

Behavioral Neuroscience: Fear thou not

Pavlovian conditioning, an enduring
model of associative learning

Thoughts

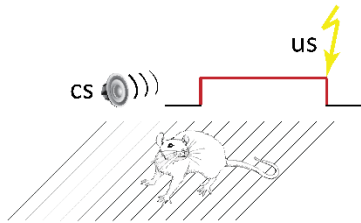
- What is a “reward”?
- Learning is best motivated by threats to survival?
- Threats are much better reinforcers?
 - **Fear is a prime motivator**

	Decreases behavior	Increases behavior
Presented	Positive punishment	Positive reinforcer
Taken away	Negative punishment	Negative reinforcer

Classical fear conditioning

A
Acquisition in wake animals

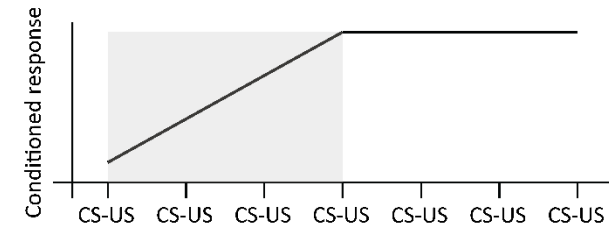
Behavioral setup



Behavioral paradigm



Behavioral result



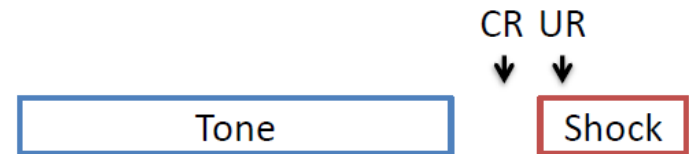
CS-US pairing

Tone = conditioned stimulus (CS)

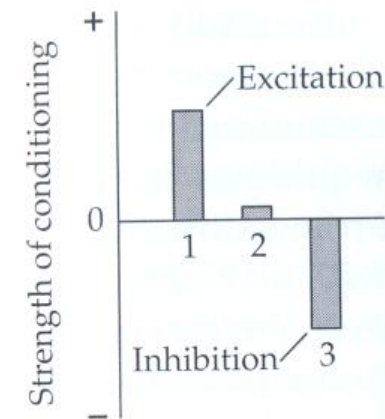
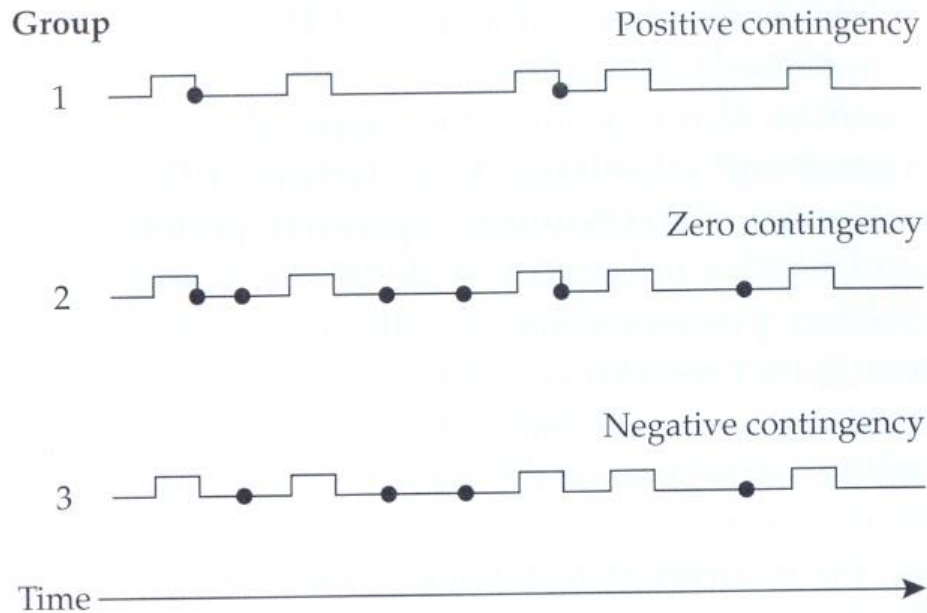
Foot-shock = unconditioned stimulus (US)

Freezing = conditioned response (CR-UR)

The CS predicts the US \rightarrow CR



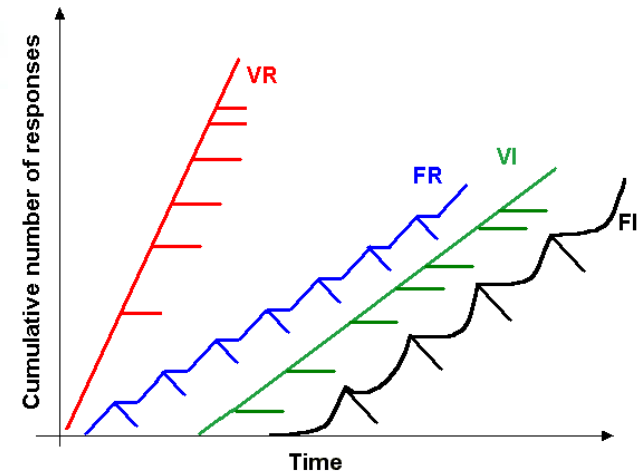
Contingency: co-occurrence



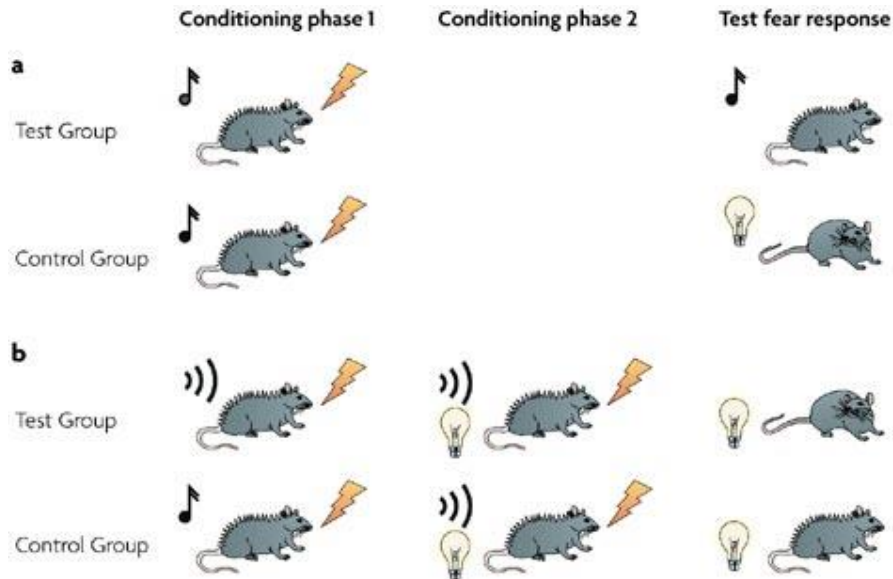
Schedules of reinforcement: Variable/fixed interval/ratio

Variable-ratio - number of responses needed for a reward varies

Variable-interval - the subject gets the reinforcement based on varying and unpredictable amounts of time



More than contingency: Surprise / added information



Aversive conditioning

Tone + Shock = CR

Tone + Light = No CR

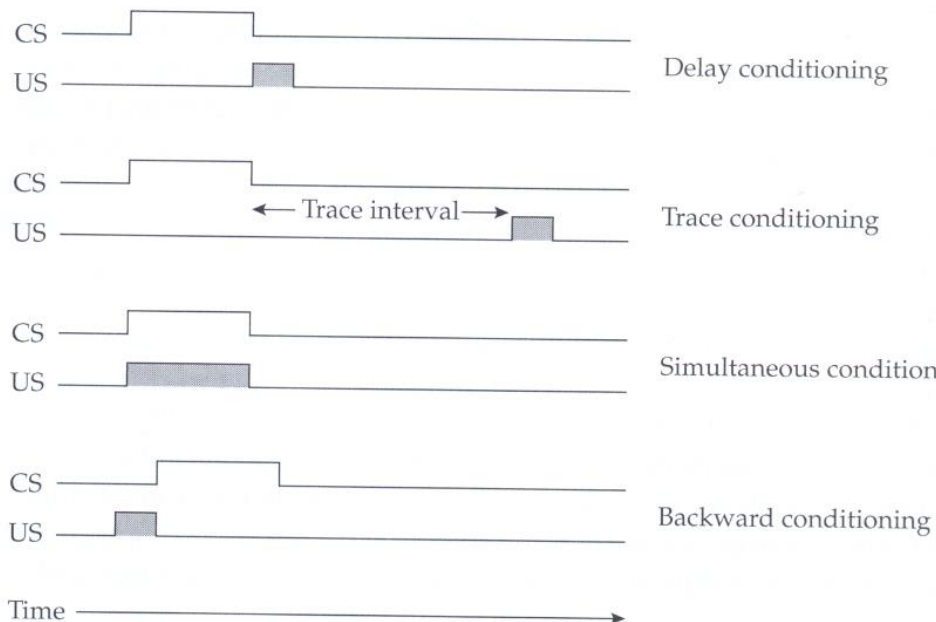
Tone = predictor

Blocking

No CR to light → the outcome is already well predicted



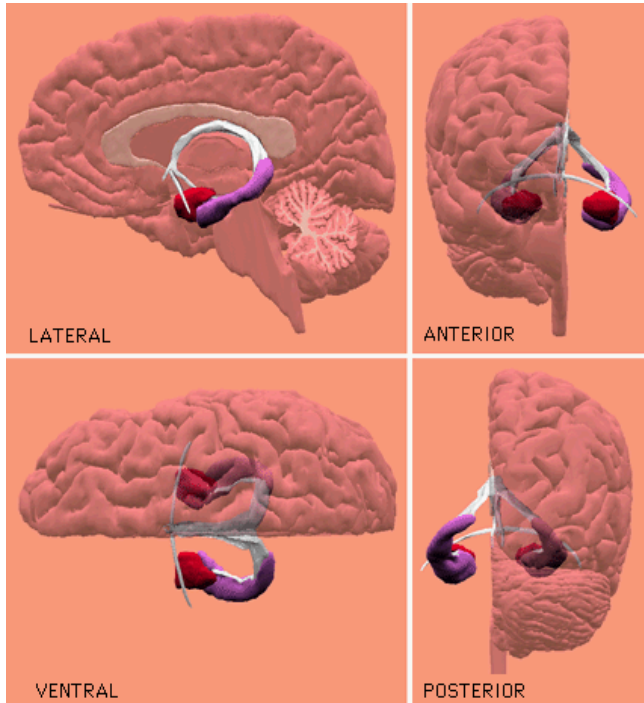
Rules of thumb for conditioning strength



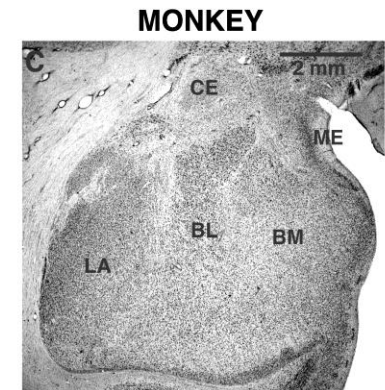
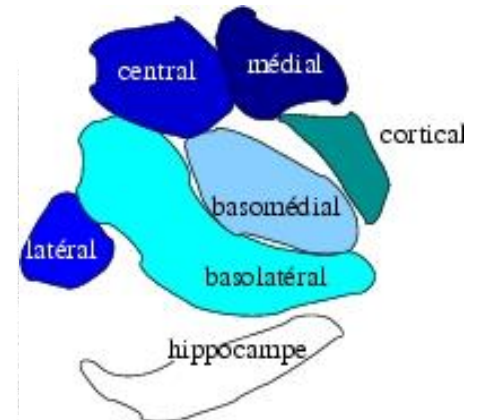
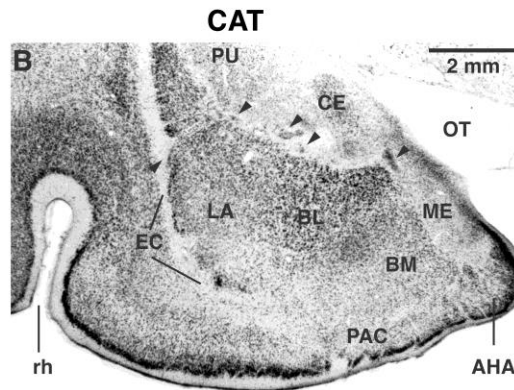
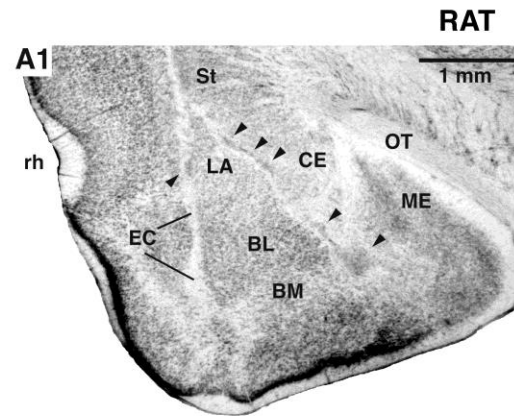
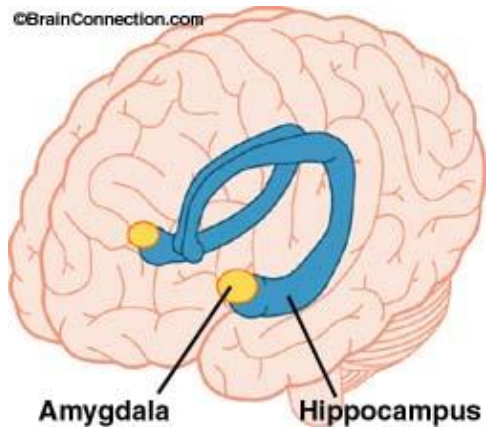
- Backward < simultaneous < trace < delay
- In trace: short interval > long interval
- In delay: short CS > long CS
- Salience of the CS
- Strength of the US
- Spaced trials is better than massed trials (the ratio between inter-trial-interval and the CS)

But notice it is hard to estimate backwards learning

Amygdala



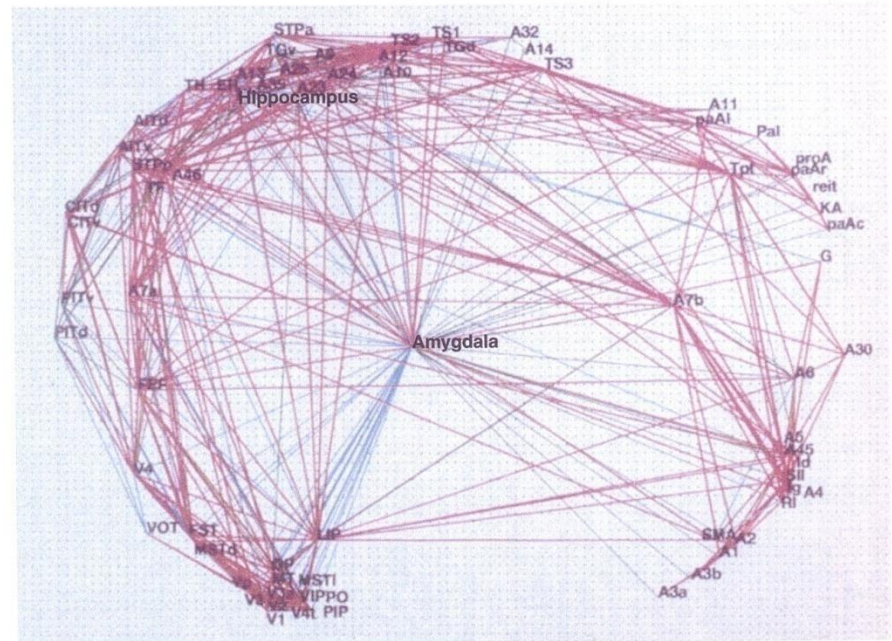
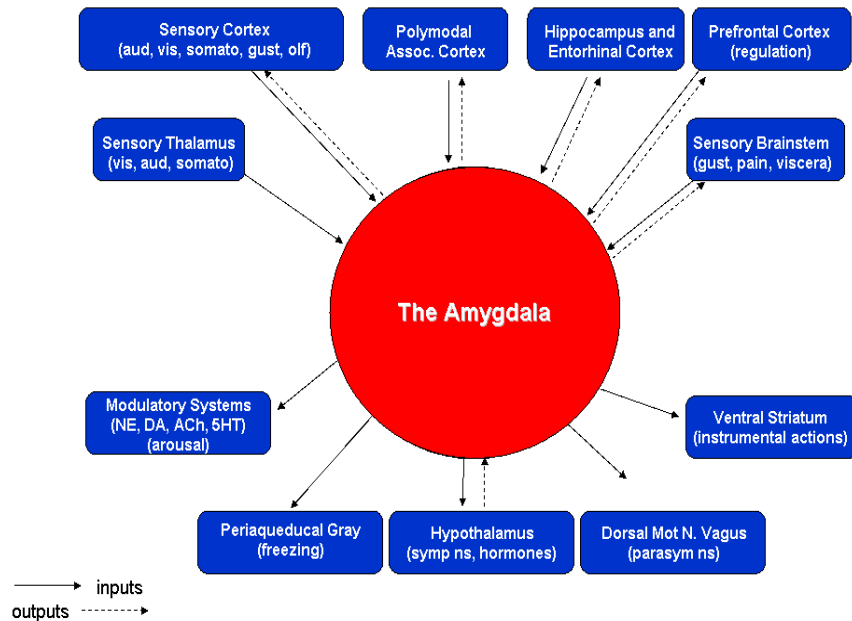
©BrainConnection.com



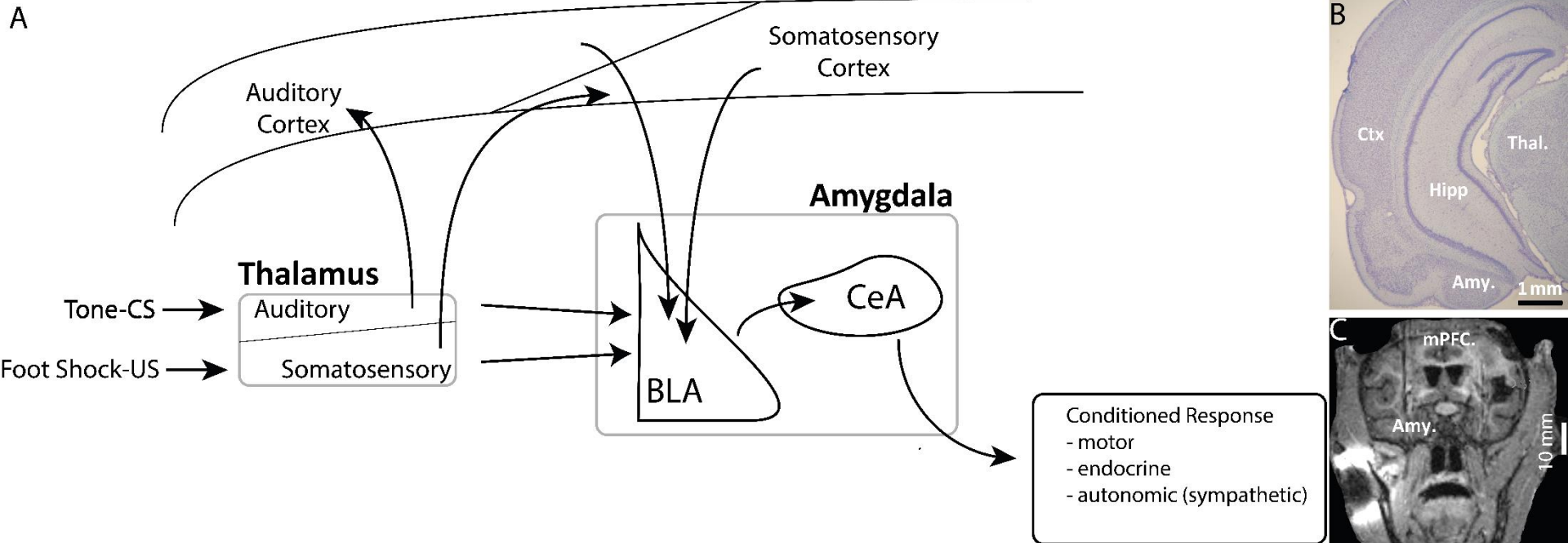
Amygdala and its basolateral complex (BLA)

- BLA evolution parallels that of the prefrontal cortex
- BLA cell types reminiscent of cortex
- Cortical projections are much more extensive in primates

SOME INPUTS AND OUTPUTS OF THE AMYGDALA

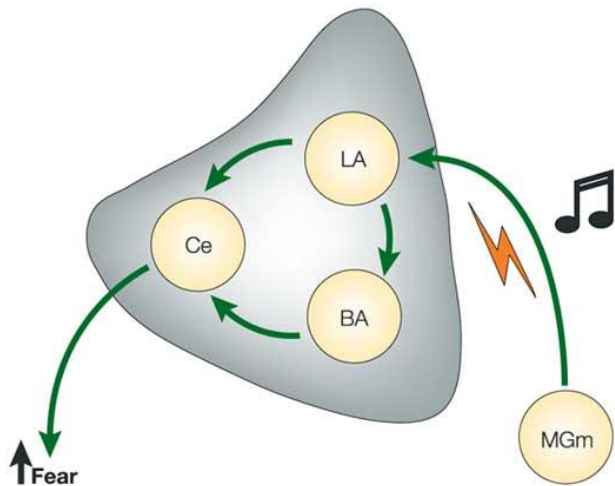


Fear circuit

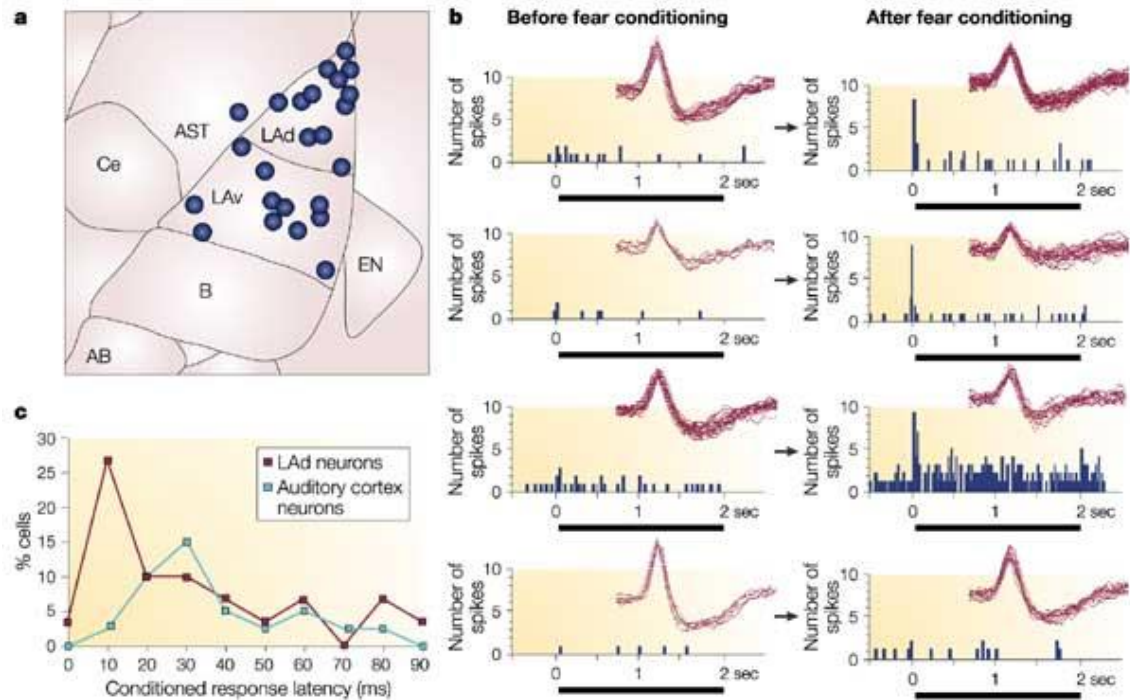


Samuel et al., 2018

Neurons acquire tone responses after conditioning



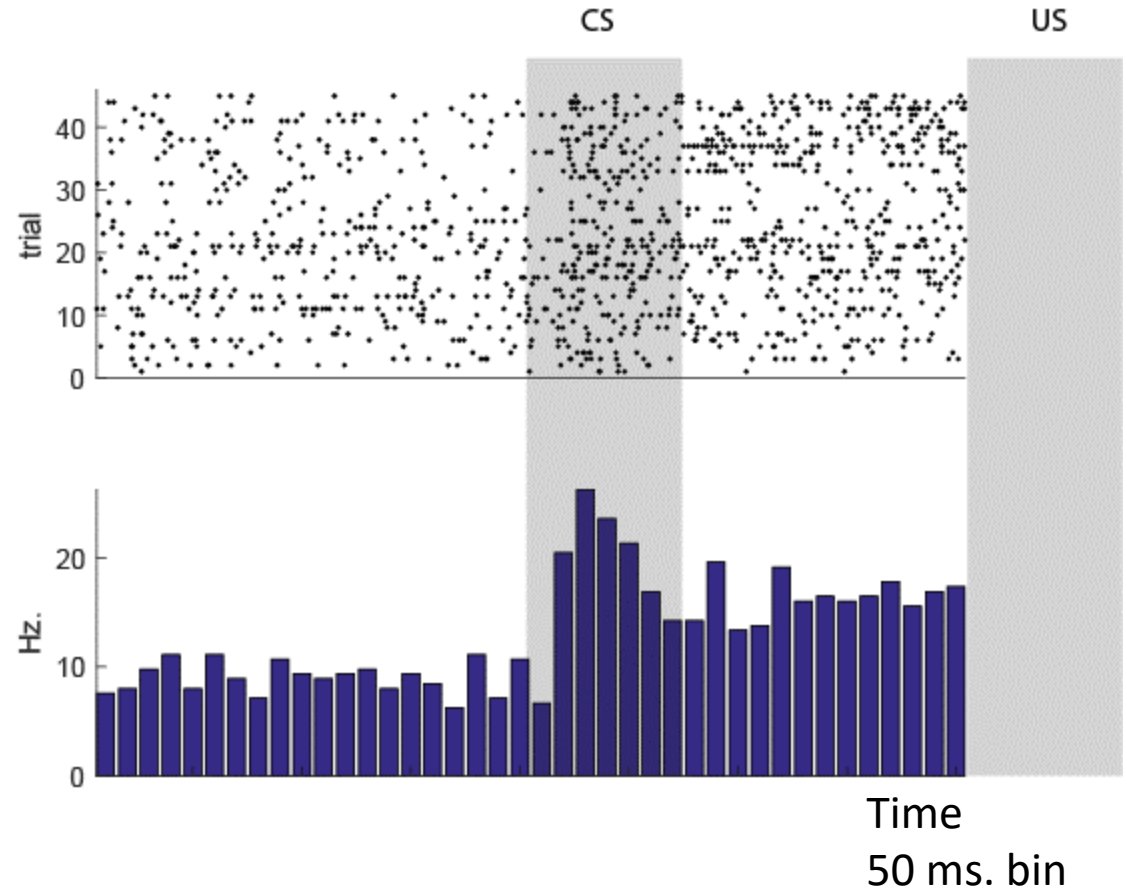
Nature Reviews | Neuroscience



Nature Reviews | Neuroscience

Neurons acquire tone responses after conditioning Primates

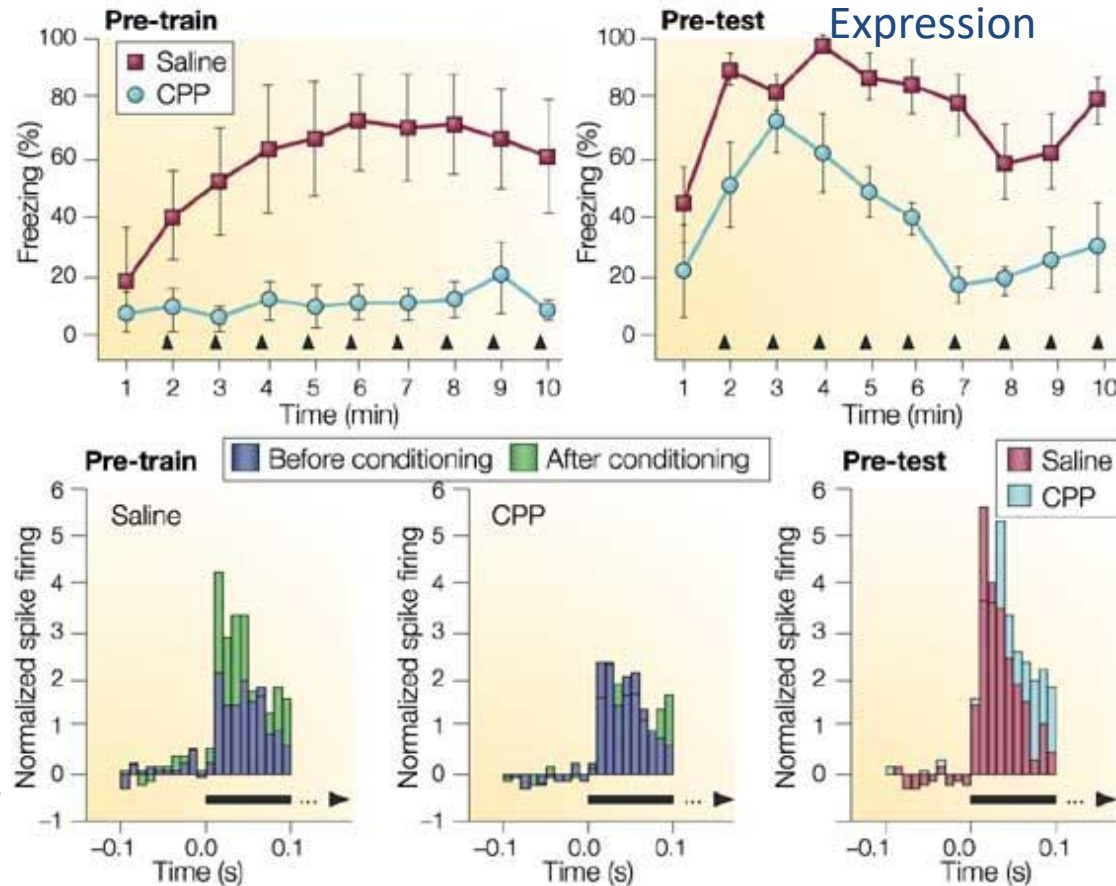
Increased response along trials



LTP in the LA is required

NMDA (**N**-methyl-**D**-aspartate, glutamate receptor) is involved in both the acquisition of fear memory and the induction of long-term potentiation (LTP) in the amygdala.

Massive effect
when injected
before learning

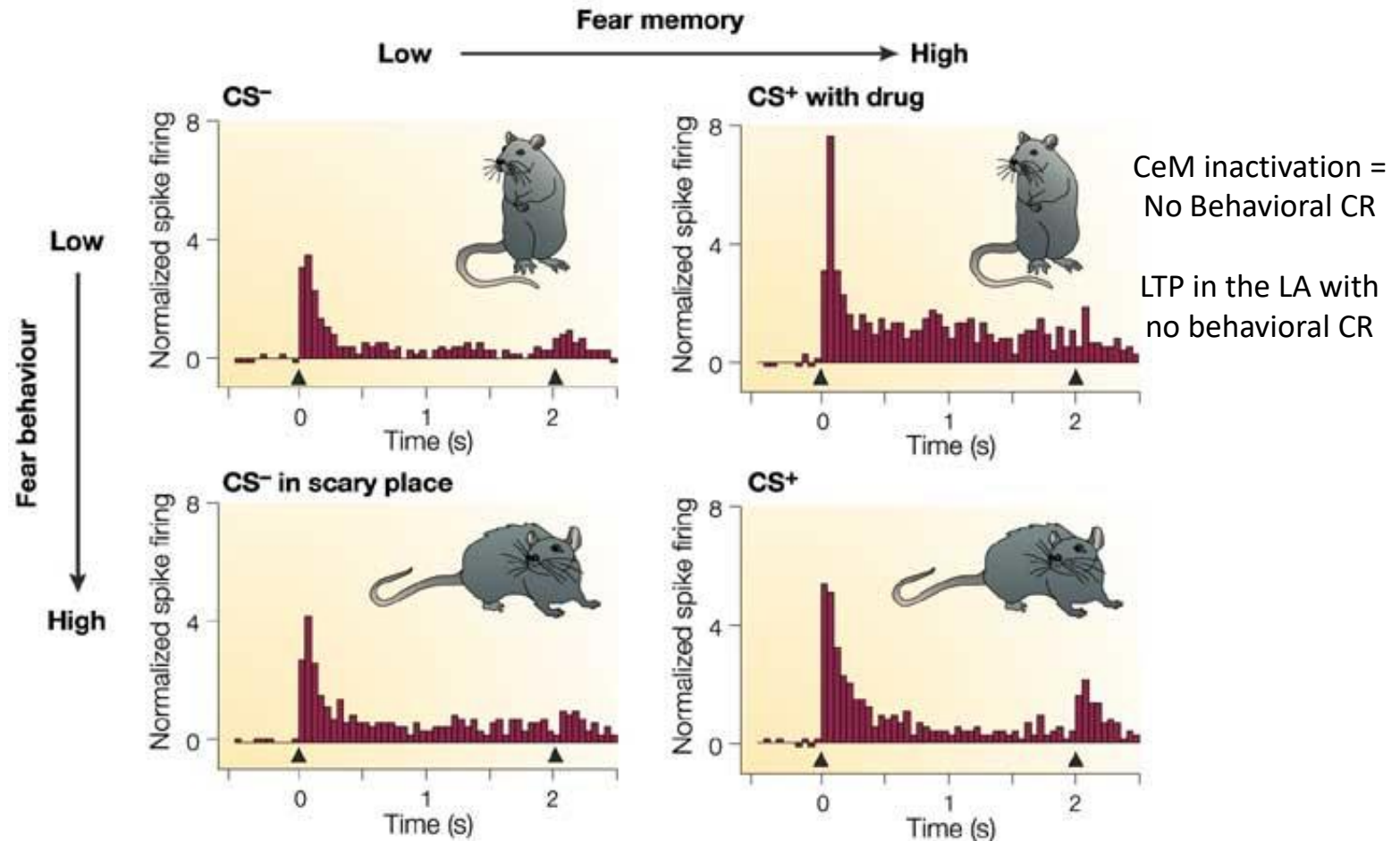


Some effect
when
injected
before
retention
test

CPP (3-(2-carboxypiperazin-4-yl) propyl-1-phosphonic acid),
a competitive NMDA-
receptor antagonist

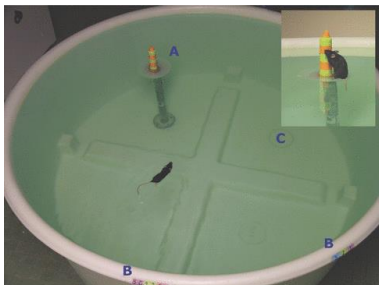
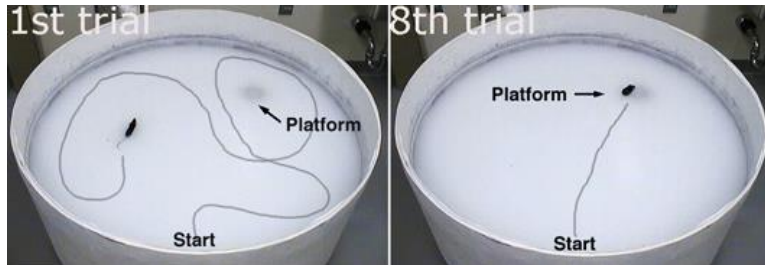
Is it fear memory or just fear behavior?

Lateral amygdala encodes memory independent of fear behavior



Amygdala modulation of memory

- Hippocampal dependent learning: spatial
- Striatum dependent-learning: cue-related



Injection of d-amphetamine into the amygdala facilitates hippocampal and striatal learning if right after training, but not if pre-testing

Neurobiology: Packard *et al.*

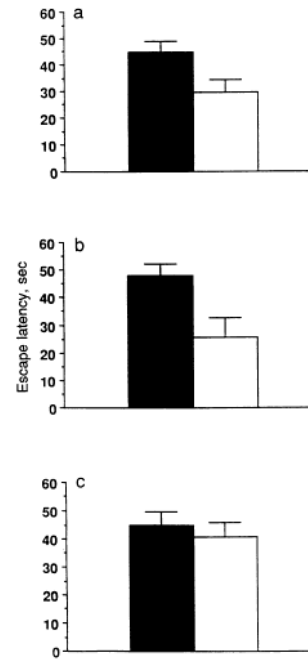


FIG. 1. Mean (\pm SE) escape latencies of *d*-amphetamine (10 μ g) (\blacksquare) and saline-treated (\square) rats on the retention test trial in the spatial task. (a) Hippocampal injections. (b) Amygdala injections. (c) Caudate nucleus injections.

posttraining intracaudate and intrahippocampal injections of *d*-amphetamine on retention of cued and spatial learning in

Proc. Natl. Acad. Sci. USA 91 (1994) 8479

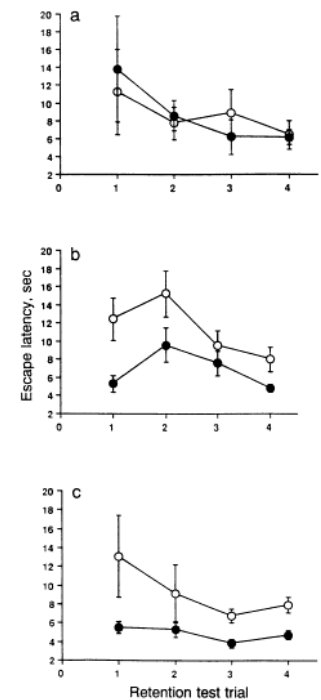
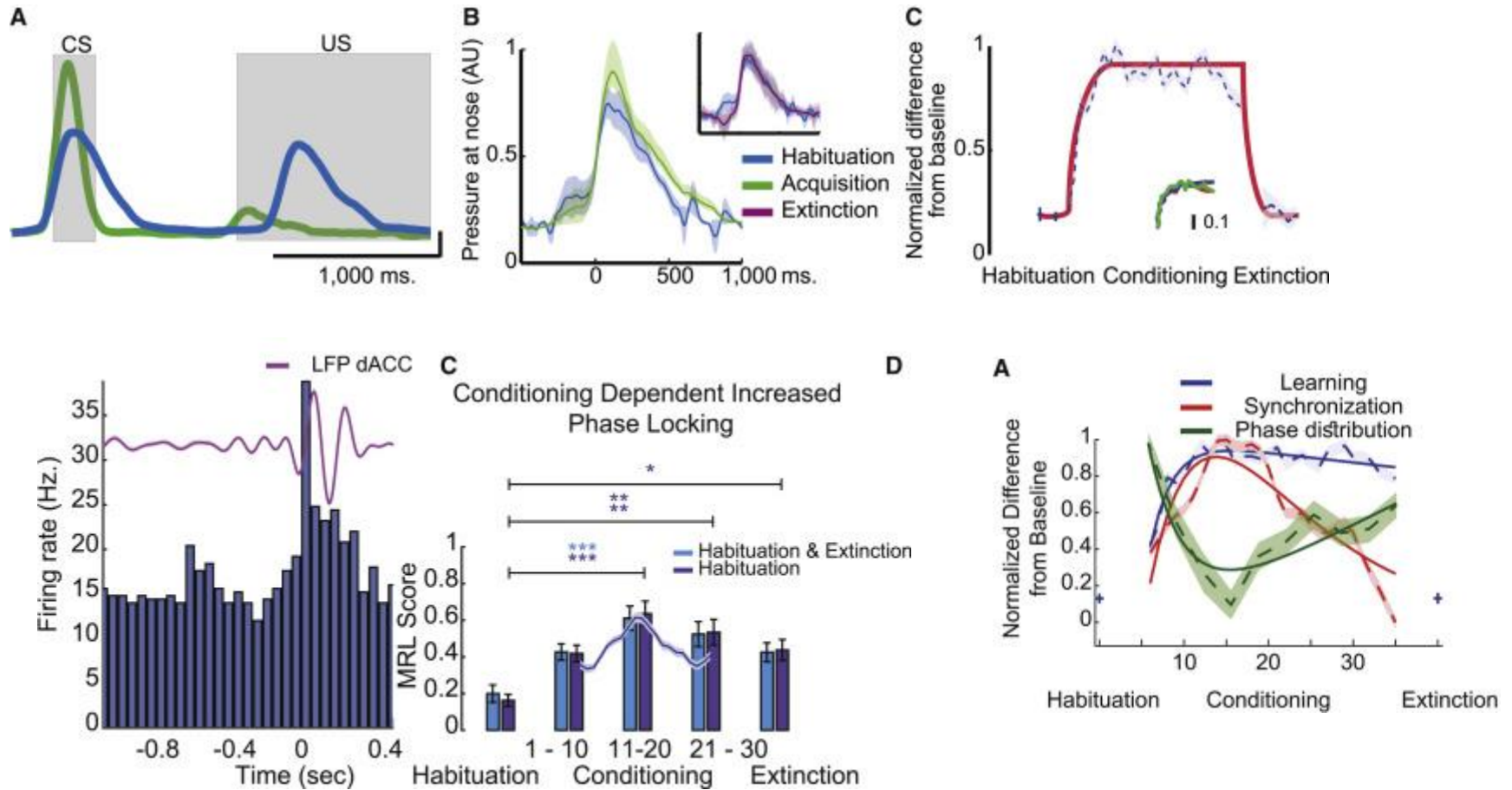


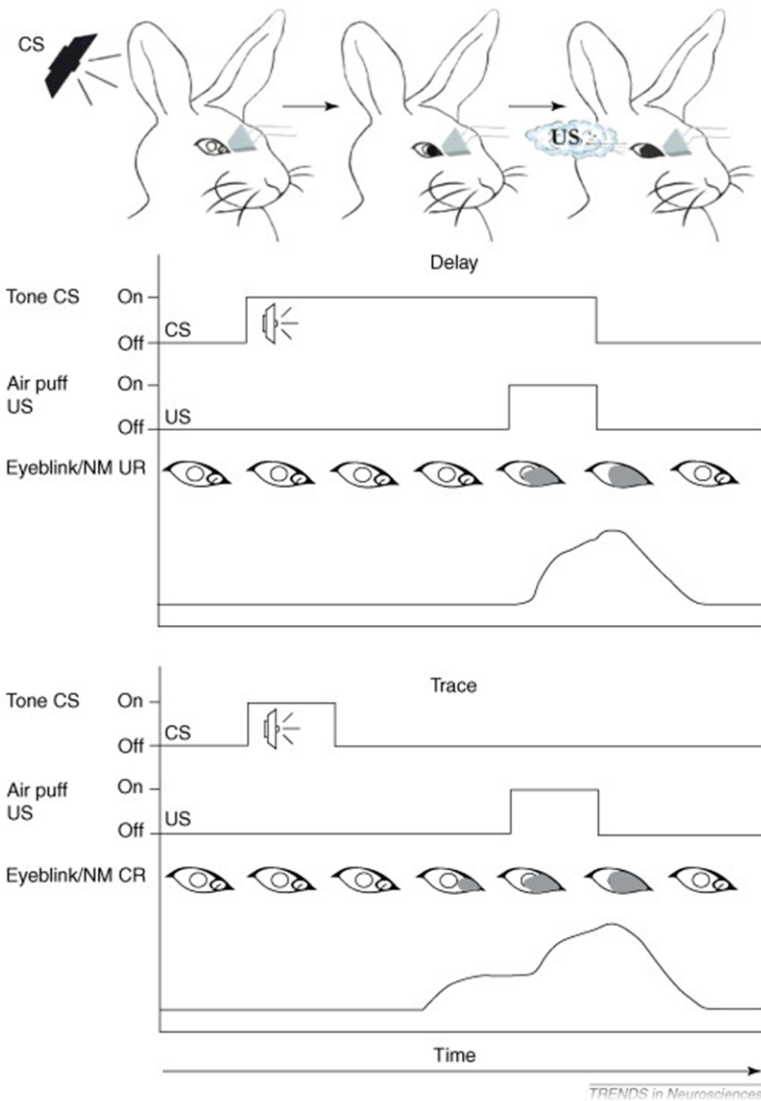
FIG. 2. Mean (\pm SE) escape latencies of *d*-amphetamine (10 μ g) (\bullet) and saline-treated (\circ) rats on the retention test trial in the cued task. (a) Hippocampal injections. (b) Amygdala injections. (c) Caudate nucleus injections.

Increased Amygdala-Prefrontal Synchrony during Aversive Learning



So, does it encode memory or just modulates it?

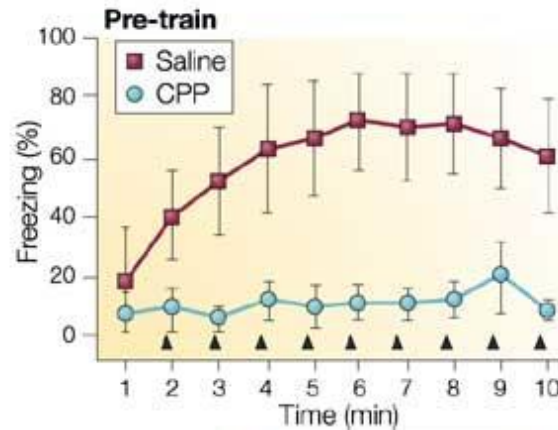
- It depends.



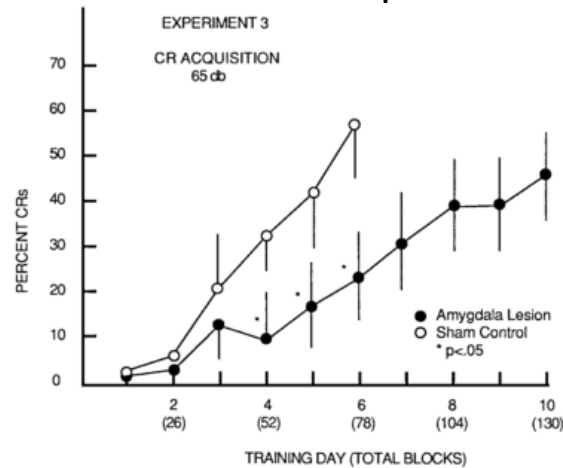
The cerebellum is essential and sufficient for eyeblink conditioning

Amygdala conditioning facilitates cerebellar eye-blink conditioning

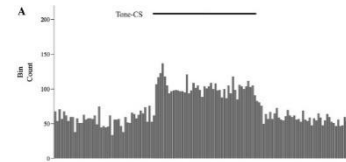
Amygdala dependent



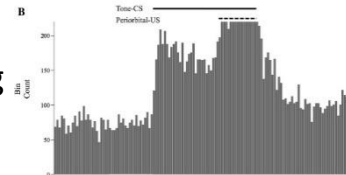
Cerebellum dependent



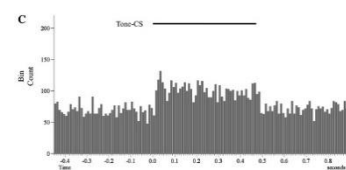
habituation



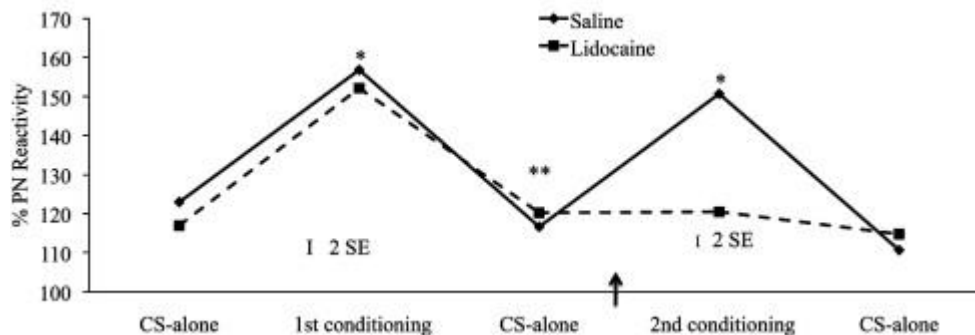
Conditioning



Extinction



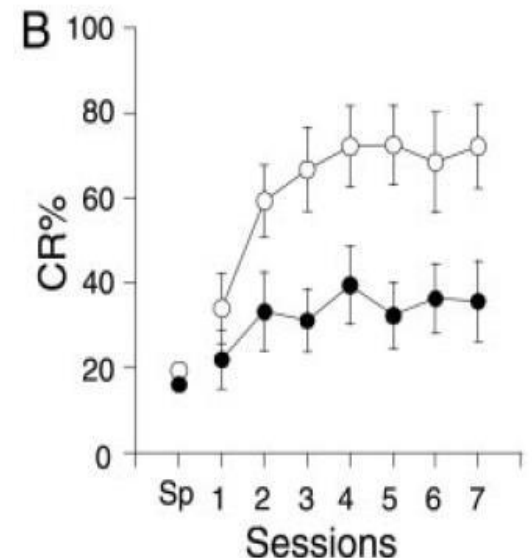
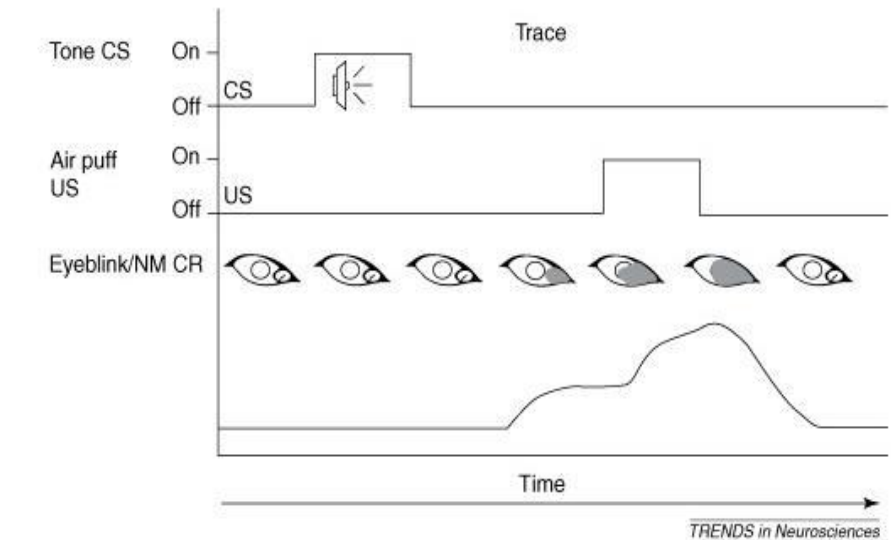
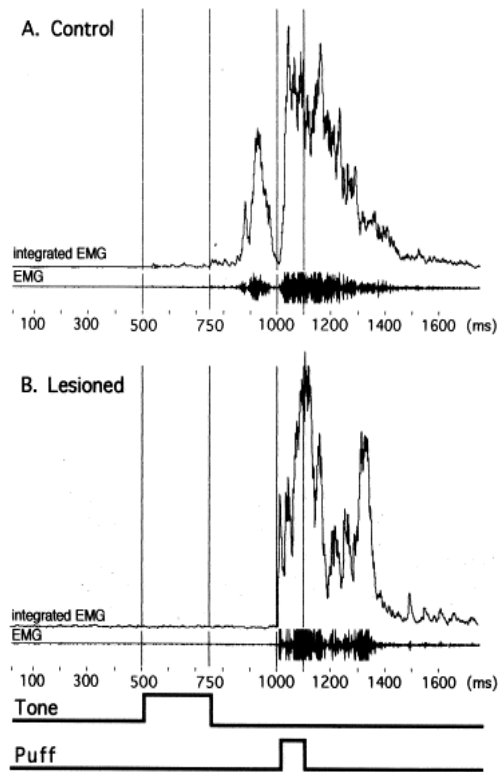
Weisz et al., 1994



CS facilitation can be abolished by amygdala inactivation

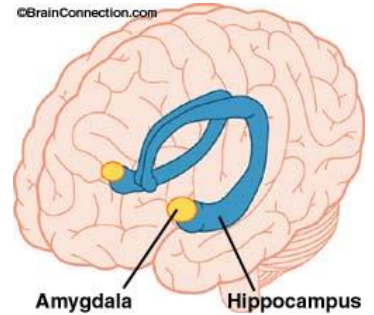
Taub and Mintz, 2010

Eyelid (blink) reflex conditioning – the role of the hippocampus

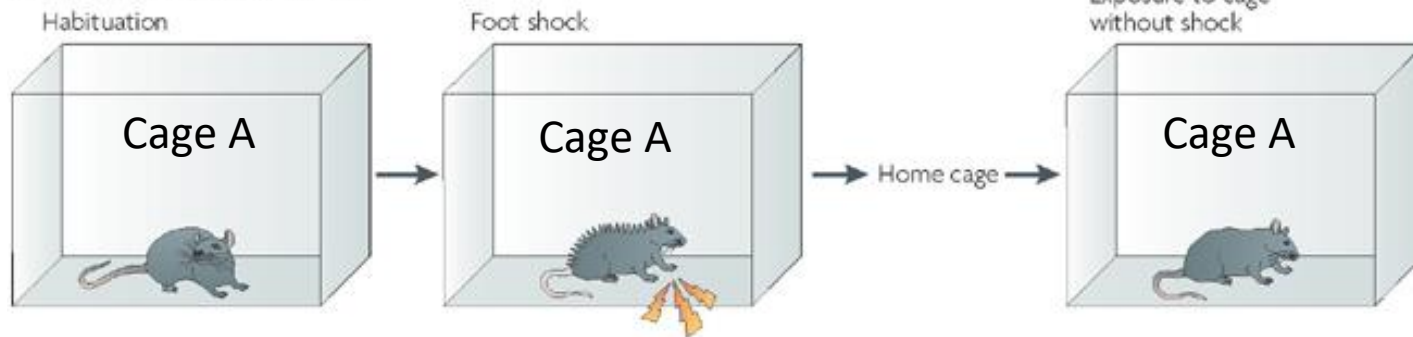


- Why is trace hippocampal-dependent?
- Maintaining the CS? Timing the trace? Harder?
- Eyeblink requires ~0.2sec, and hippocampus is required when 0.4-1sec.
- In tone-shock, trace can be 3sec, and hippocampus is required for ~20sec
- This suggest context-conditioning

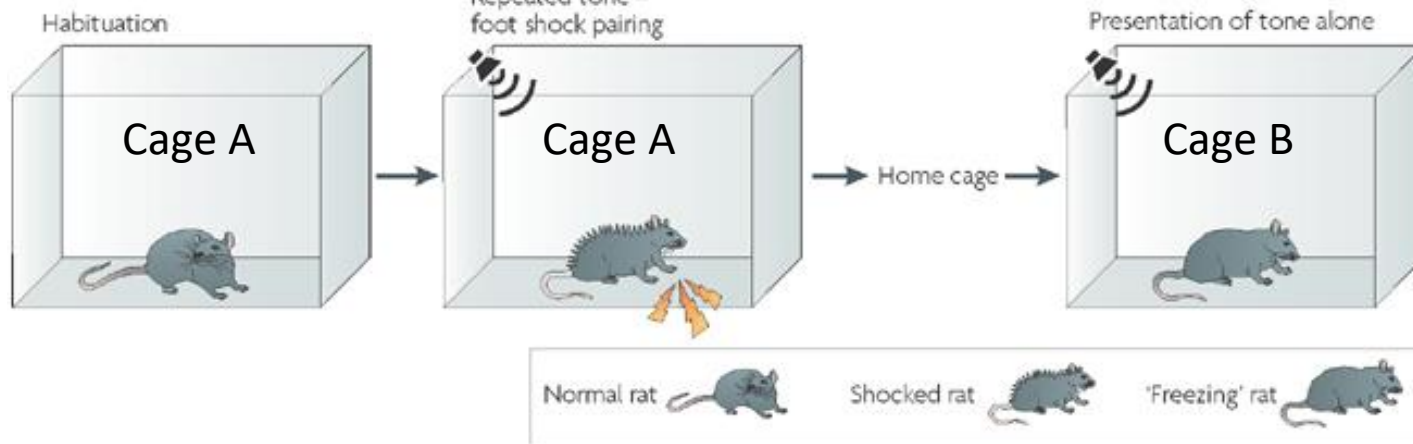
Contextual fear



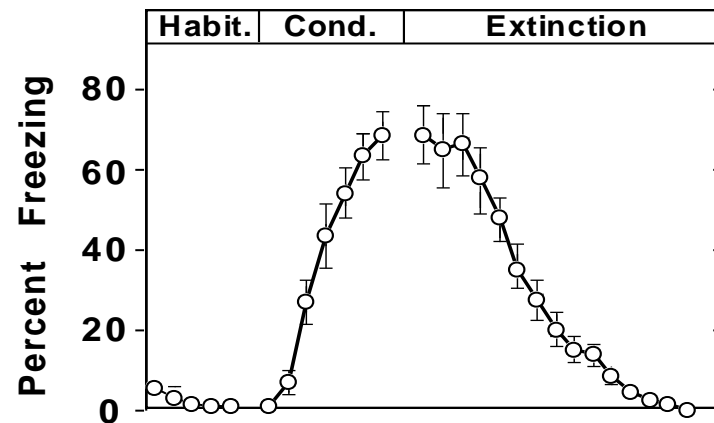
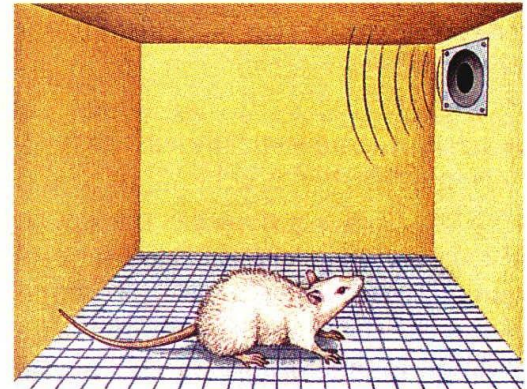
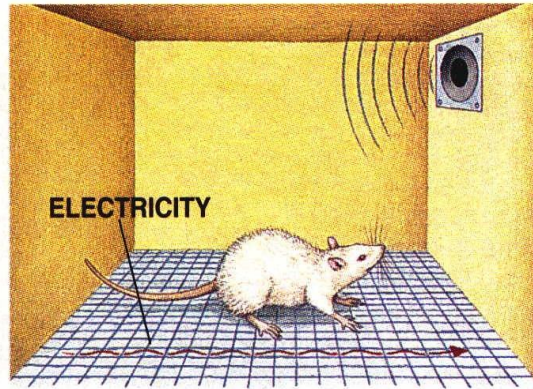
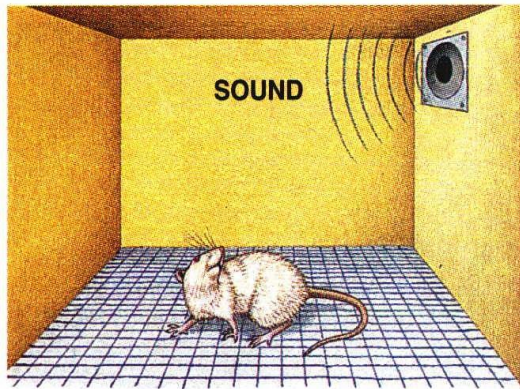
a Contextual fear conditioning



b Acoustic-cued fear conditioning

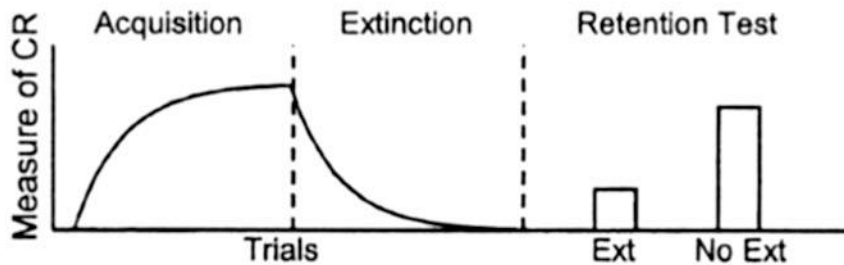


Extinction of fear-conditioning

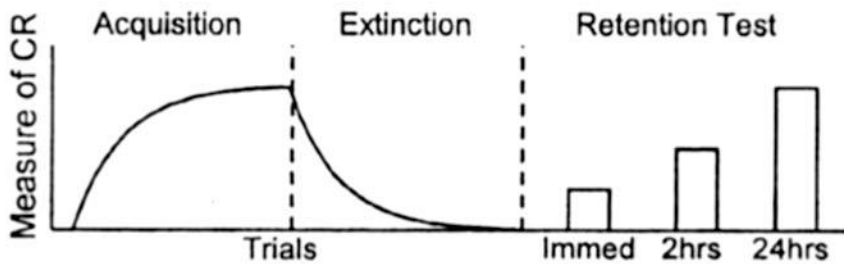


Extinction: a new learning

A Extinction is not the same as forgetting

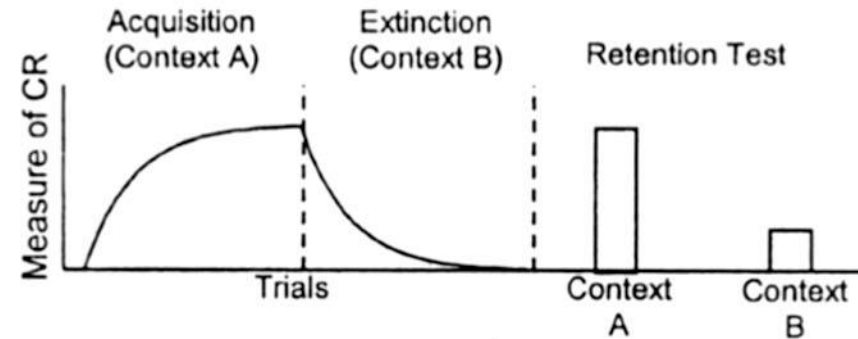


B Spontaneous recovery simple passage of time



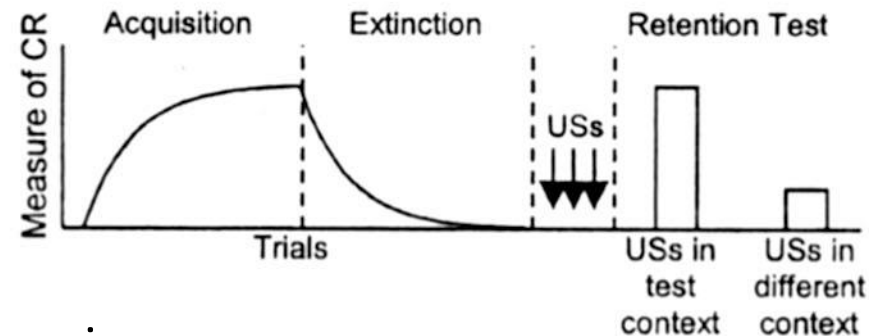
C Renewal

testing the subject in a context different from the one used during extinction



D Reinstatement

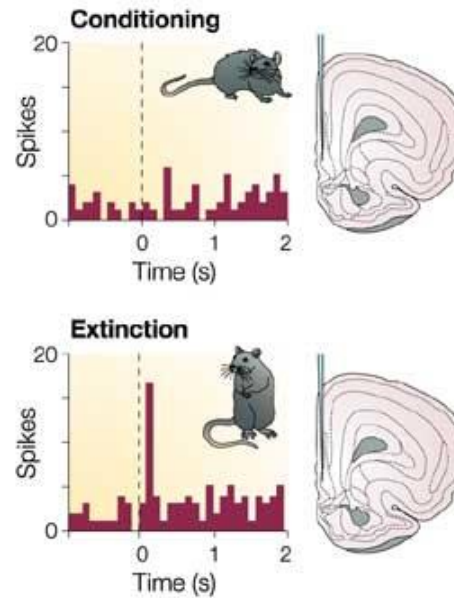
presentation of the US before testing



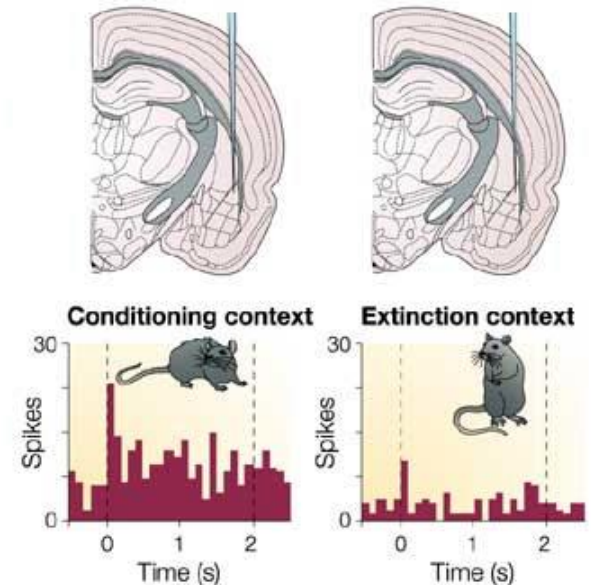
Faster re-learning

Extinction: brain mechanisms

a Prefrontal cortex (safety memory)

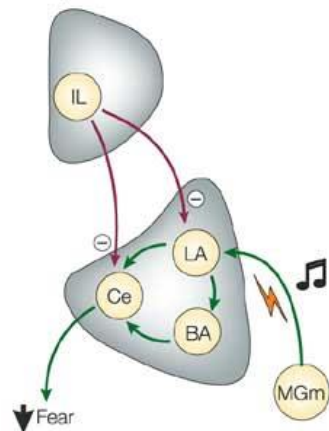


b Lateral amygdala (fear memory)

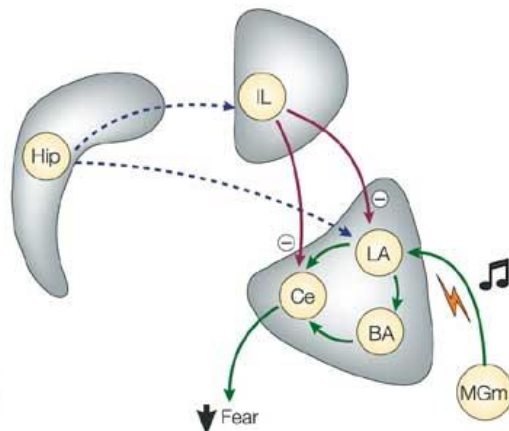


Nature Reviews | Neuroscience

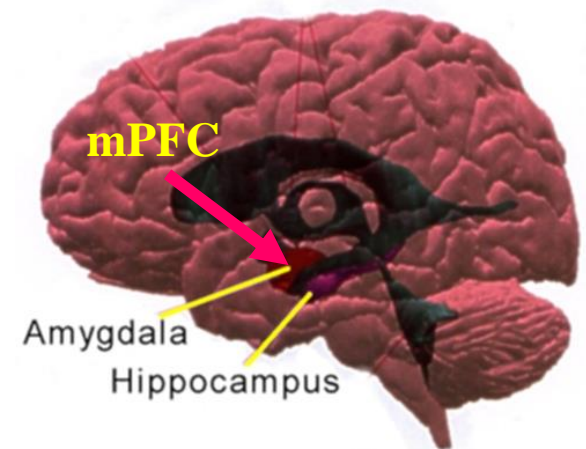
a Expression of extinction



b Modulation of extinction

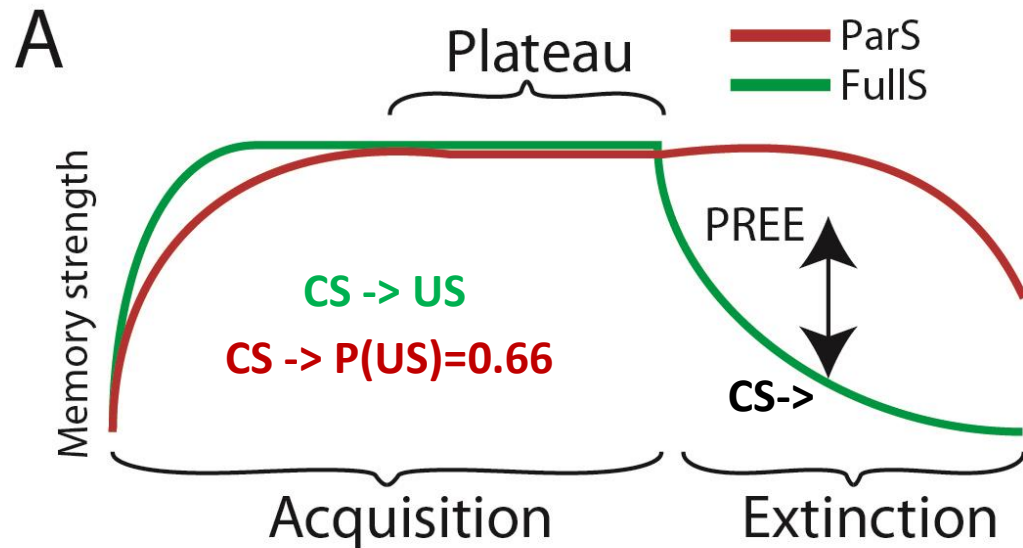


Nature Reviews | Neuroscience



Partial reinforcement extinction effect

- Partial reinforcement
 - Fixed/variable ratio
 - Fixed/variable schedule



- Results in longer extinction learning

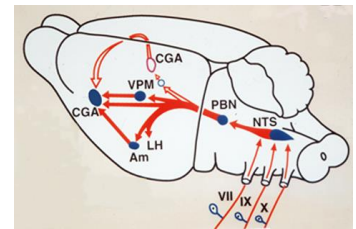
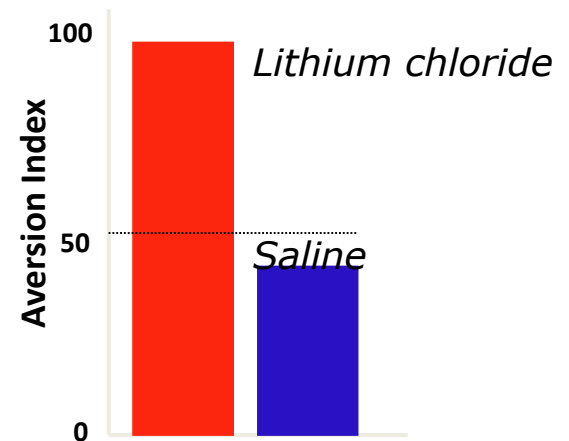
Livneh & Paz, 2012

- Frustration theory (Amsel): The omission of the US induces frustration. Therefore, during extinction, the frustration predicts the US.
- Sequential theory (Capaldi): conditioning to strings of NNNRNNNR

Conditioned Taste Aversion

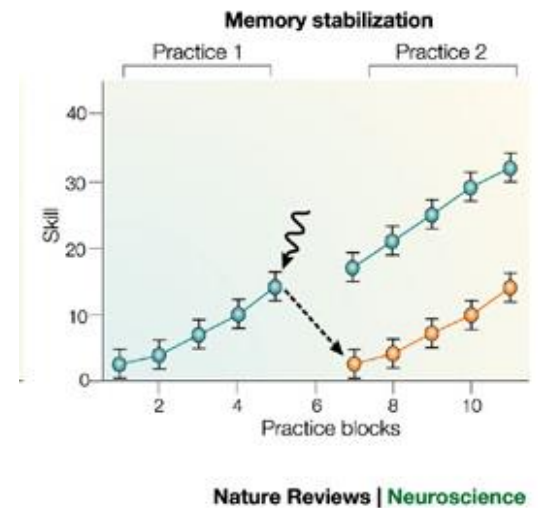
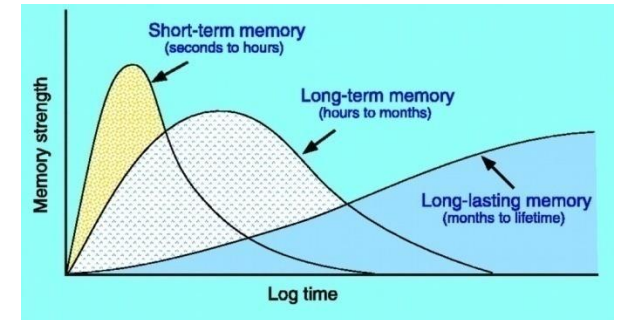
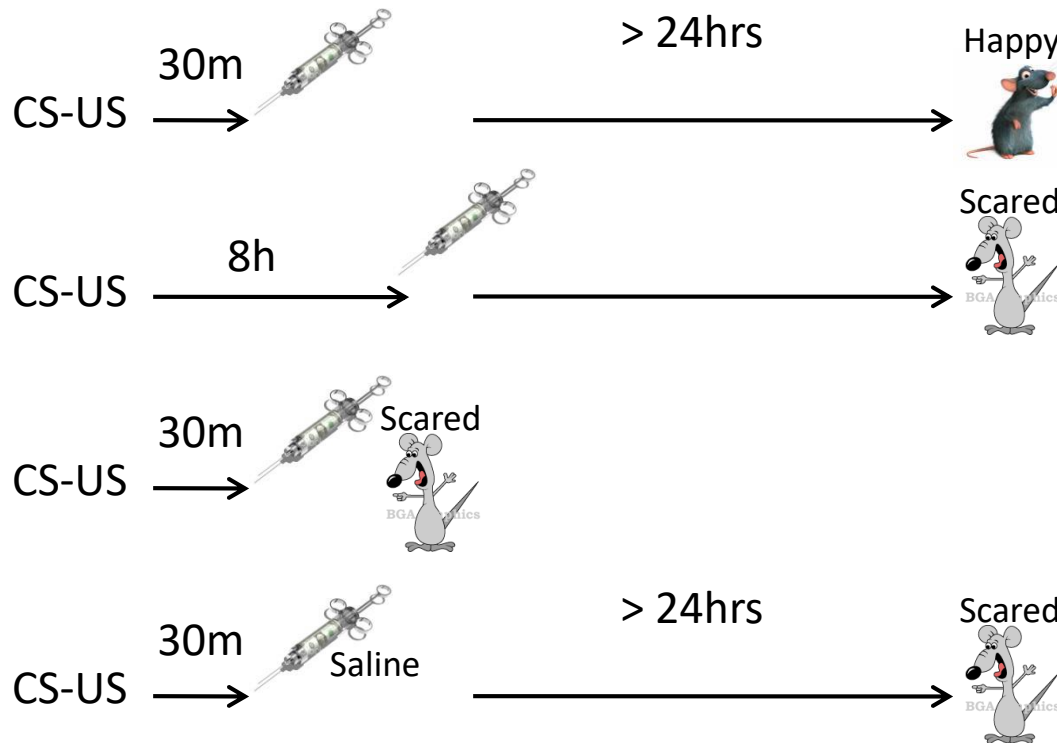


- One-trial learning
- Long-delay learning (few hours)
 - A [lack of] interference effect?
 - Still a problem for neuroscientists



Consolidation

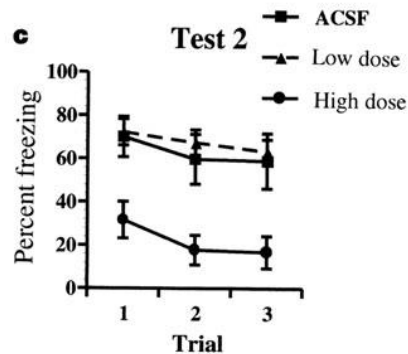
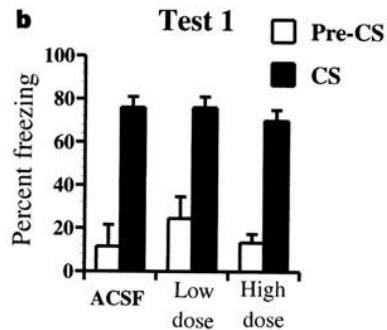
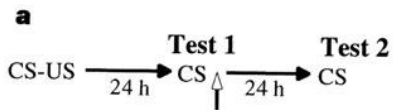
- Anisomycin, a protein synthesis inhibitor, into the Basolateral complex of the amygdala (BLA)
 - No effect on short-term-memory
 - No effect after XX time (rule of thumb is 6hrs)
 - But harms long-term memory below that.



Reconsolidation

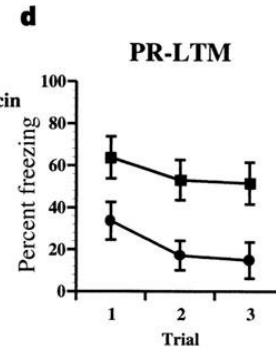
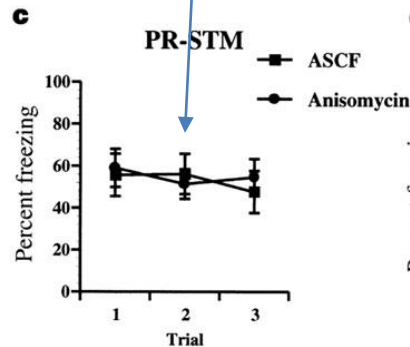
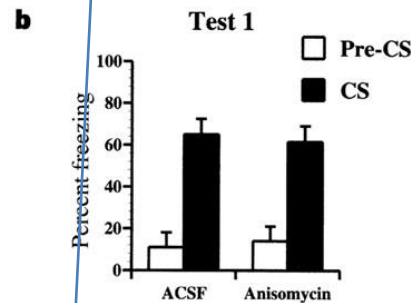
Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval

A test of whether consolidated fear memories can become labile when reactivated

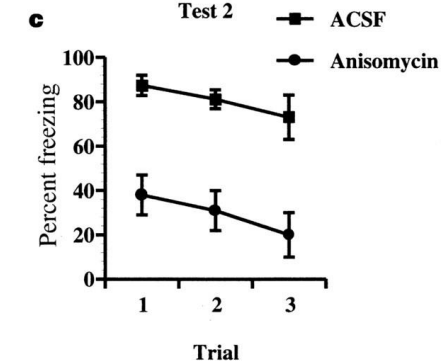
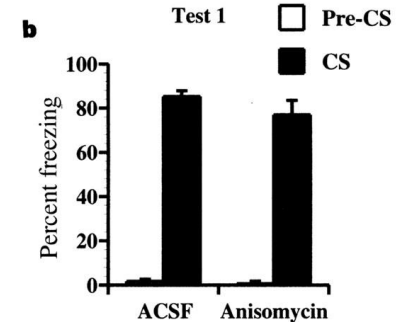
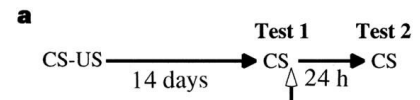


No CR reminder

No effect on STM



Fourteen days after training, anisomycin infusions after reactivation of the memory still produce amnesia



An updated view of memories

(a)



Short-term memory (STM)

- Lasts for seconds to hours
- 'Labile' (sensitive to disruption)
- Does not require new RNA or protein synthesis

Long-term memory (LTM)

- Lasts for days to weeks
- Consolidated (insensitive to disruption)
- Does require new RNA or protein synthesis

(b)



Active state (AS)

- Lasts for seconds to hours
 - 'Labile' (sensitive to disruption)
- (Does not require new RNA or protein synthesis)

Inactive state (IS)

- Lasts for days to weeks
 - Inactive (insensitive to disruption)
- (Does require new RNA or protein synthesis)





Cell Phones & Accessories > Accessories



Pavlok

Pavlok

★★★★☆ 440 customer reviews | 80 answered questions

Price: \$199.99 + \$44.03 Shipping & Import Fees Deposit to Israel Details

Your cost could be \$189.99. Eligible customers get a \$10 bonus when reloading \$100.

Color: Black



- Download the app, and choose the habit you want to break.
- Pavlok integrates with sensors, friends, and GPS to keep you on track with your goals
- Use the 'manual' mode for habits that aren't yet detectable.
- Breaks bad habits via zaptic feedback, Other wearables track what you've already done, Pavlok changes your behavior
- Use the Pavlok iPhone app to adjust device setting & engage with habit breaking courses

New (2) from \$199.99 ✓prime

Report incorrect product information.



Shipping to Israel?

Explore deals that ship internationally with Amazon Global. [Shop now](#)

Share

\$199.99

+ \$44.03 Shipping & Import Fees Deposit to Israel Details

This item ships to Israel. [Learn more](#)

Only 1 left in stock - order soon.

Sold by First Infinity and Fulfilled by Amazon.

Add to Cart

Turn on 1-Click ordering for this browser

Deliver to Aryeh - Rehovot 7610001

Add to List

Add to your Dash Buttons

Other Sellers on Amazon

New (2) from \$199.99 ✓prime

Have one to sell?

Sell on Amazon

Stay safe, be fearless