

Addiction, Brain Change, and Gambling: *Deep Learning, not Disease*

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Models of Addiction

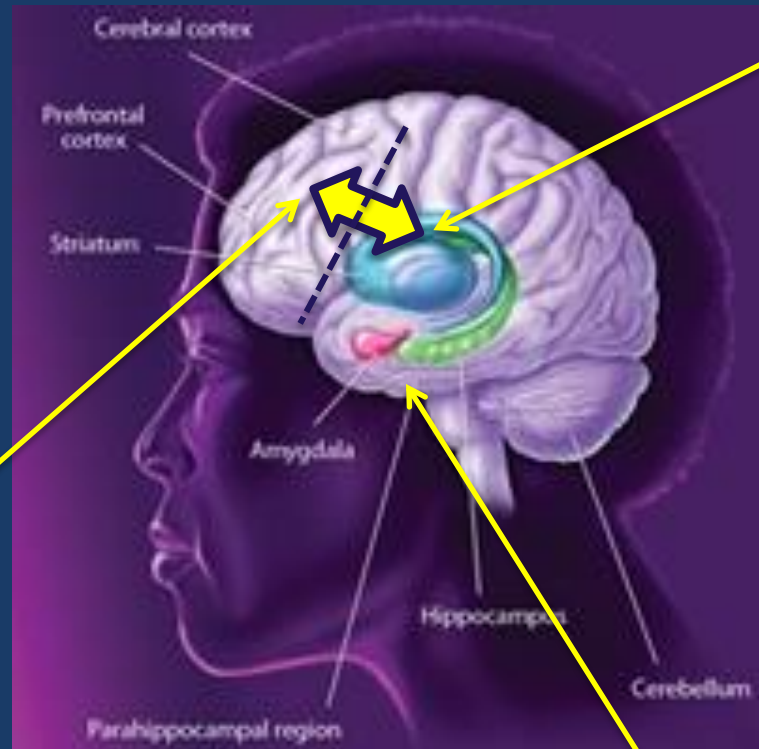
- Disease model
- Choice model
- Social construction of addiction
- Traumatic early history
- Developmental-learning model

Addiction defined as a brain disease

- NIDA (National Institute on Drug Abuse):

“Addiction is defined as a **chronic, relapsing brain disease** that is characterized by compulsive drug seeking and use, despite harmful consequences.”

“Brain-imaging studies from drug-addicted individuals show **physical changes** in areas of the brain that are critical for judgment, decision-making, learning and memory, and behavior control.”



Striatum:
Nucleus accumbens

The Motivational Engine

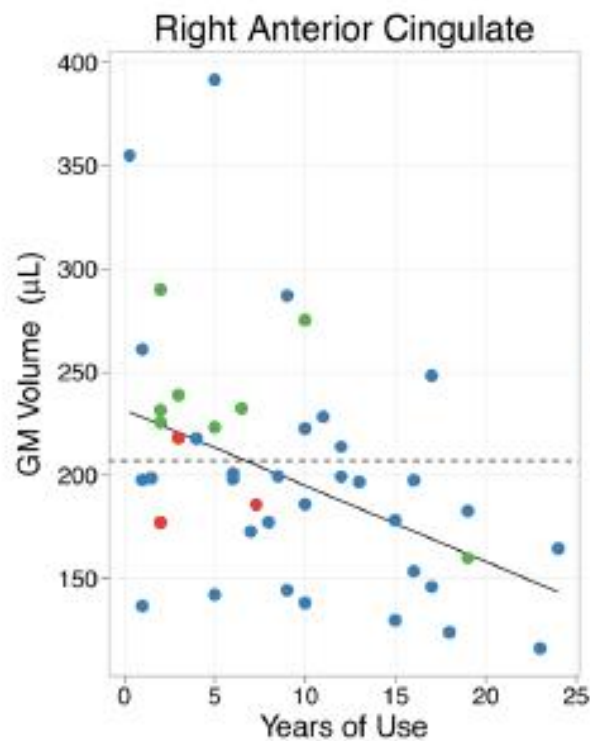
Dorsolateral
prefrontal cortex

The Bridge of the Ship

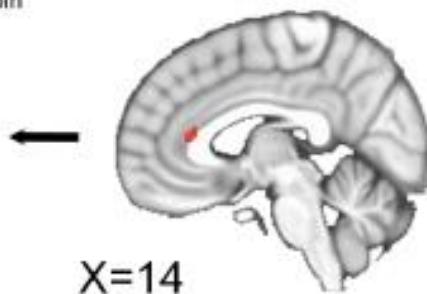
Midbrain

Dopamine Pump

Use it or Lose it?!?

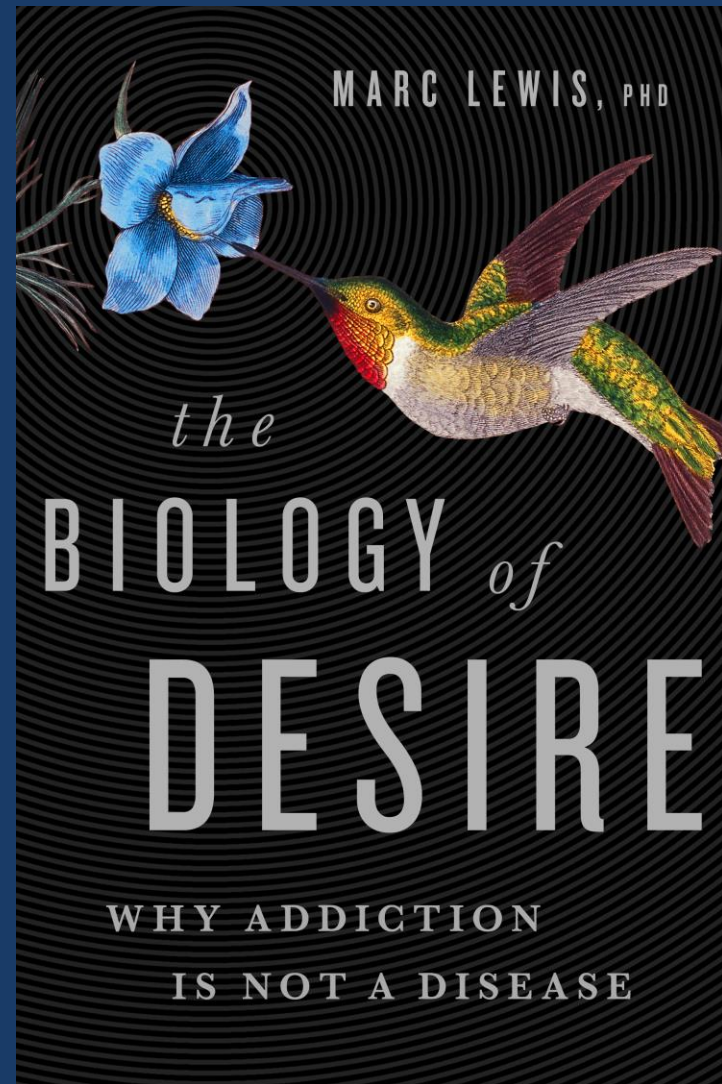


Looks suspiciously
like brain disease...?



From Connolly, Bell, Foxe, & Garavan. *PLOS ONE*, vol. 8, 2013.

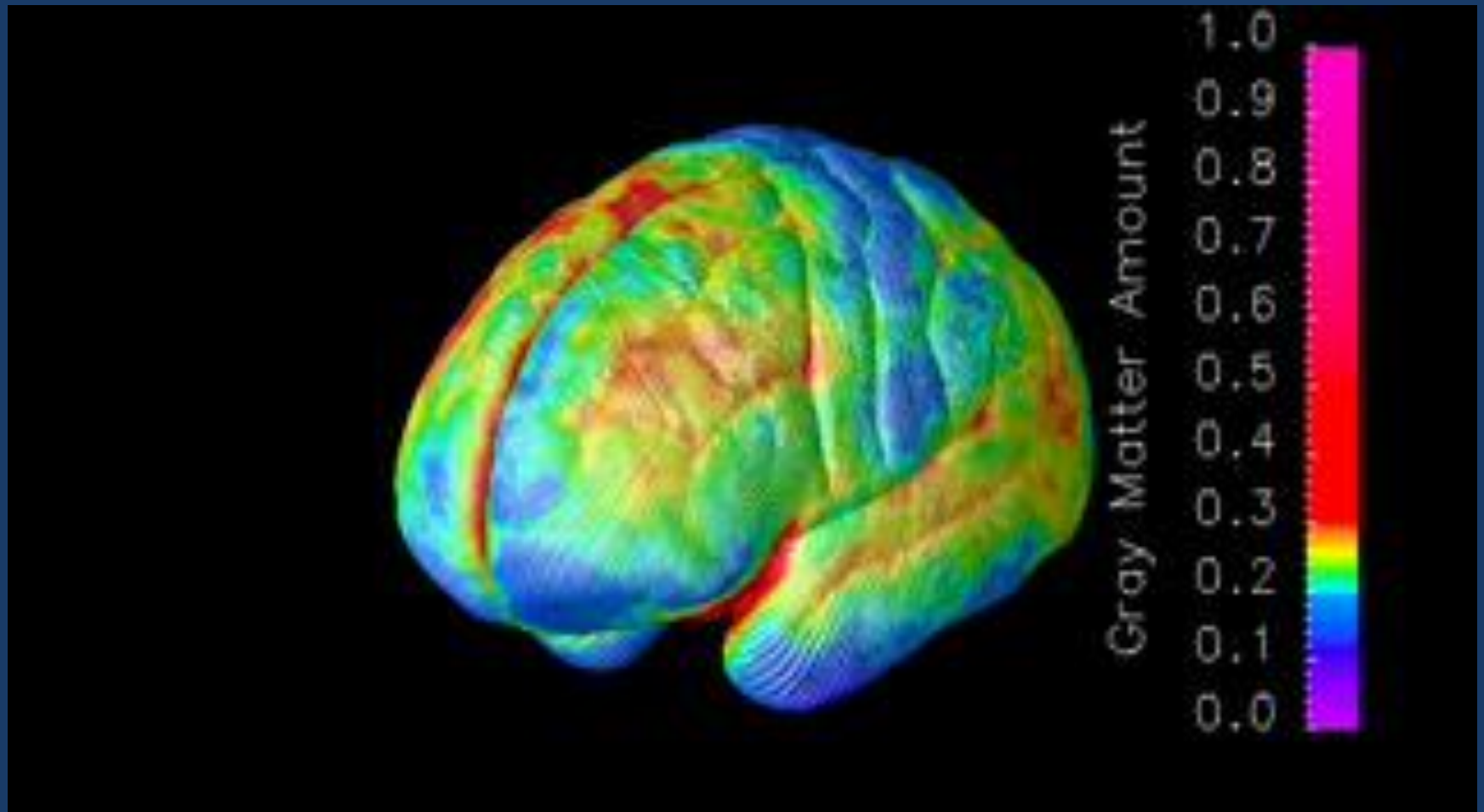
But what if it's not a disease?



Reinterpreting the neural data...

- If brains change with learning and development, then *brain change doesn't necessarily mean brain disease*
- But how do brains change with development?

Changes in cortical density from age 4 through age 20 (from averaged MRI data)

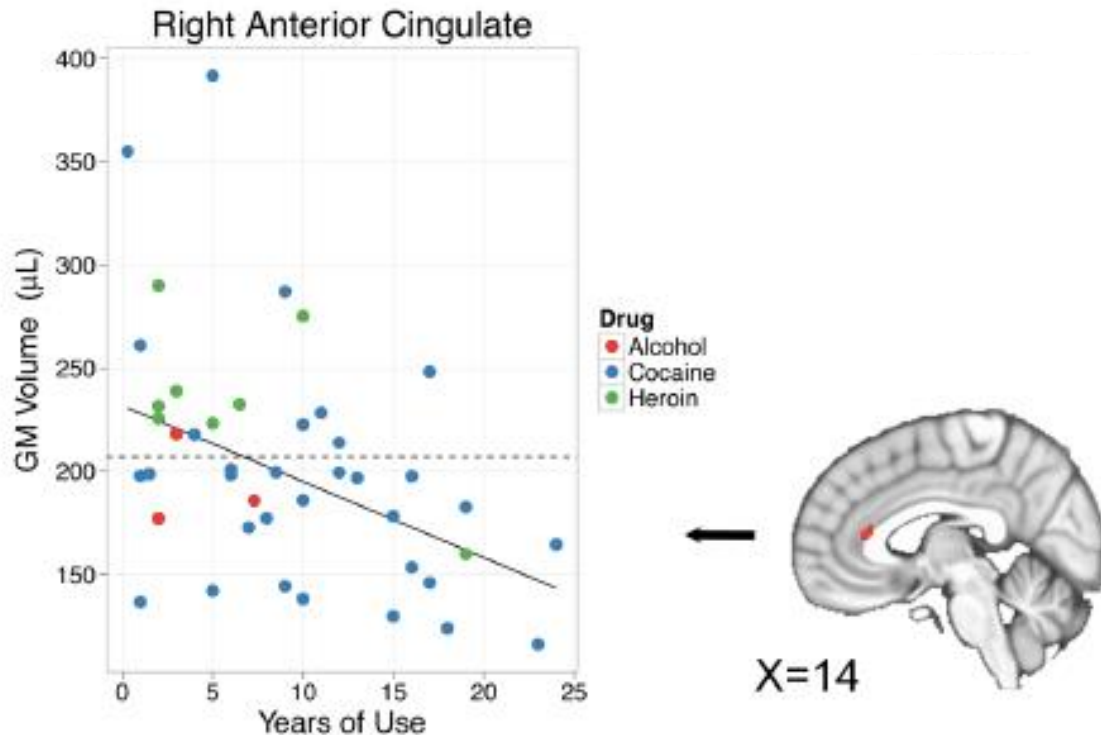


Development = Synaptic growth + synaptic pruning



- Synaptic growth → flexibility, novelty, increasing range of knowledge and skills
 - Synaptic pruning → consolidation, efficiency, habit formation

If this thinning is viewed as synaptic pruning....



...then we should not be surprised by further synaptic alteration!

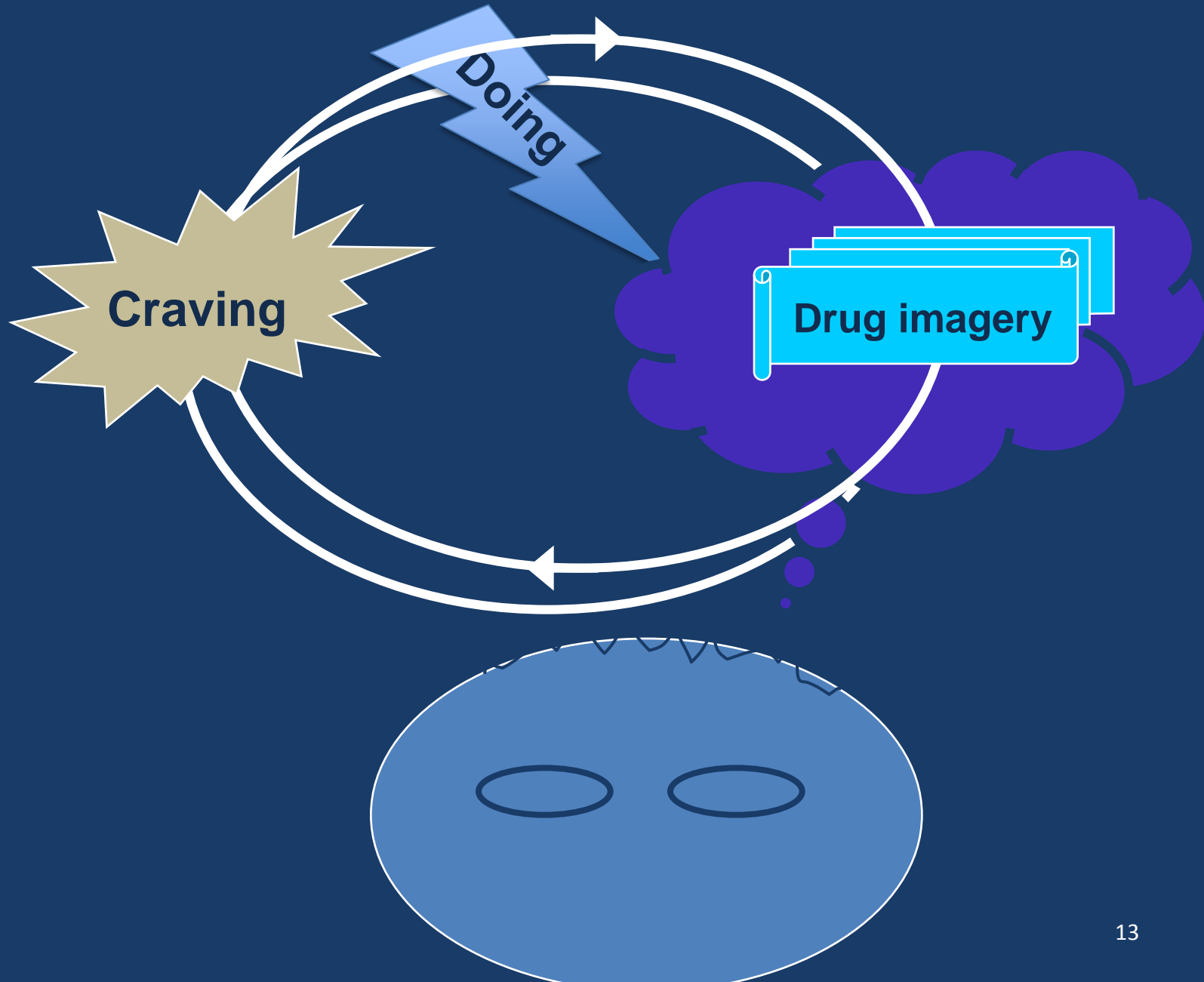
Since pruning makes the brain more efficient...

- ...the addict's brain learns *to aim* behaviour toward (expected) rewards – *i.e., tuning the brain to the goodies*
- I think it's exactly the same for gamblers
- So, addiction (including gambling) is highly **efficient**
 - striatal tuning
 - gradual shift from **impulsive** (ventral striatum) to **COMpulsive** (dorsal striatum) tuning
- This “efficient” reward-seeking tries to counteract three kinds of loss
 - short-term loss
 - long-term “blunting”
 - longer-term isolation, shame, and despair

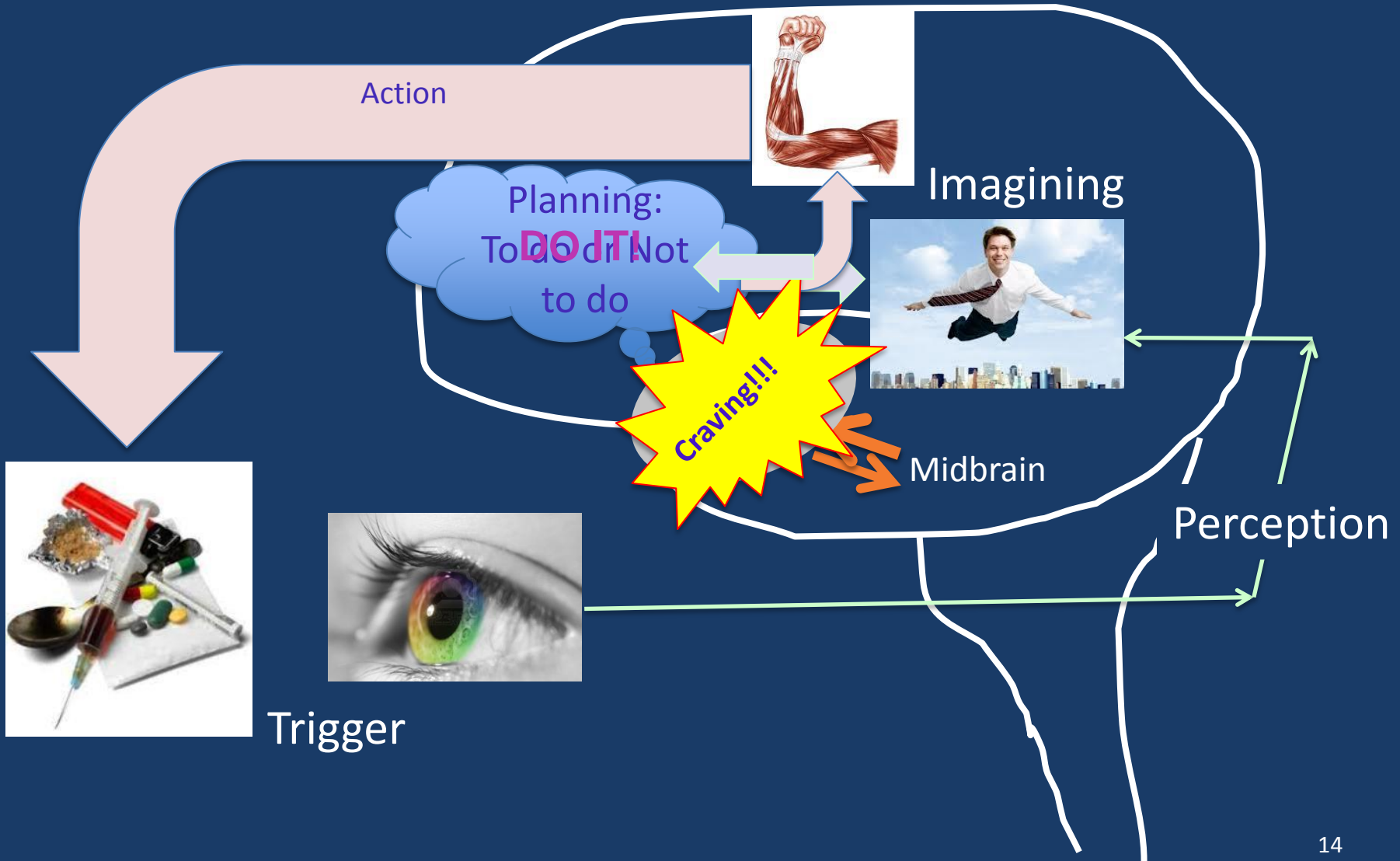
So why is it so hard to stop?

1. Strong attraction → repetition → deep learning → deliberate mood regulation
2. Getting trapped by “now appeal”
3. Ego fatigue: the loss of self-control

1. The classic feedback cycle in addiction



Cycle of brain activation





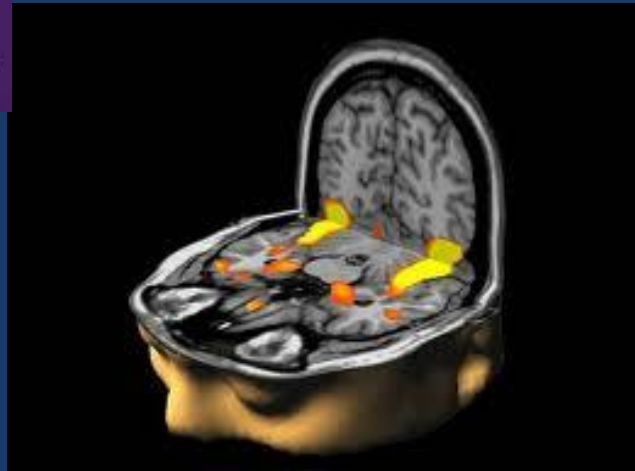
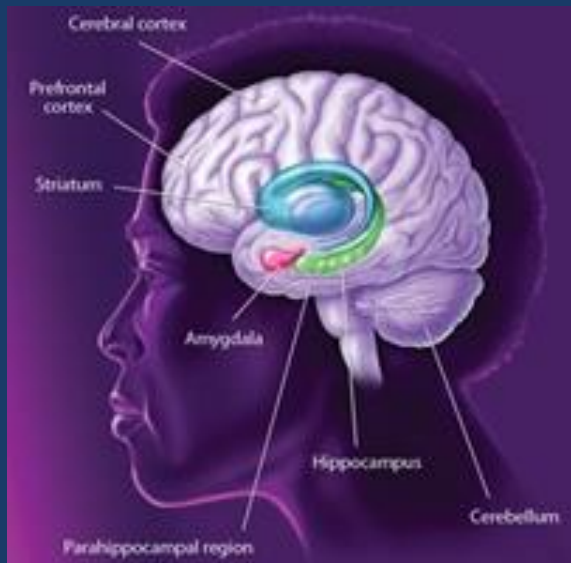
....ongoing modification of networks

Shift of activation from ventral to dorsal striatum



2. Now Appeal

The circuitry of desire

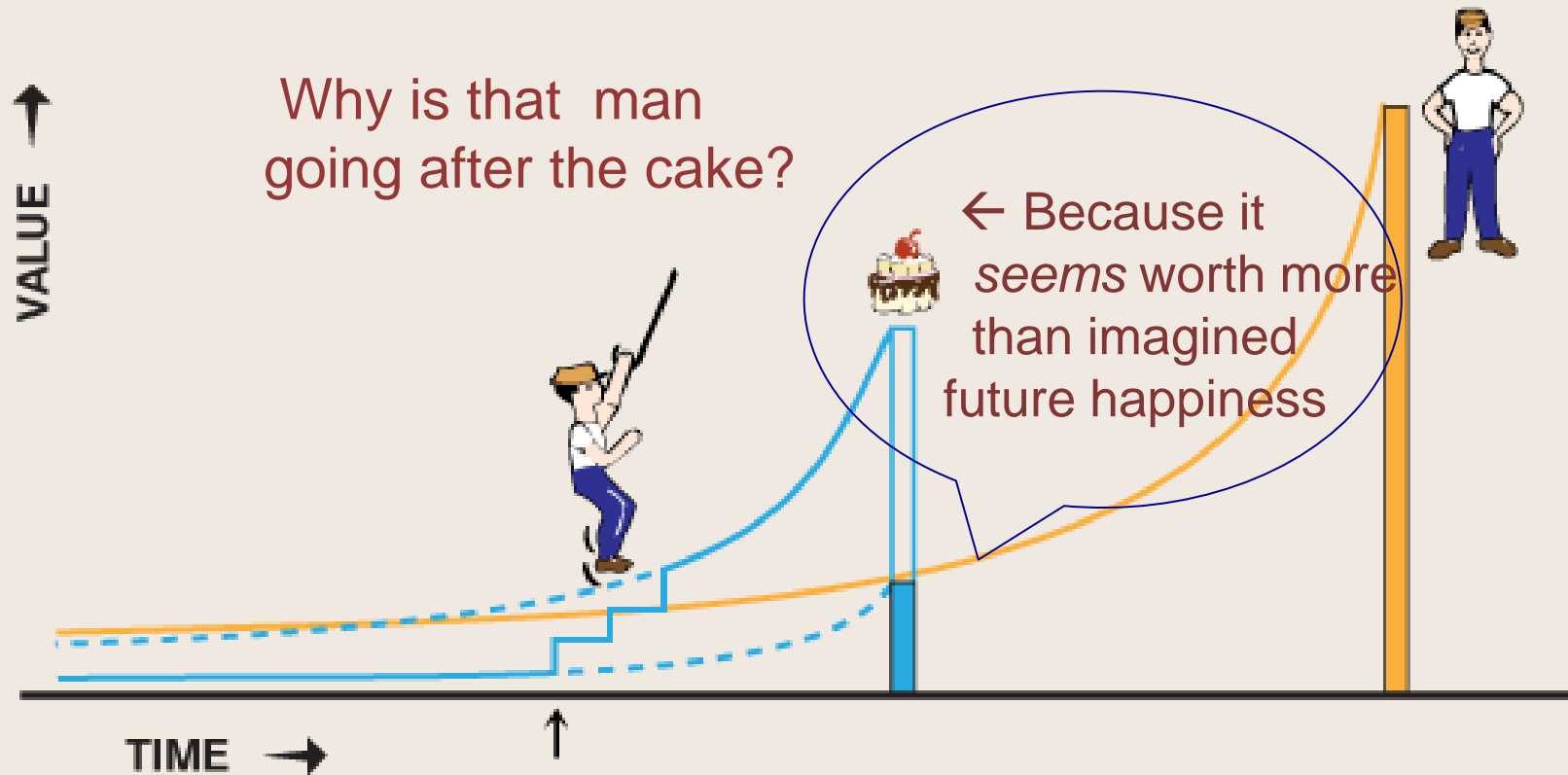


Dopamine focuses attention on the immediate goal....

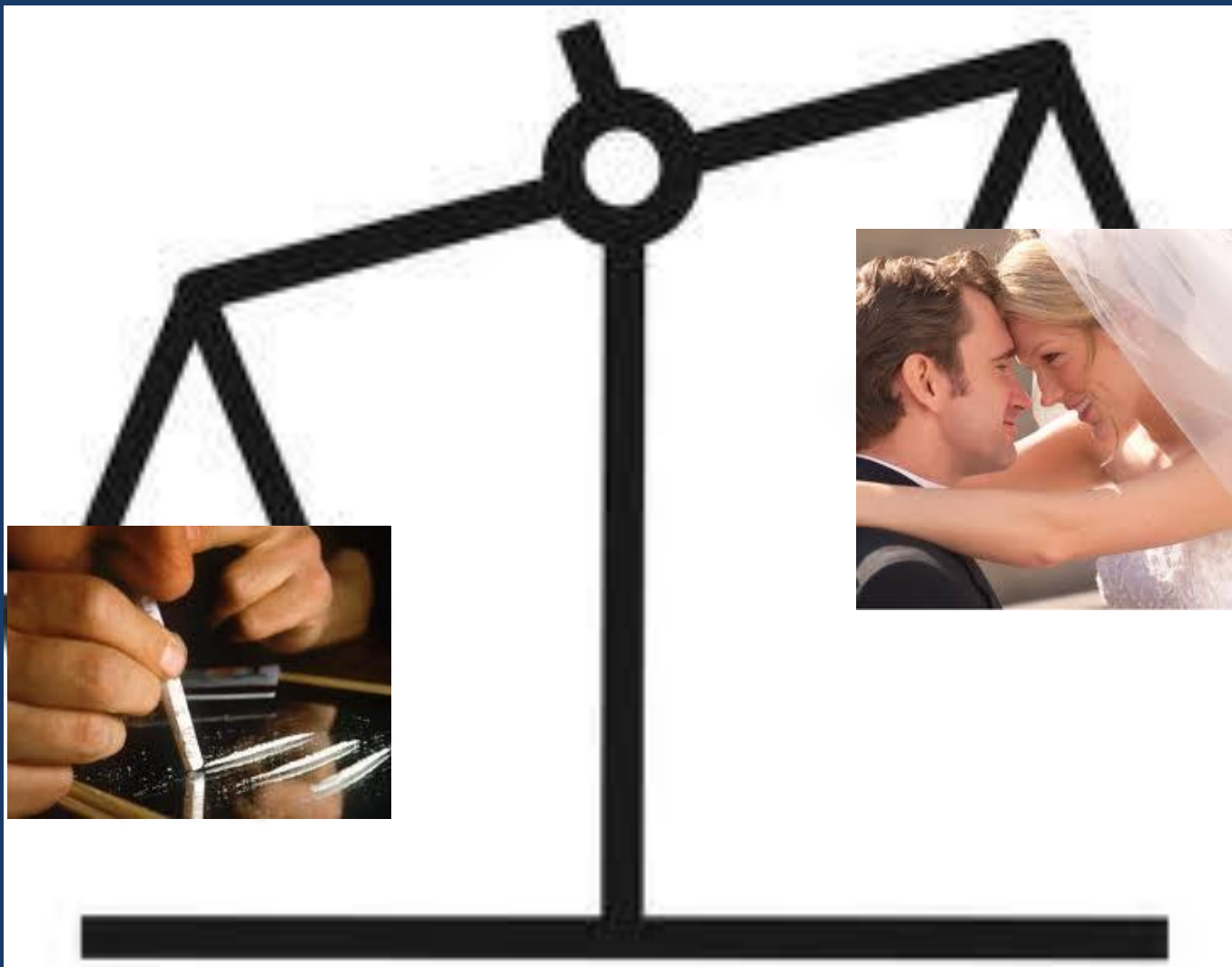
→→ *craving*



Craving → delay discounting = “now appeal”



...dopamine is *tuned* to the cake.

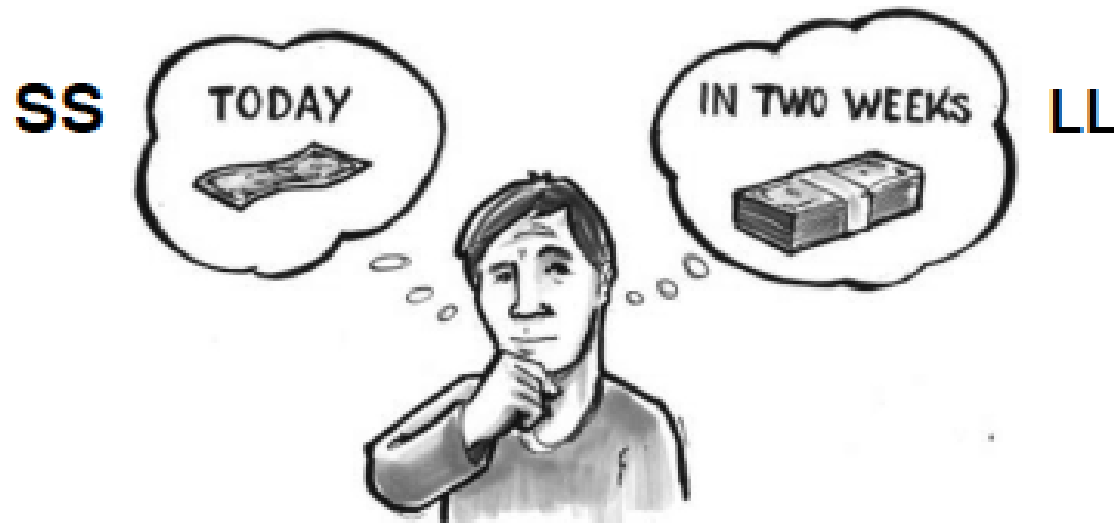


...outweighs the imagined future!

Money as intertemporal rewards

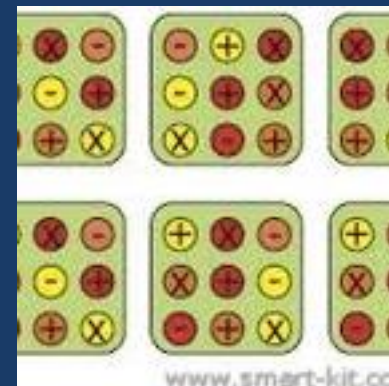
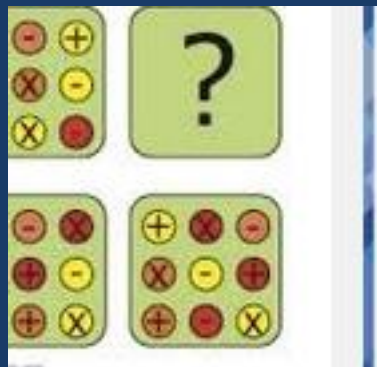
Marshmallow choices might not work equally well for all age groups...

- Choices between monetary outcomes
 - a smaller-sooner monetary reward (SS) versus
 - a larger-later monetary reward (LL)



3. Ego fatigue

Hungry?



Cues, cues, cues

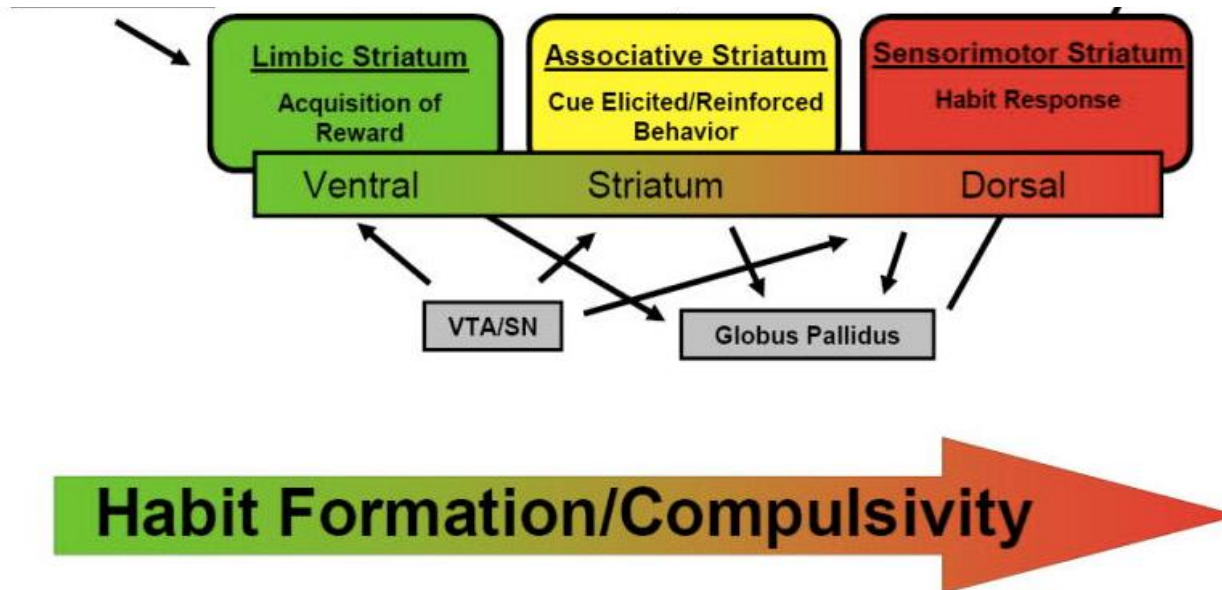


Cues, cues, cues



Gambling...

- ...looks similar to substance addiction in the brain and in real life



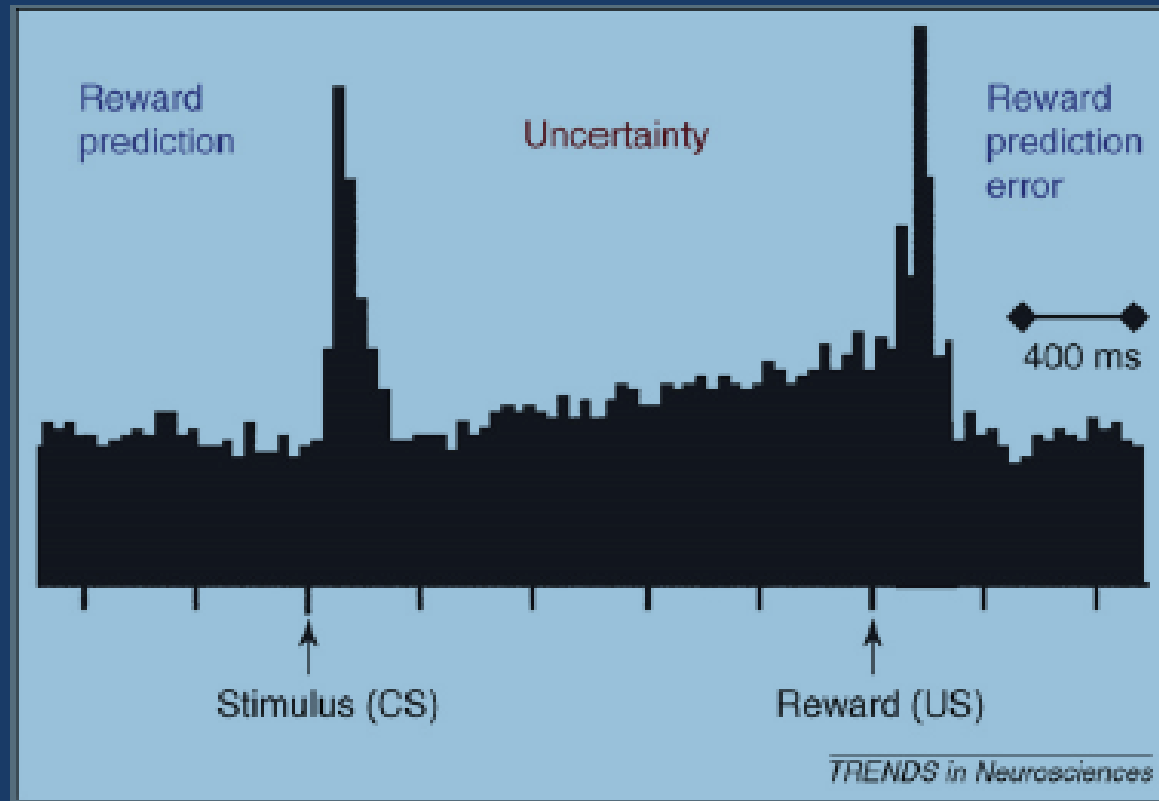
From Brewer & Potenza (2008). The neurobiology and genetics of impulse control disorders: Relationships to drug addictions, *Biochemical Pharmacology*, vol 75.

But gambling may be particularly insidious

Dopamine has three jobs

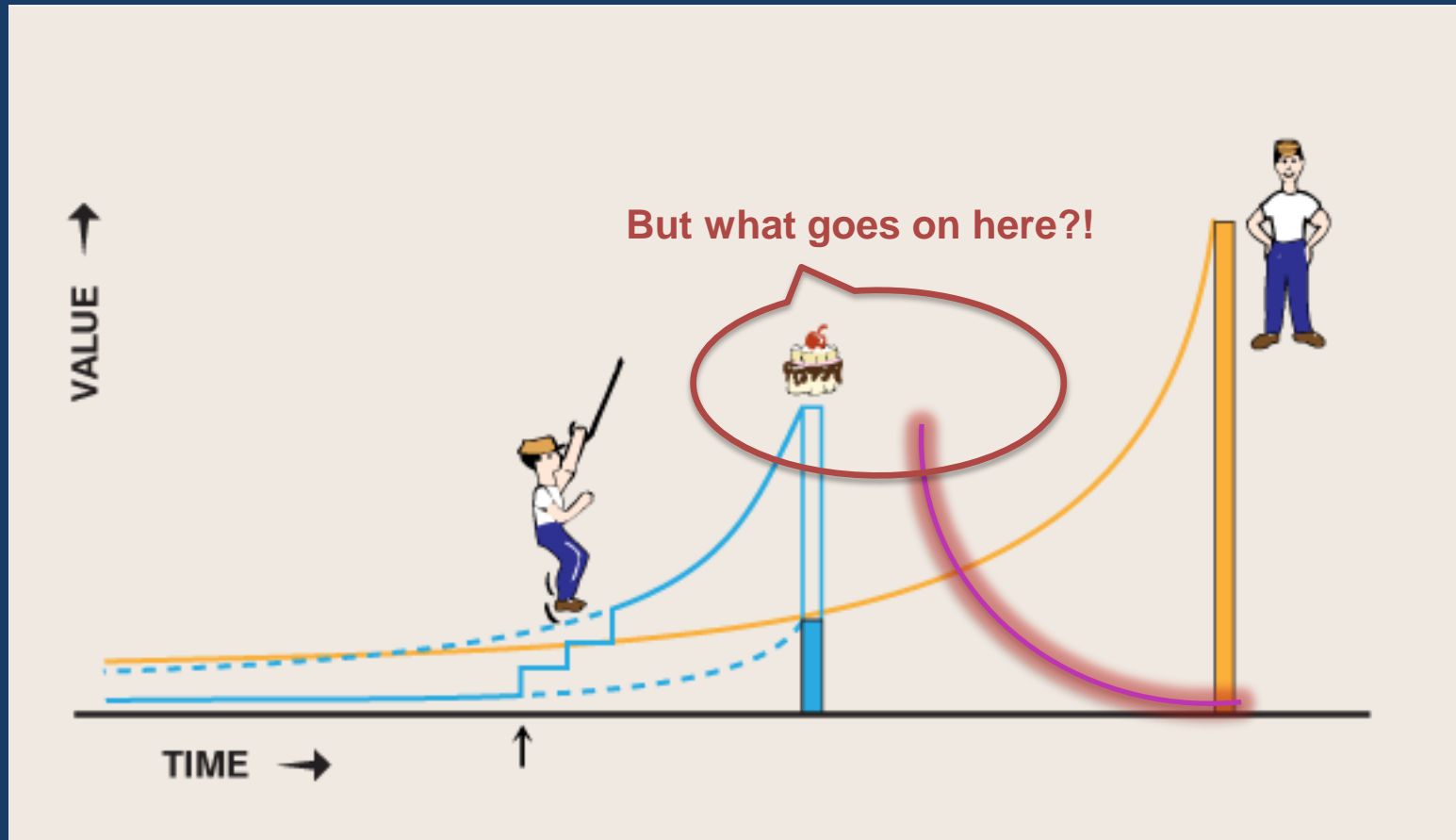
- Reward-predicting stimuli → dopamine rush
- Reward prediction error → dopamine tuning
- Reward uncertainty → ? → ?? → ??? → ????

The three faces of dopamine



From Schultz, 2007. *Trends in Neuroscience*.

Reward prediction --



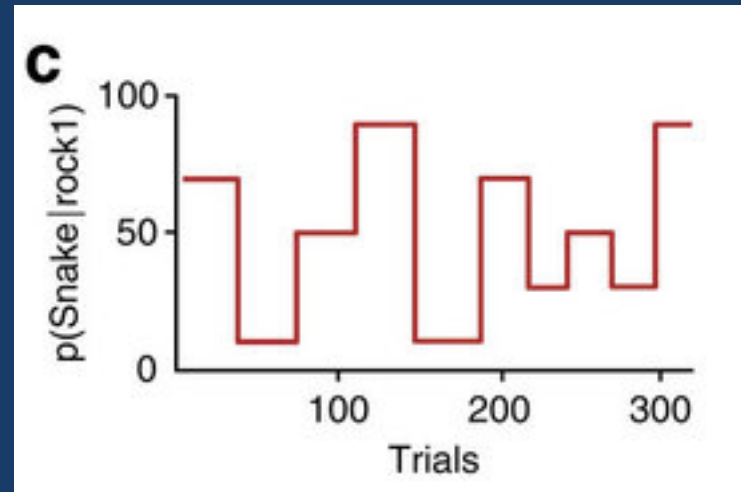
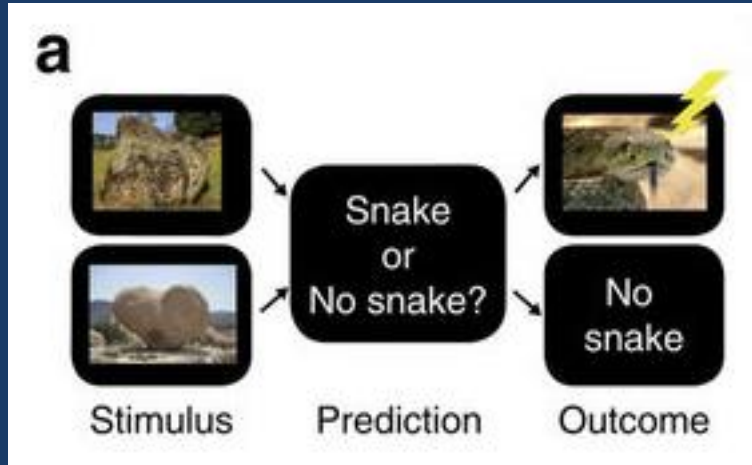
-- reward prediction error

The lure of uncertainty

“One of the main underlying factors to the phenomenon of loss-chasing may relate to the importance of reward uncertainty..... In PG, accumbens DA is maximal during a gambling task when the probability of winning and losing money is identical—a 50% chance for a two-outcome event representing maximal uncertainty...”

Anselme et al., 2013. What motivates gambling behavior?
Insight into dopamine's role. *Frontiers in Behavioral Neuroscience*

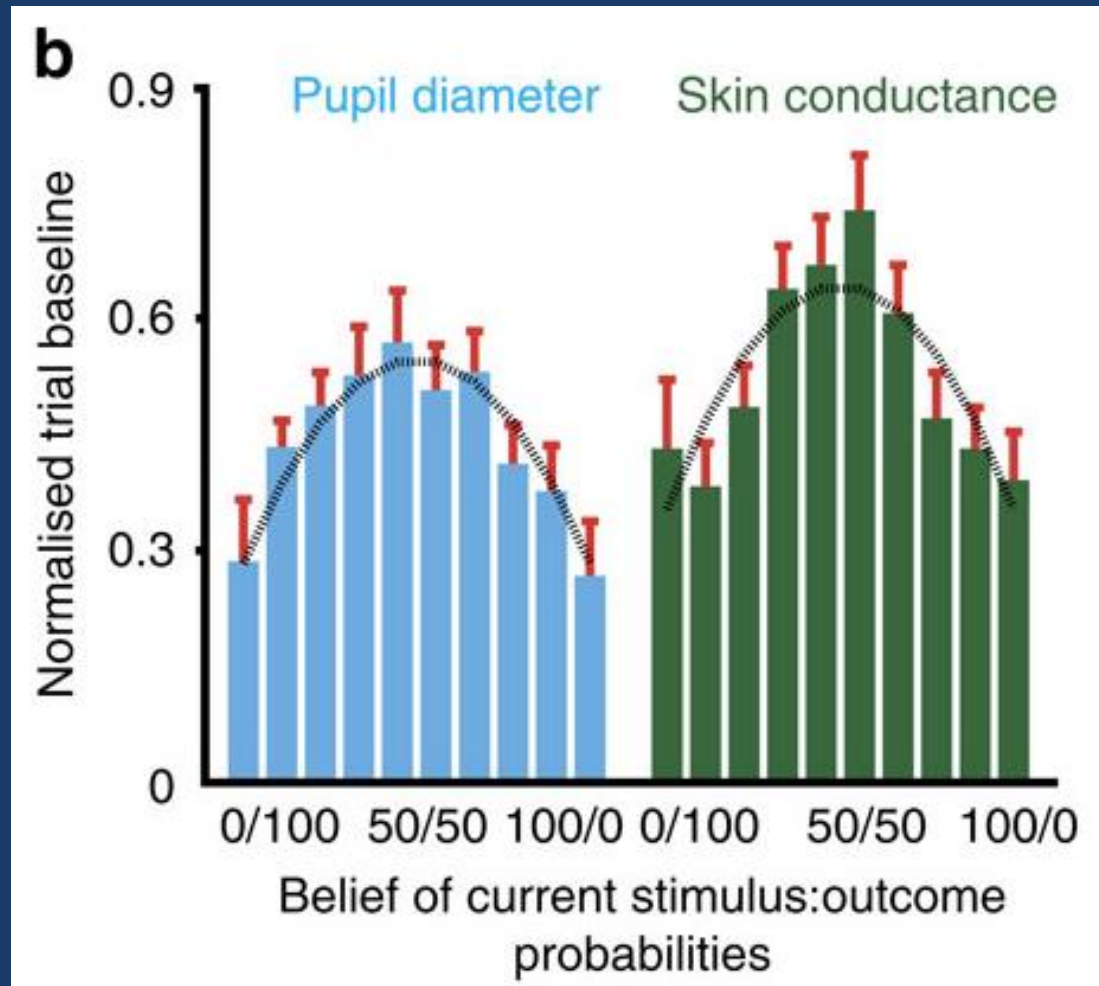
Snakes and shocks study



Designed to track “irreducible uncertainty”surrounding 50% level.

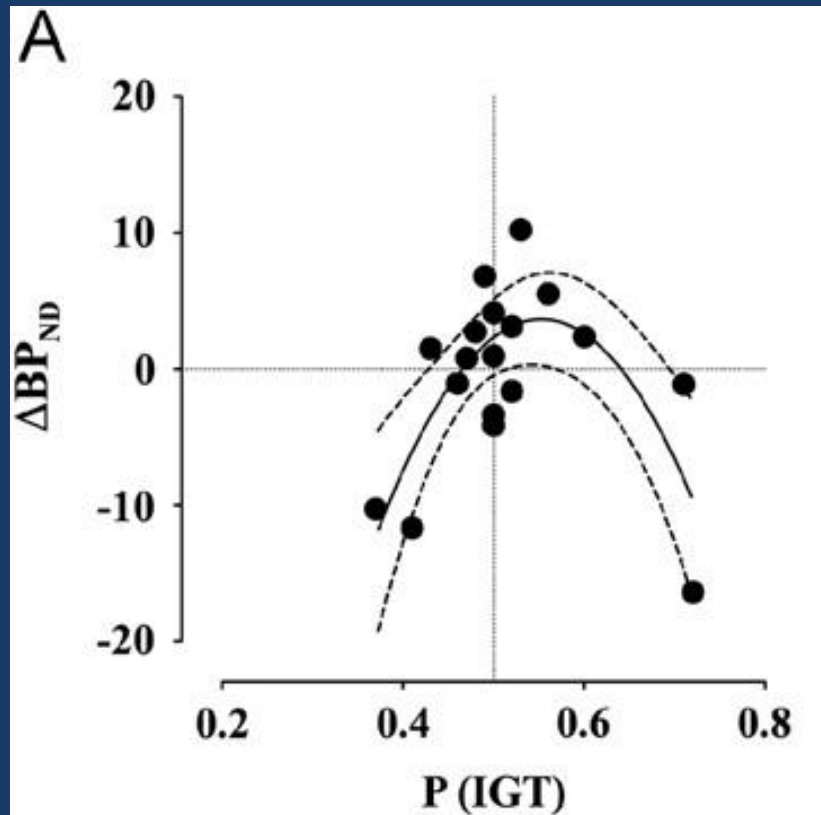
De Berker et al. (2015). *Nature Communications* 7.

Excitement/stress peaks with uncertainty



“Irreducible uncertainty best predicted subjective stress responses.”

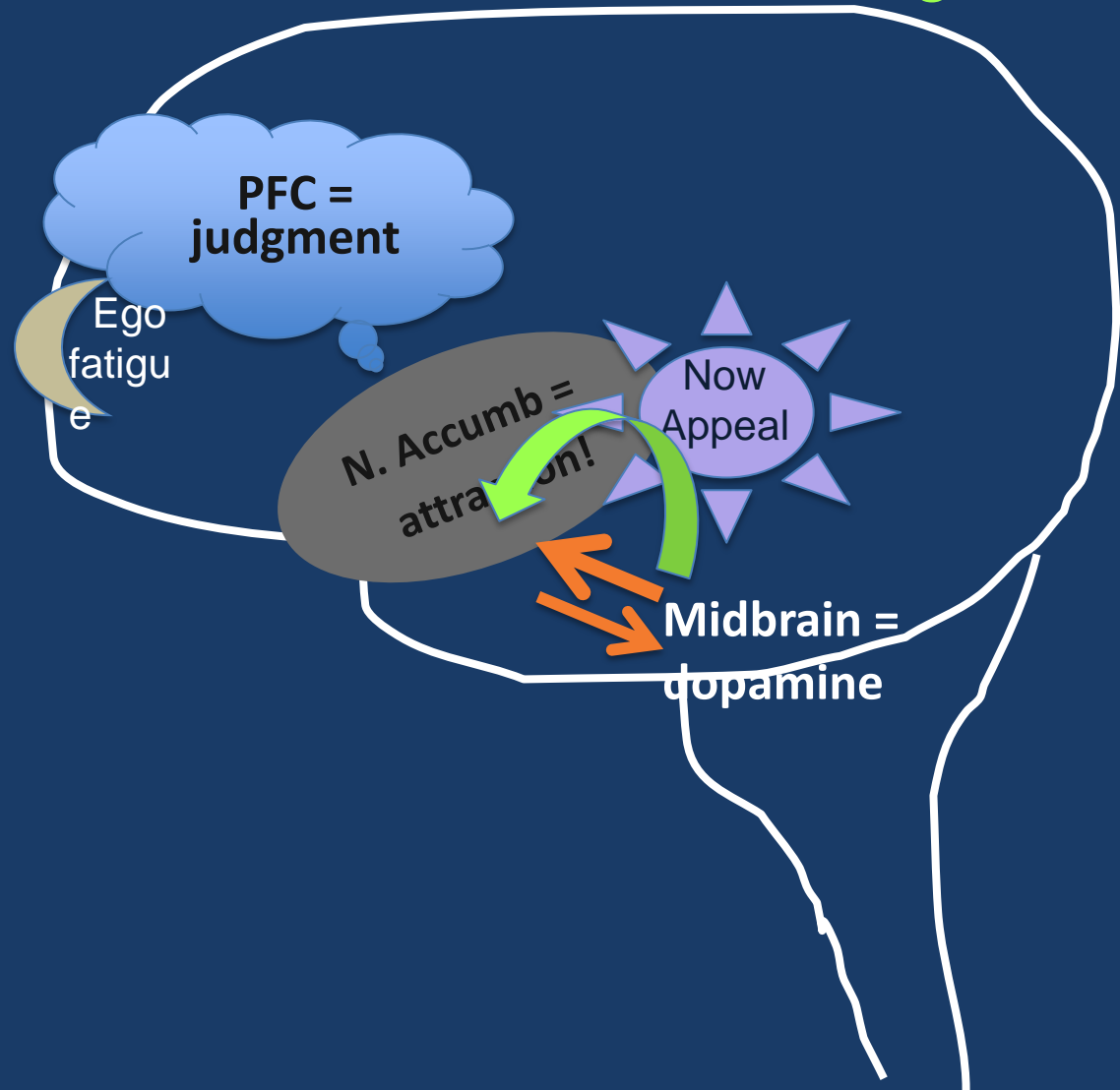
Iowa Gambling Task: variability and dopamine



“The pathological gambling (PG) group shows a significant ($p < .002$) quadratic Relationship between [dopamine uptake in striatum] and probability of selecting advantageous decks (P(IGT)). The healthy control group shows no significant quadratic interaction.”

Linnet et al. (2012) *Psychiatry Research: Neuroimaging*. 204, 55–60.

In sum: brain change with addiction and gambling



The disease model of addiction
isn't just wrong...

It's also harmful!

Why the disease model fails addicts

- The disease model calls for medical treatment
- “Medicalization” makes addicts into *patients*
- Patients don’t feel they have the *power* to change their goals
- Because they’re not formulating those goals
(somebody else is...)

Empowerment is an antidote to ego fatigue

But how do we encourage it?

Utilize addicts' desire for other goals

What happens when you give the wheel to your teenage kid?



Stretching one's sense of time into the future is an antidote to *now appeal*

But how do we help addicts & gamblers connect with their past and their future?

Help them see their life as a narrative
...embedded in a past



...and stretching into a desired future





Perhaps they can start a
dialogue with a future self

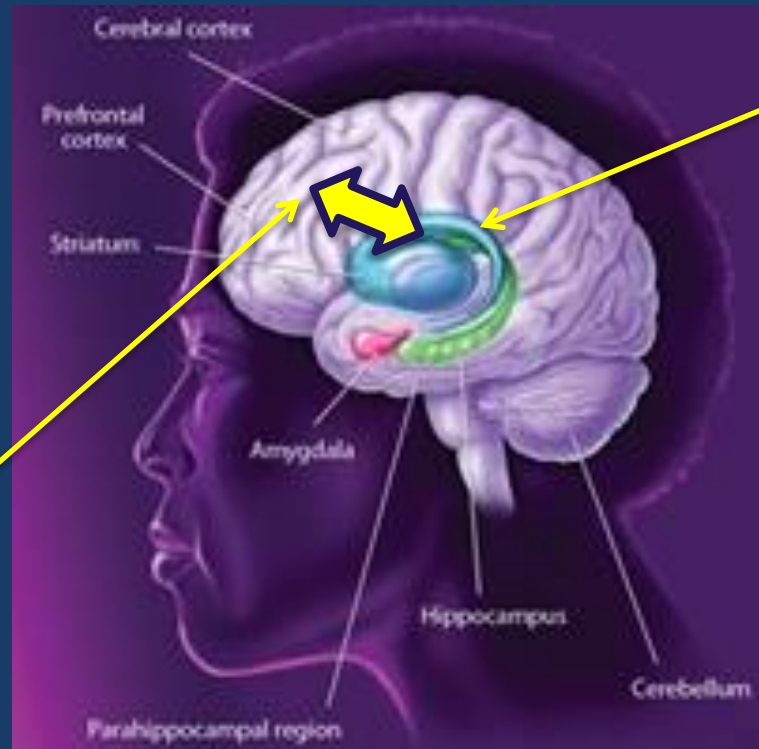
Ainslie's
Intertemporal dialogue

But addicts have a hard time seeing their future self as anyone but an addict....



And addicts aren't
trustworthy!

Reconnect...



Striatum
The Motivational Engine

Dorsolateral
prefrontal cortex

The Bridge of the Ship

...empowerment to a sense of personal time

How do you change the brain?

- Not by taking drugs (e.g., opiate substitutes, sedatives, antagonists)
- Not by repeating familiar slogans
- Not by continuing to do what you've been doing

But by...

~~Frontal lobotomy~~

- Meditation
- Psychotherapy
- Development itself

- NOT believing you have a chronic disease

Notes for update for Australia

- The flow experience is considered the most addictive of all states: see <https://www.youtube.com/watch?v=y1MHyyWsMeE> at 20:00 for discussion, esp idea of hypofrontality...suppressing the dlPFC...we like turning it off
- Also see Maia's talk about dopamine and the hedonic treadmill phenomenon – very relevant! – The Influence
- Notes from Monday night:
 - Amazing flatness of affect whether just won or just lost...almost nil
 - When I hovered a bit, I was asked to go away several times. Looks like shame...or else just wanting to be in your own world
 - Idea of two types: those who just oscillate vs those who go down hard and wipe themselves out
 - Anger (e.g. at the dealer) even if you're a winner (1000 ahead at roulette) after a few losses.... 4:00 on George Paddy Power recording, also 9:13 for a failed attempt at imagining a different future; on George William recording, ; 8:25 Don't talk to me, let me be, also 10:30 for a glimpse of Just Say No uselessness