AT WHO YOU WANT TO BE, AND START SCULPTING YOURSELF INTO THAT PERSON.

... AND START MOVING YOUR LIFE IN THAT DIRECTION.

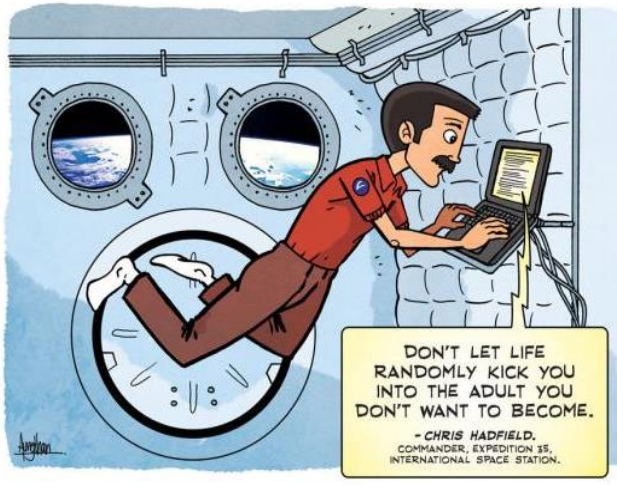
YOU MAY NOT GET EXACTLY WHERE YOU THOUGHT YOU'D BE...



EVERY DECISION YOU MAKE, FROM WHAT YOU EAT TO WHAT YOU DO WITH YOUR TIME TONIGHT...

...BUT YOU WILL BE DOING THINGS THAT SUIT YOU IN A PROFESSION YOU BELIEVE IN.

... TURNS YOU INTO WHO YOU ARE TOMORROW, AND THE DAY AFTER THAT.



From Gavin Zen Pencils 'Chris Hadfield'

Thank you for listening with your hearts and minds

For training and workshops please contact me

Dr Haley Peckham @Haley_peckham
haleypeckham@gmail.com

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