

NST IB Psychology

Emotion and motivation – 2

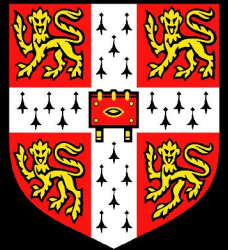
Neurobiology of emotion

Rudolf Cardinal

Department of Experimental Psychology

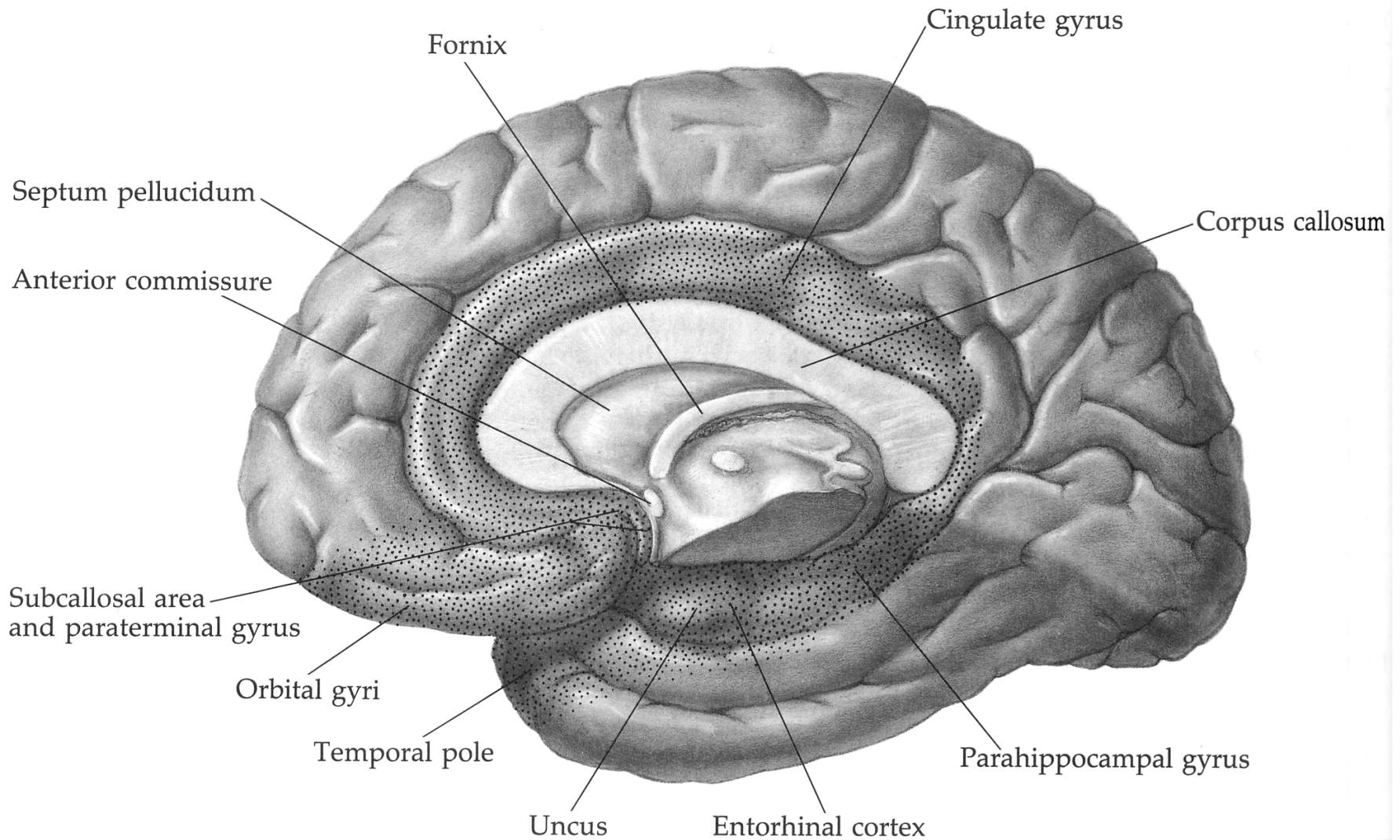
Thursday 6, Saturday 8, Tuesday 11 March 2003; 11am

Lecture Theatre 3, Physiology



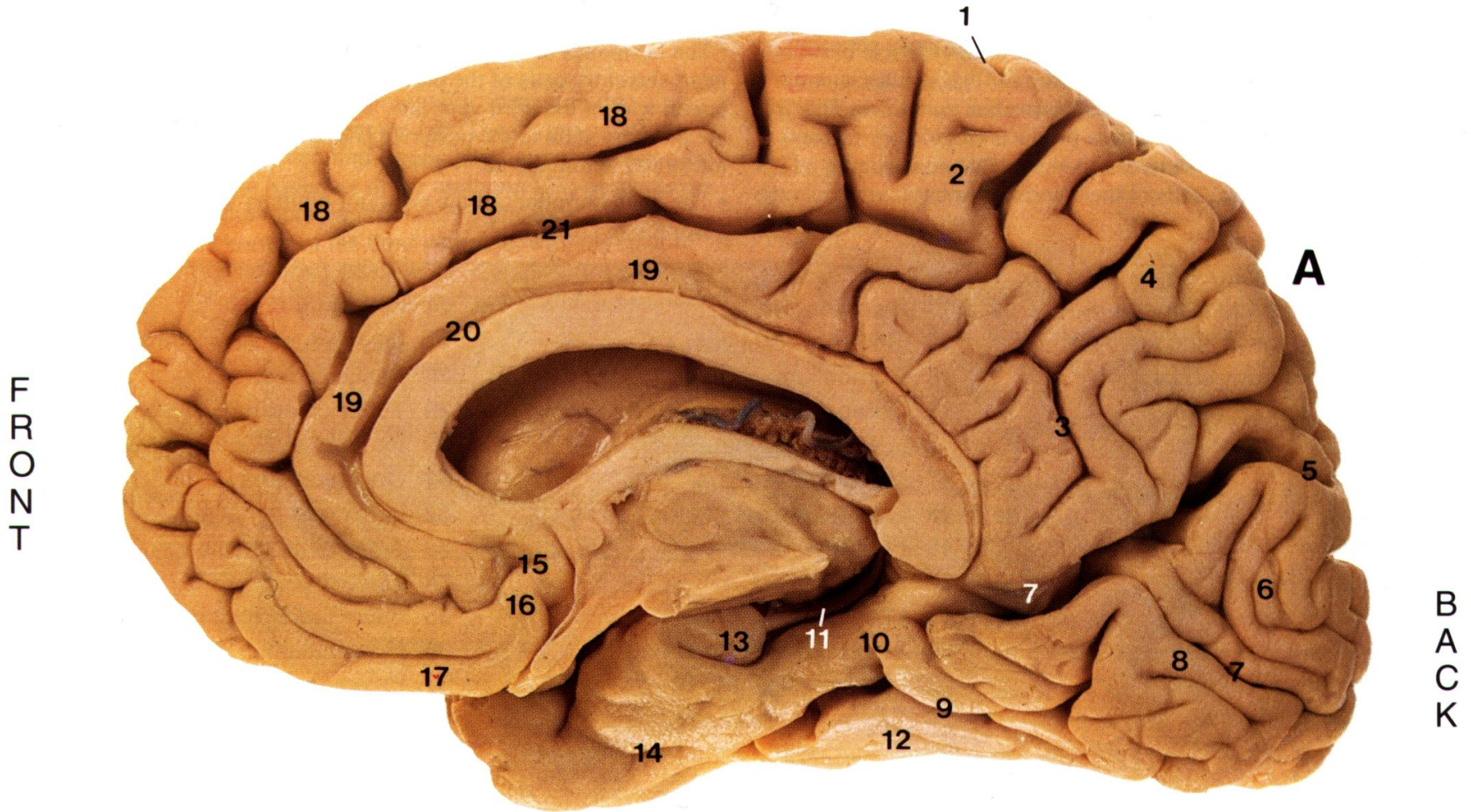
The limbic system

The 'limbic lobe': limbic cortex



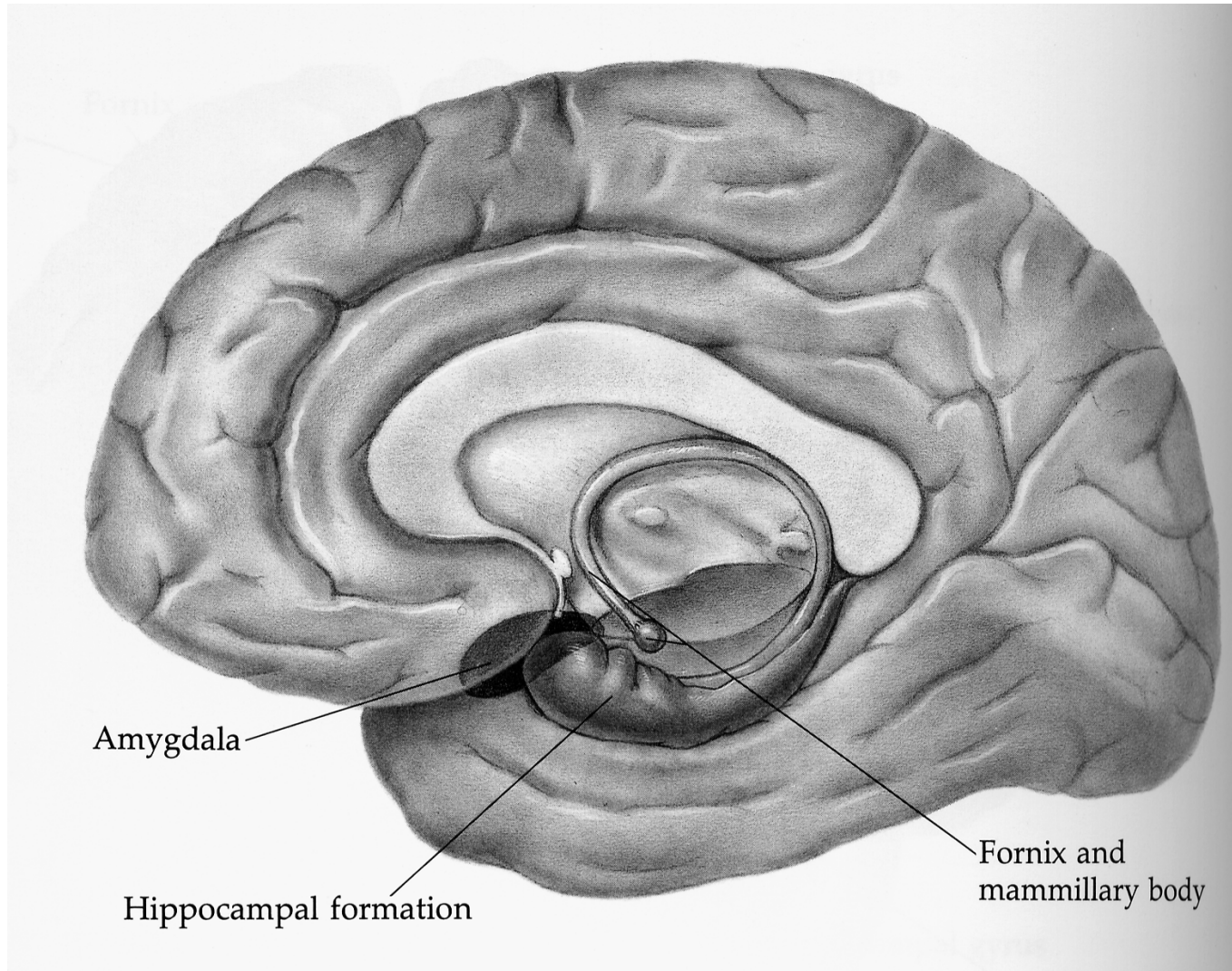
Broca (1878); picture from Martin (1991)

Midline view of the brain showing limbic cortex

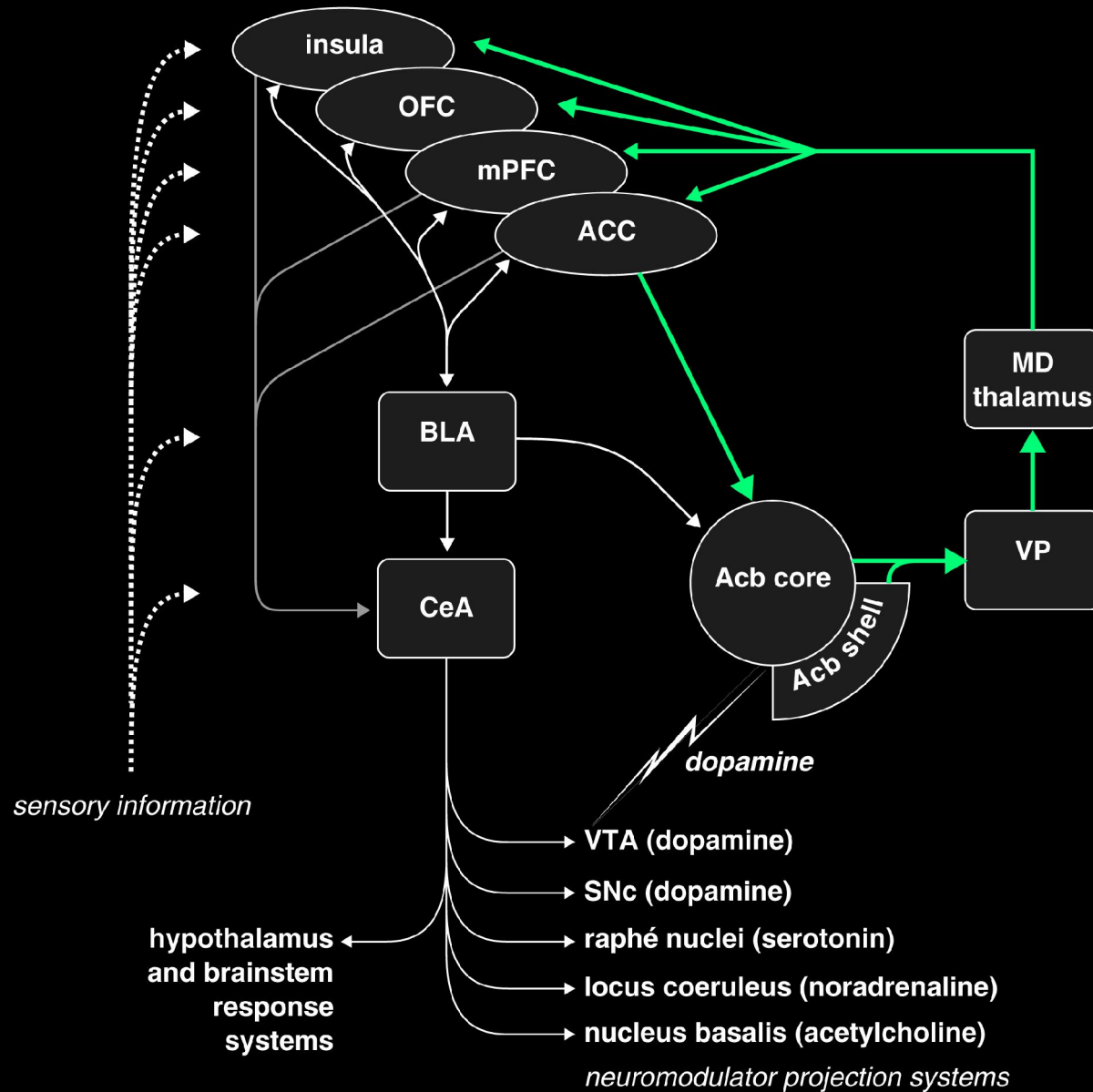


(The numbers don't mean anything!)

The medial temporal lobe: hippocampus, amygdala, fornix



The 'limbic' corticostriatal circuit



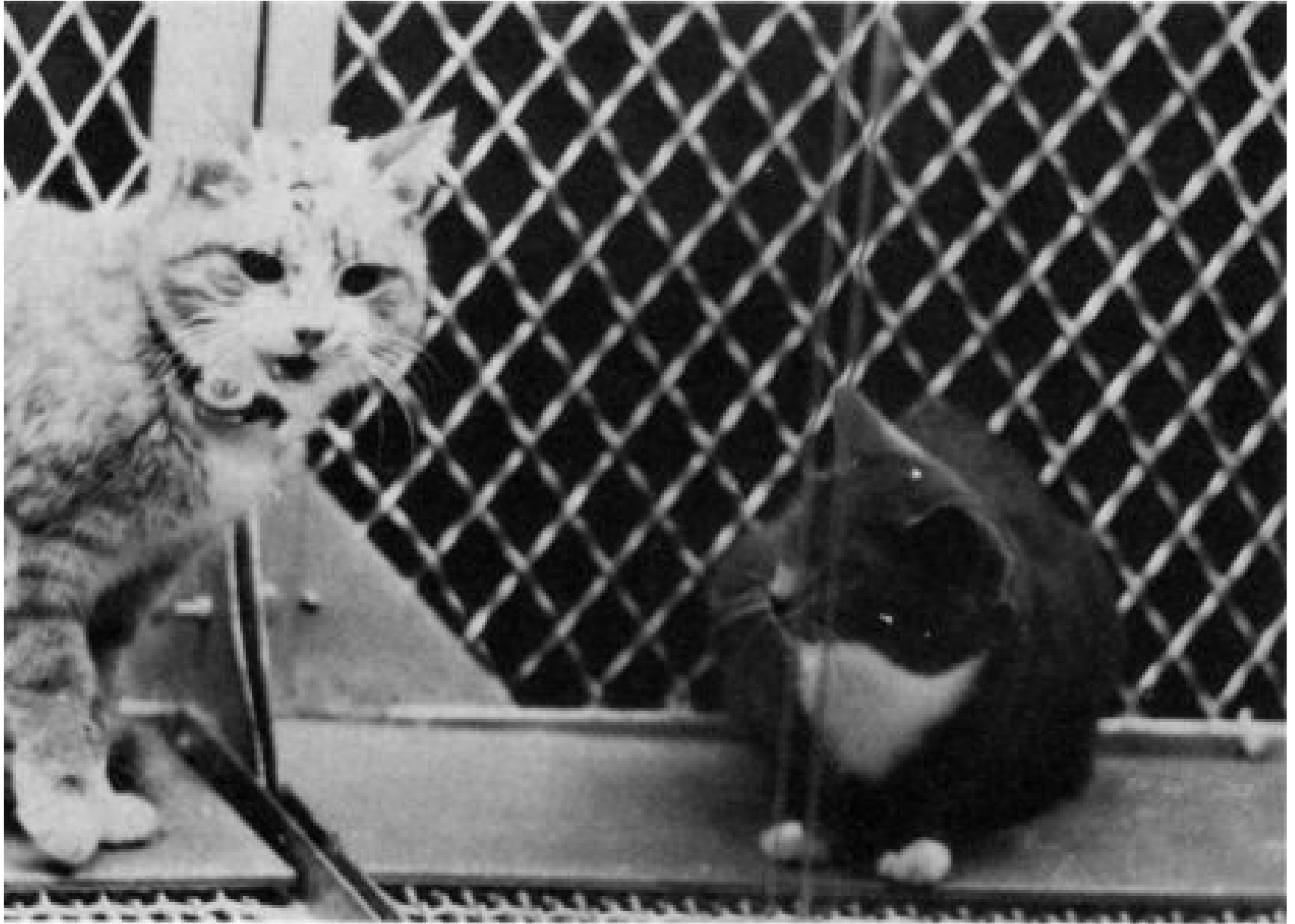
*Early work: rage and the
hypothalamus*

Hypothalamic stimulation in cats. At rest...



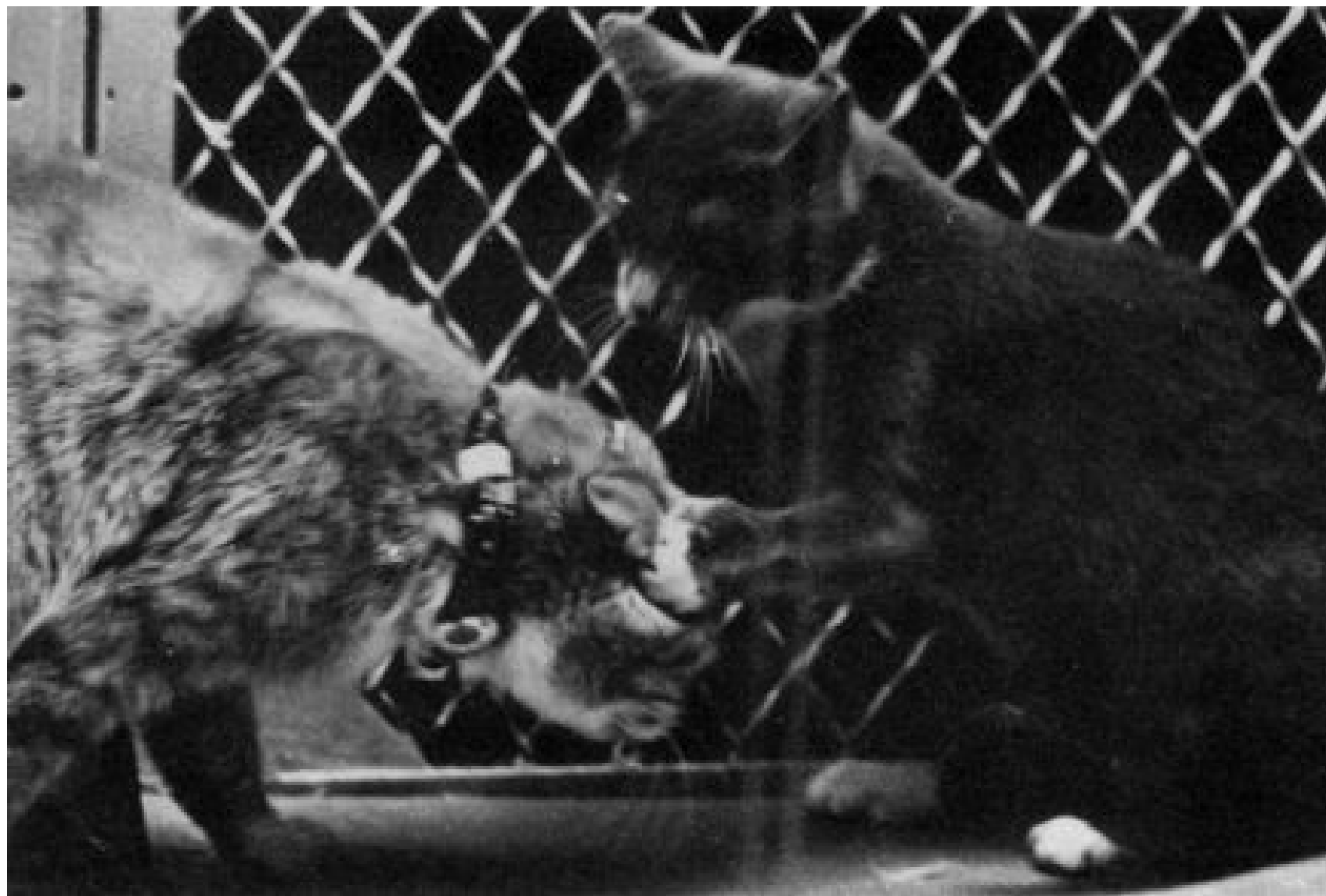
Hess (1932) / Delgado (1969)

'Sham rage' following anterior hypothalamic stimulation (1)



Hess (1932) / Delgado (1969)

'Sham rage' following anterior hypothalamic stimulation (2)



Hess (1932) / Delgado (1969)

'Directed rage' following lateral hypothalamic stimulation (1)



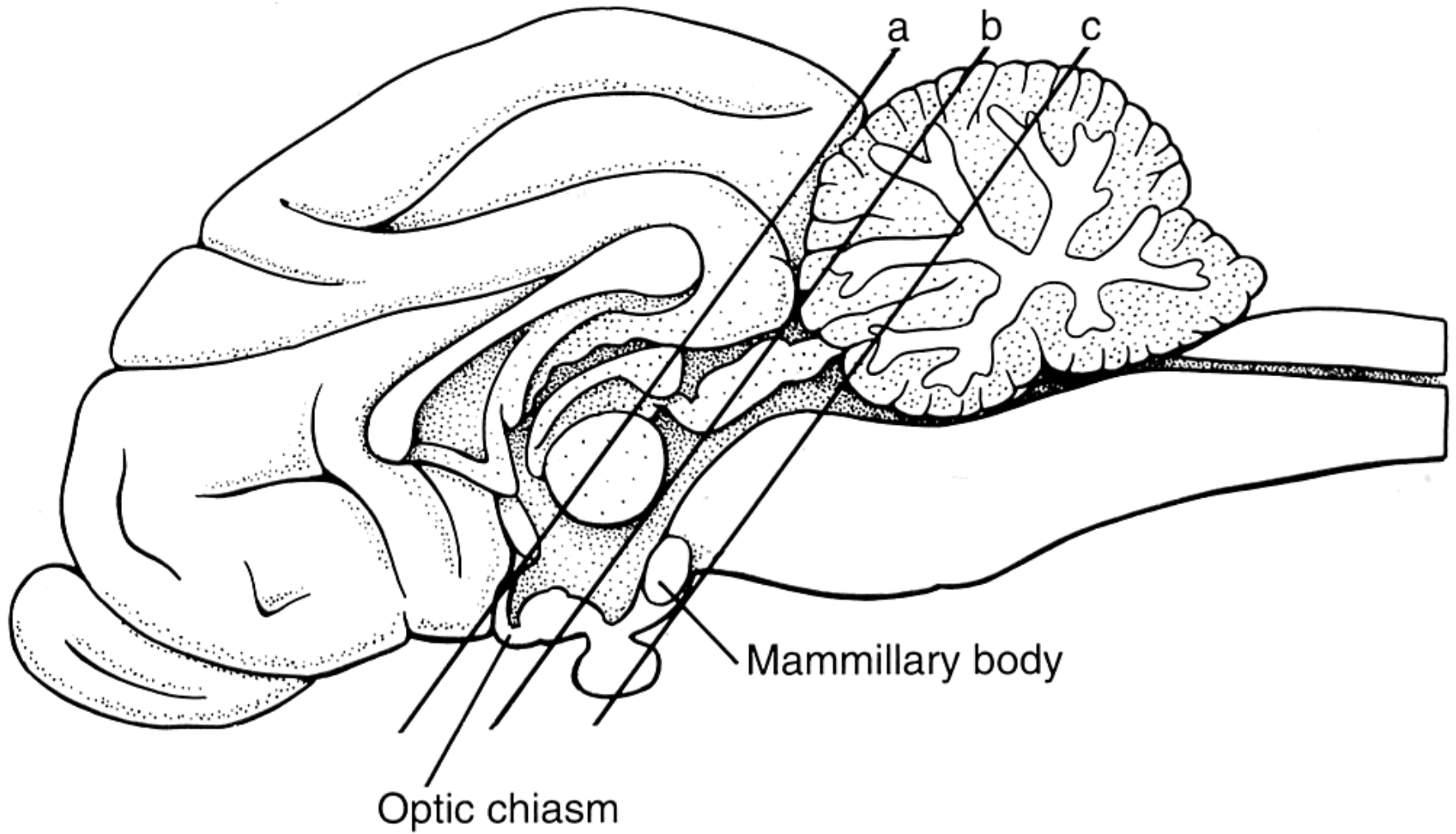
Hess (1932) / Delgado (1969)

'Directed rage' following lateral hypothalamic stimulation (2)

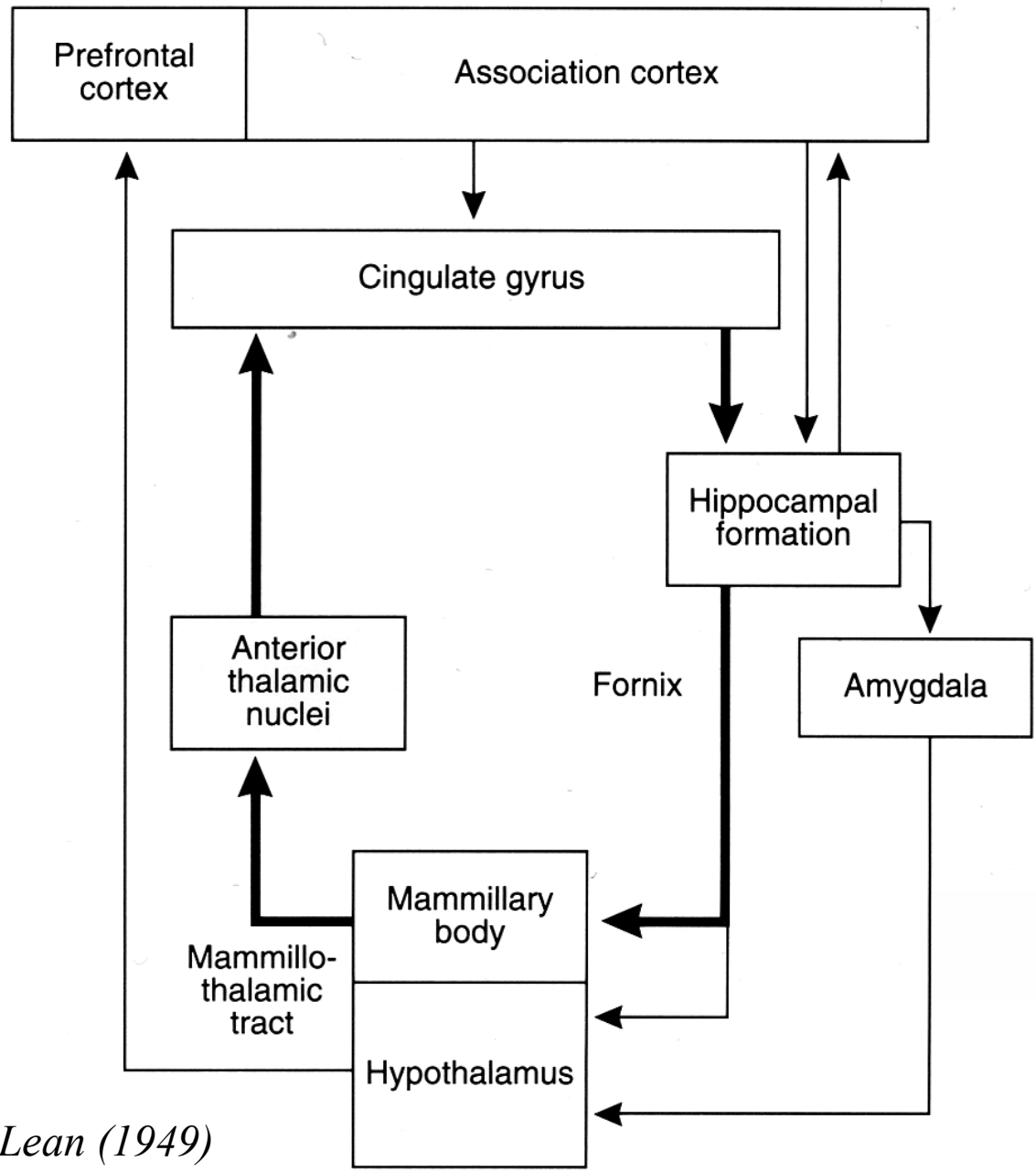


Hess (1932) / Delgado (1969)

The posterior hypothalamus was required for 'sham rage'



Papez's 'circuit of the emotions' (bold) and later additions



Papez (1937); MacLean (1949)

The amygdala

Klüver–Bucy syndrome

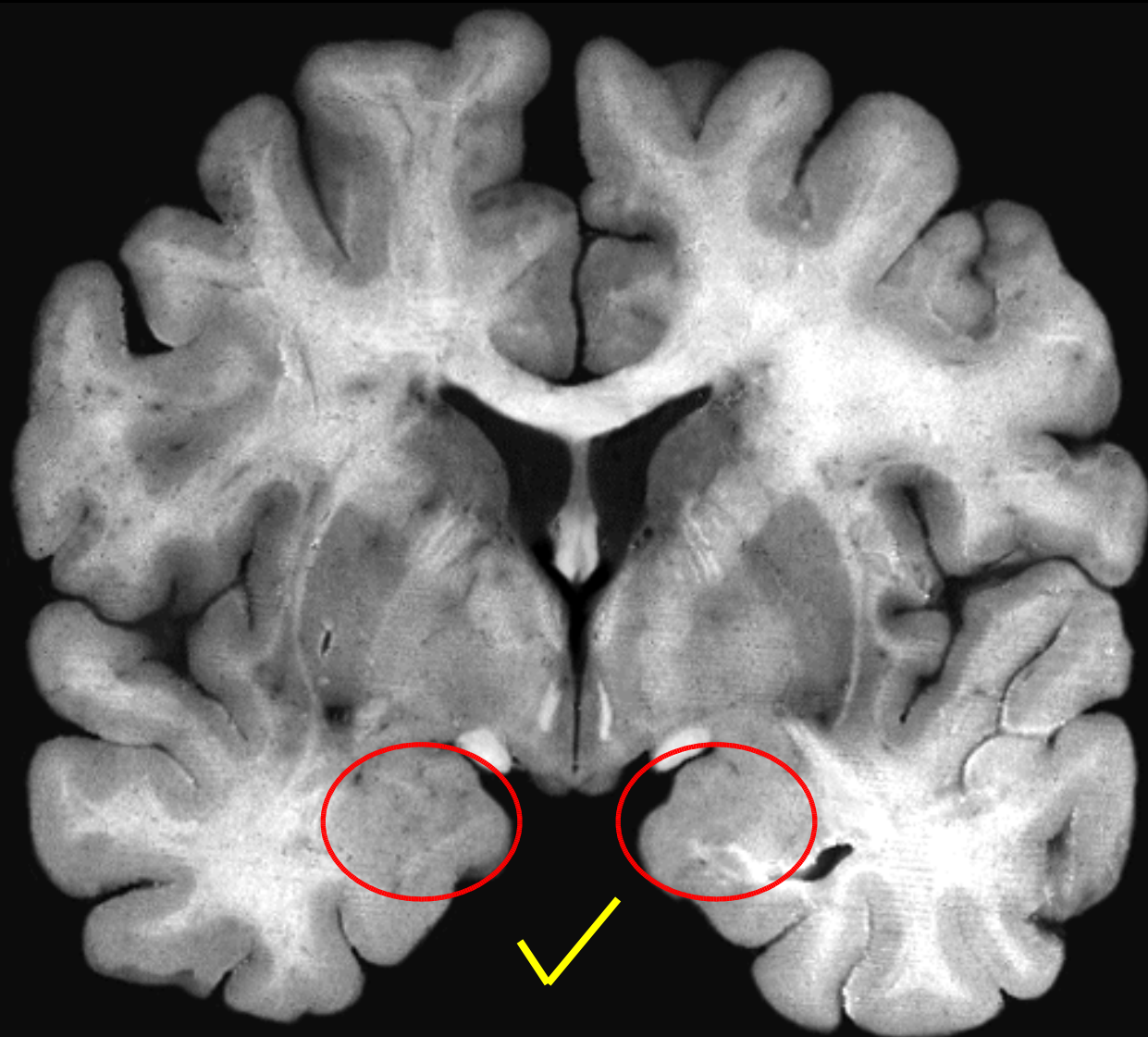
Bilateral temporal lobe resections in monkeys caused

- *tameness*
- *emotional unresponsiveness*
- *visual recognition problems*
- *hyperorality*
- *hypersexuality*

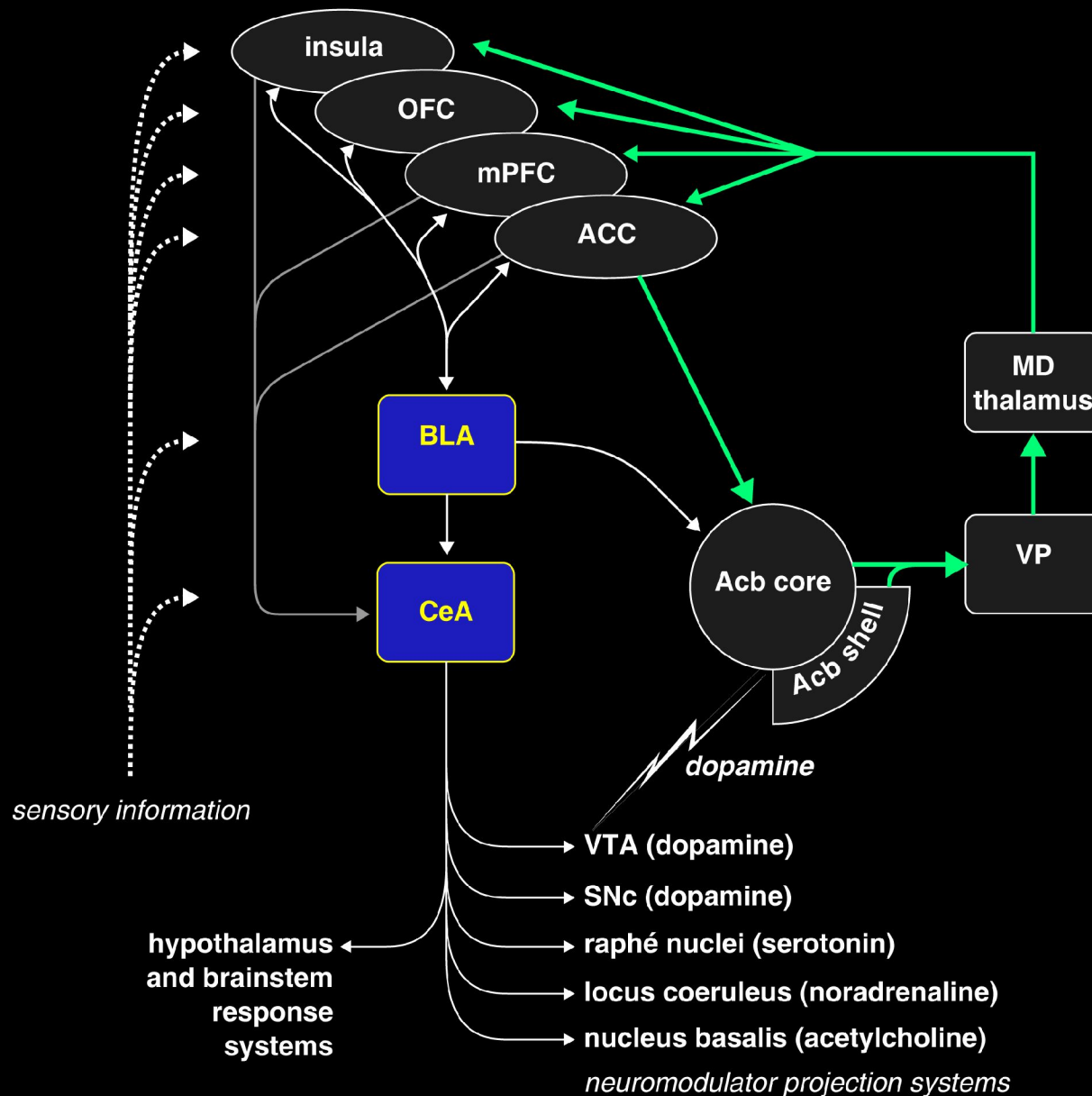
Klüver–Bucy syndrome has also followed similar damage in humans.

Pavements beware.

The amygdala



The amygdala within the limbic corticostriatal circuit



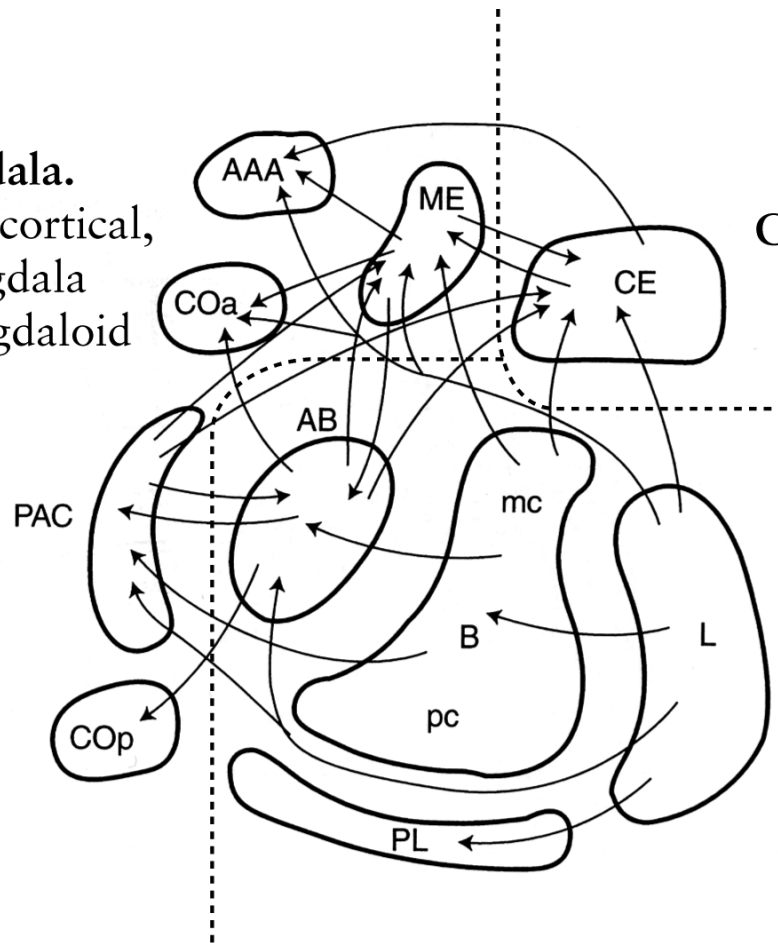
Subdivisions of the amygdala (rat brain shown)



Three main subdivisions of the amygdala

Corticomedial amygdala.

[ME = medial, CO = cortical, AAA = anterior amygdala area, PAC = periamygdaloid cortex.]

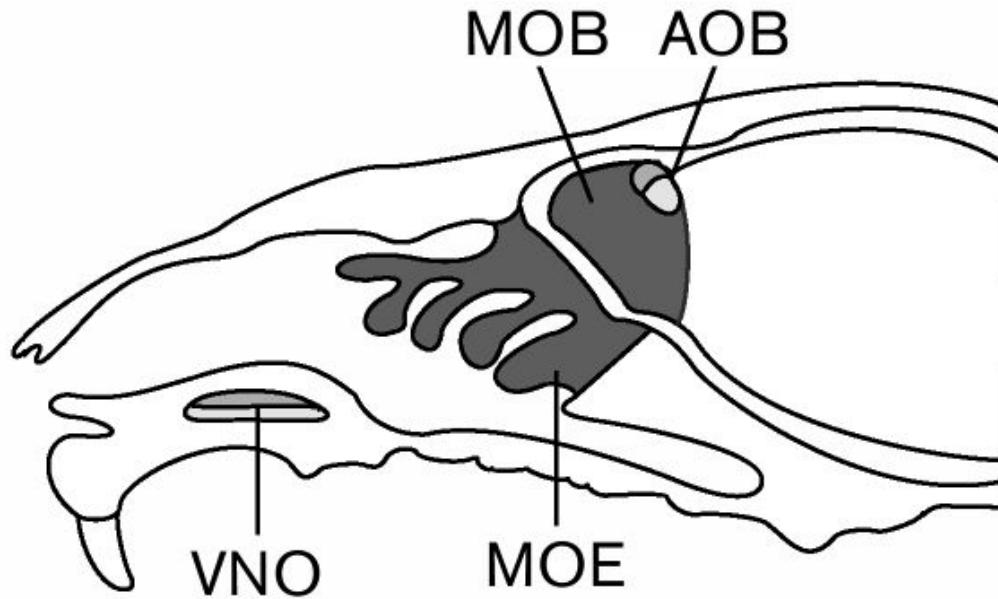


Central amygdala (CeA).

Basolateral amygdala (BLA).

[B = basal, L = lateral, AB = accessory basal, PL = paralamellar part of basal.]

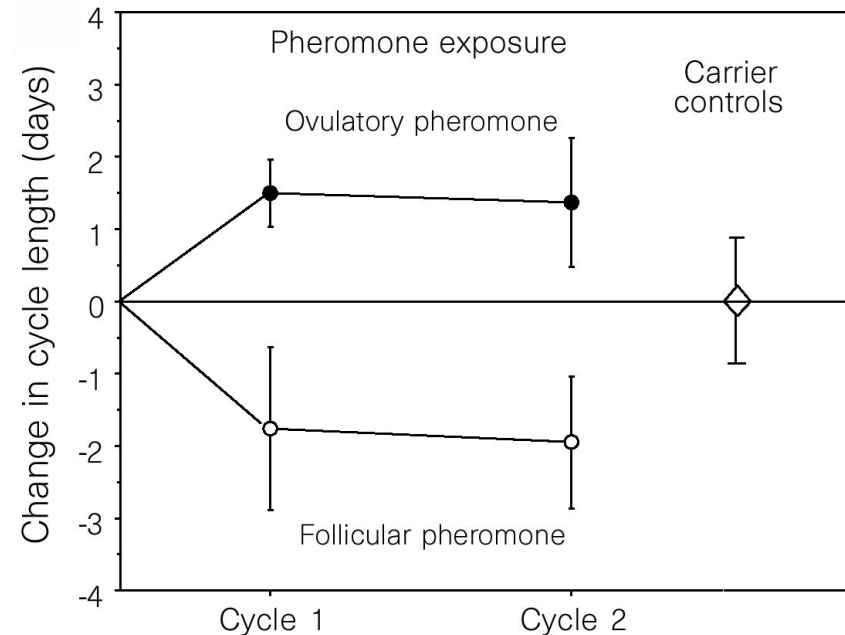
The corticomedial amygdala: olfaction, pheromones...



e.g. reproductive (sexual and maternal) behaviour in rats influenced by:

- pheromone from another rat*
- *vomerolateral organ (VNO)*
- *accessory olfactory bulb*
- ***corticomedial amygdala***
- *hypothalamus*

*Pheromones in humans:
regulation of menstrual cycle*

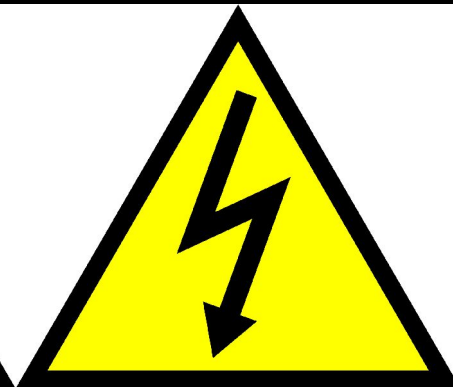


Numan & Sheehan (1997); Stern & McClintock (1998); Dulac (2000)

Aversive conditioning and the amygdala



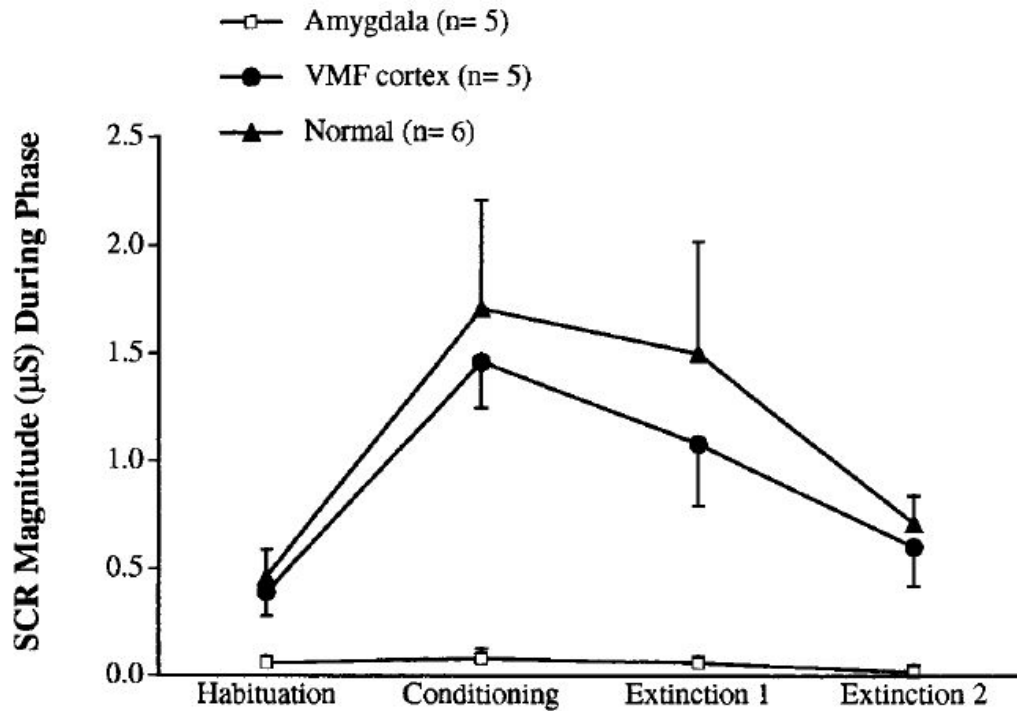
Rats



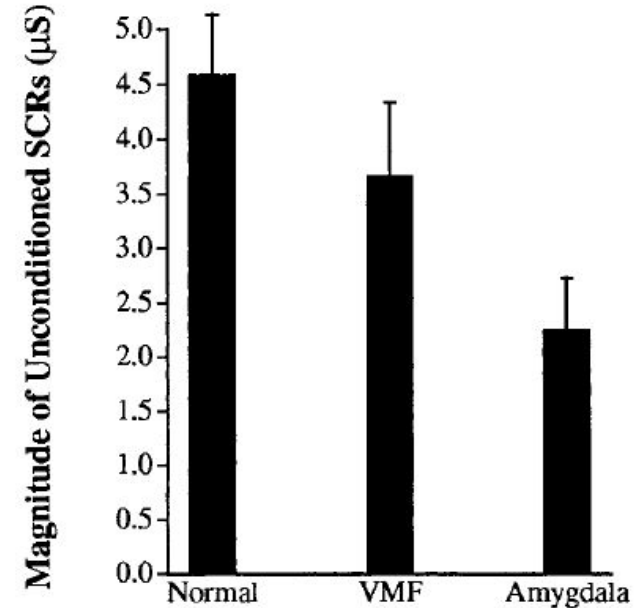
**Danger
High voltage**

Conditioned SCRs impaired by amygdala lesions in humans

Conditioned responses



Unconditioned responses



blue slide (CS) → foghorn (US)

Amygdala activated by fear conditioning in humans



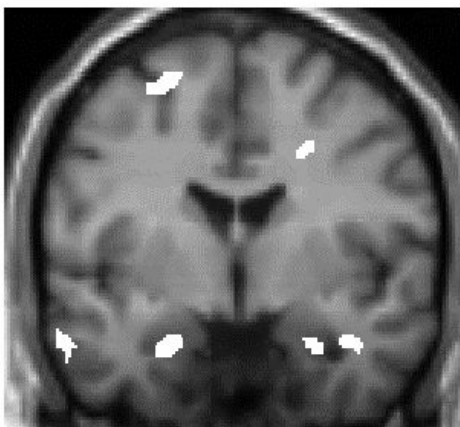
*face 1 (CS+) → loud noise (US)
versus control (unpaired) face stimuli*

*Also see amygdala activation with
colour (CS) → electric shock (US)*

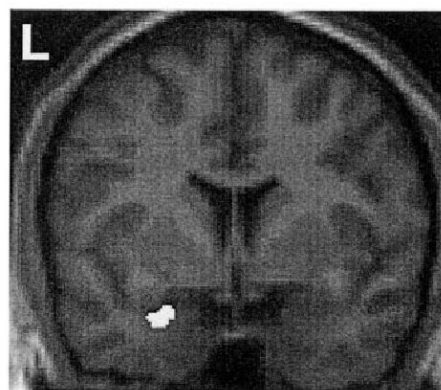


Anterior cingulate

Insulae

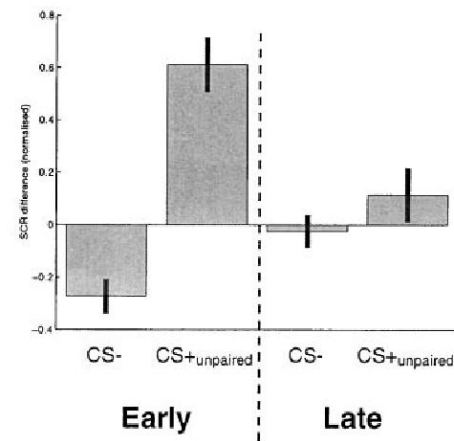


Amygdala

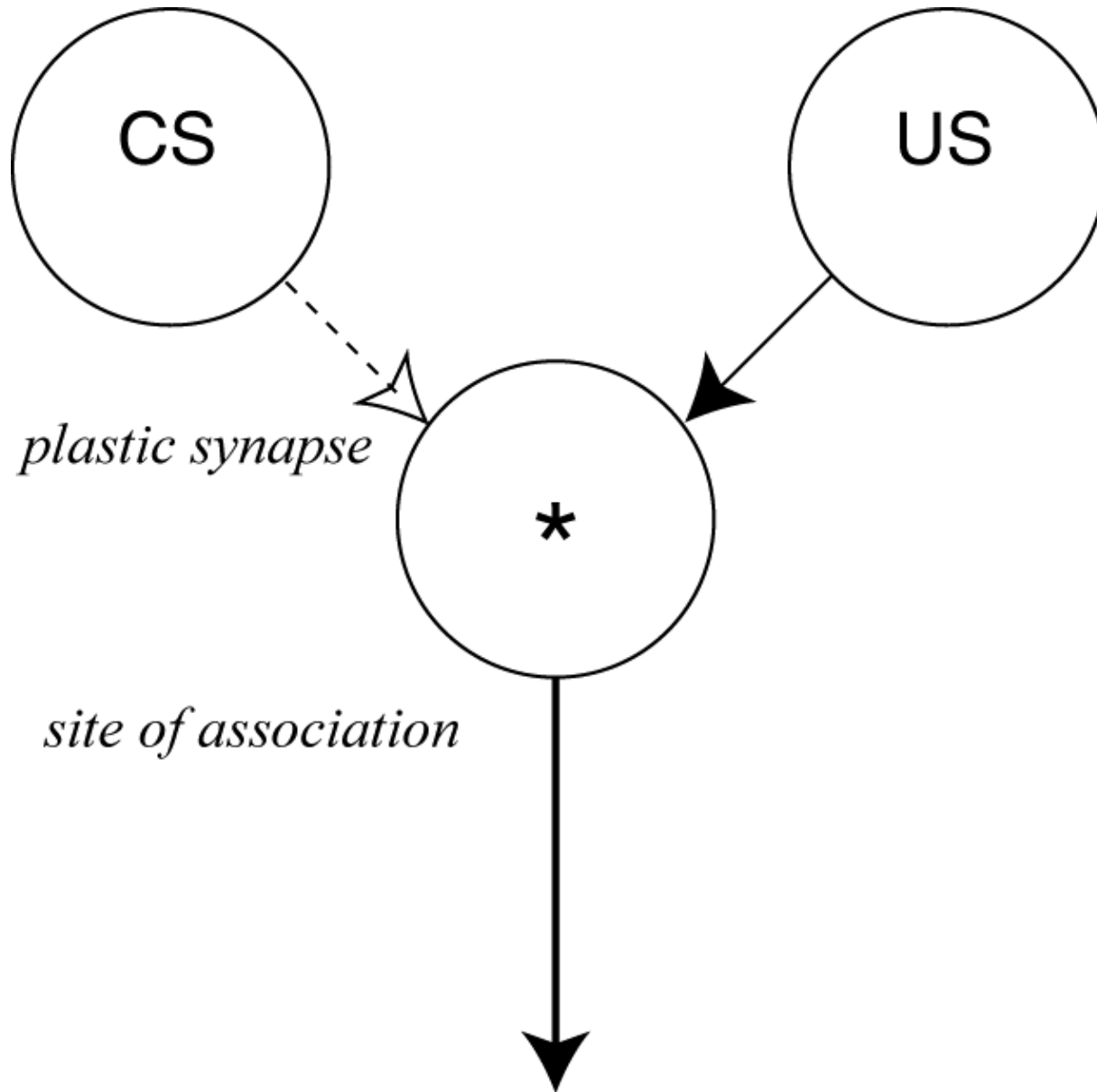


y = 3 mm

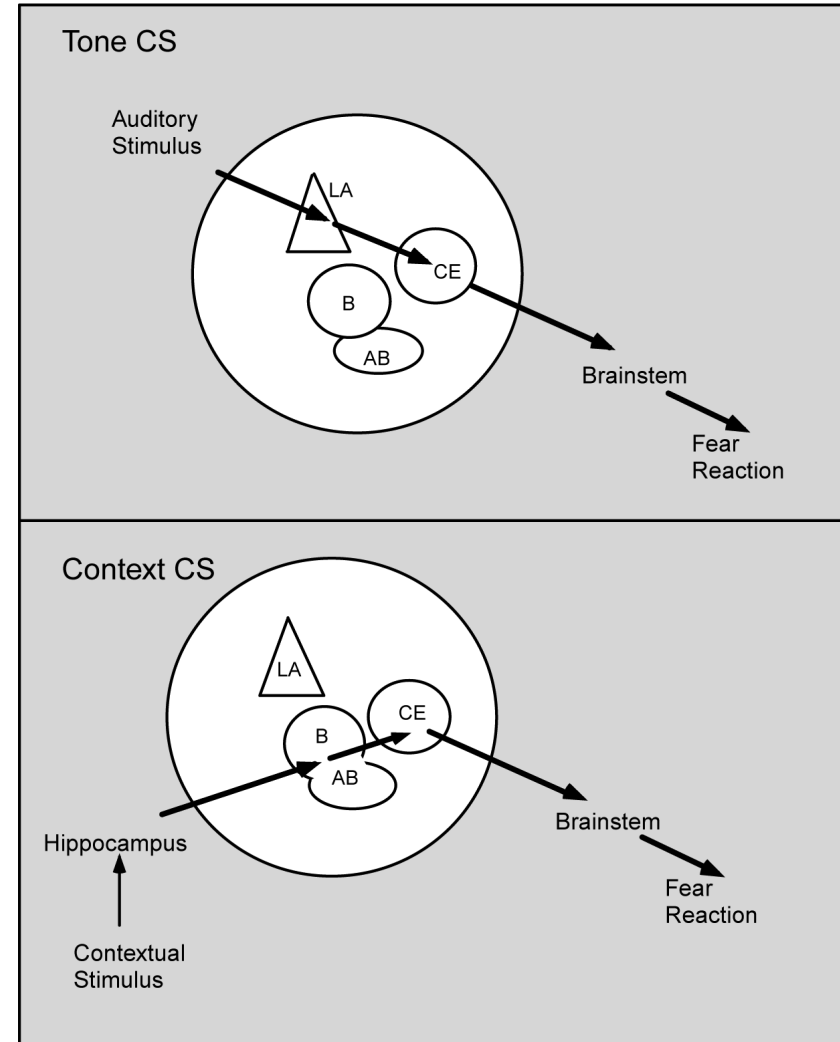
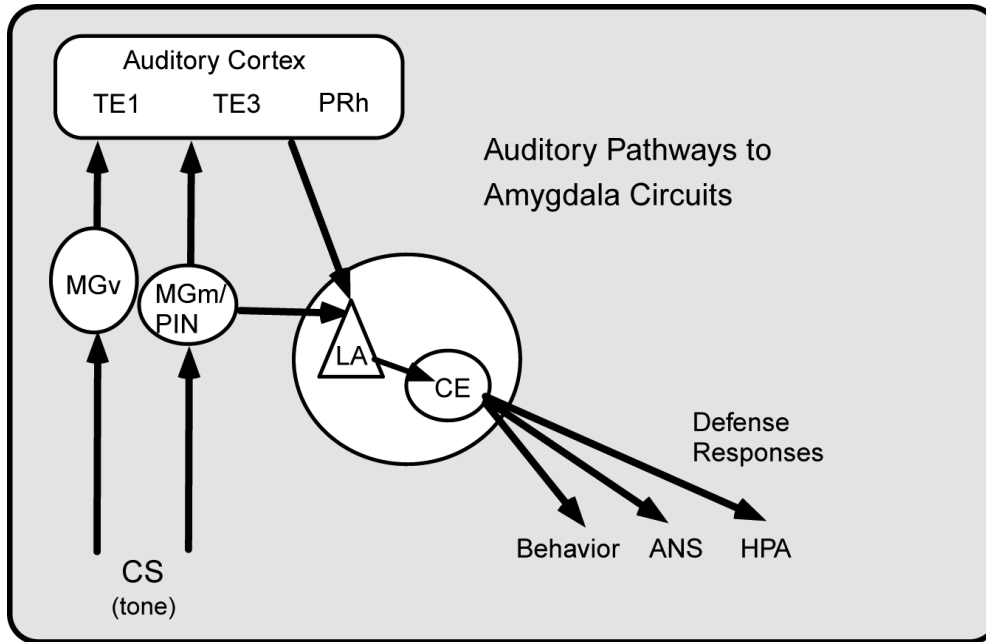
Interaction: SCR early versus late



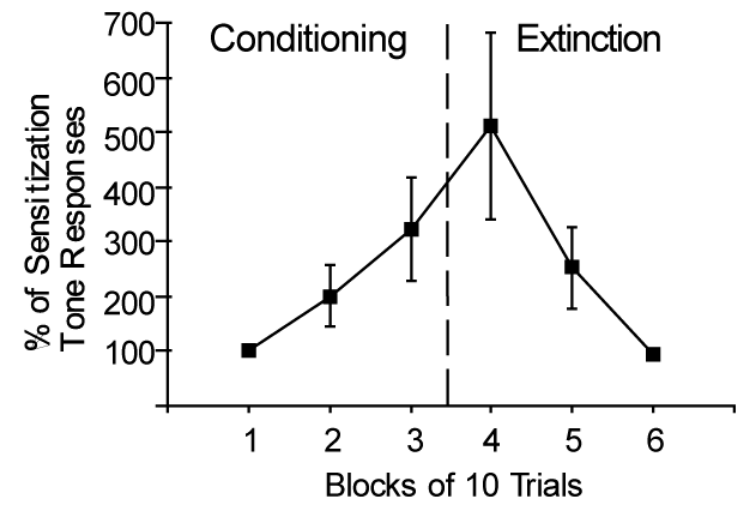
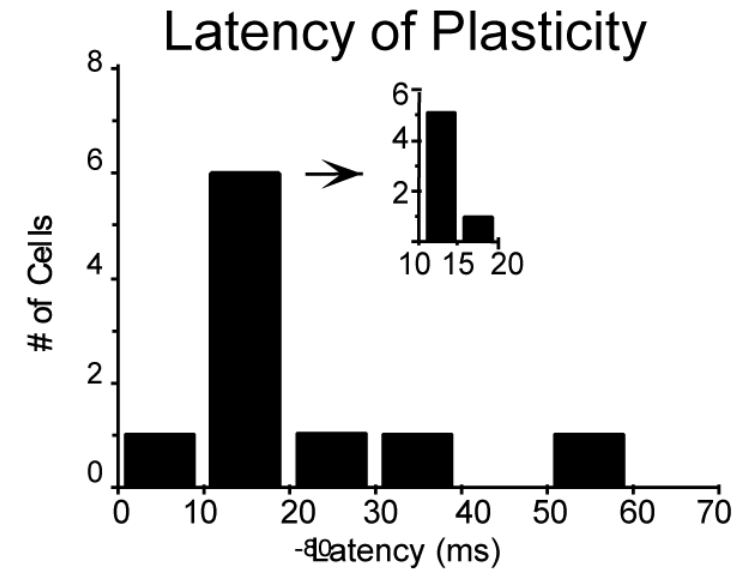
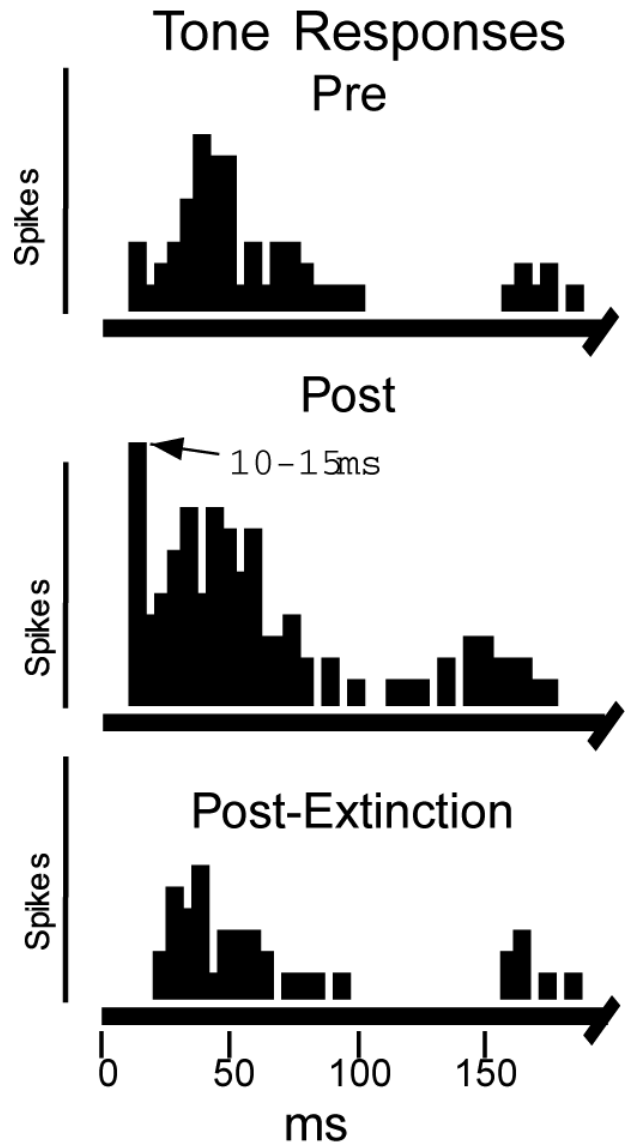
A cellular mechanism of Pavlovian conditioning



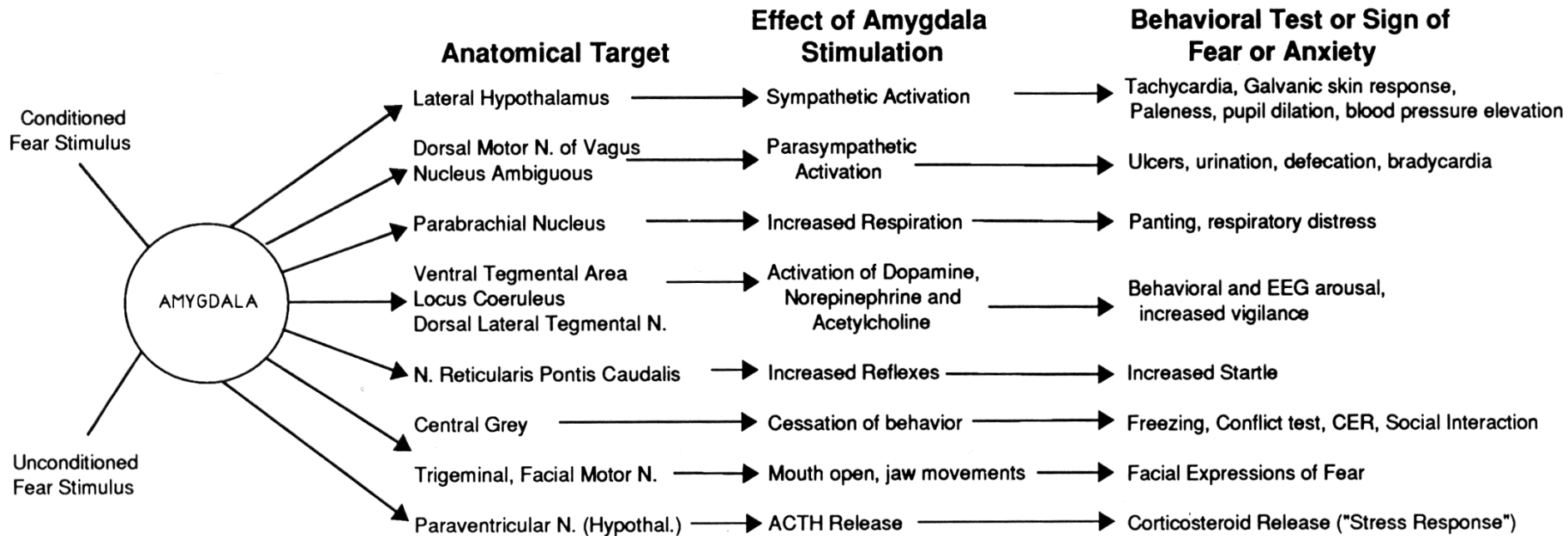
Conditioned freezing and the amygdala



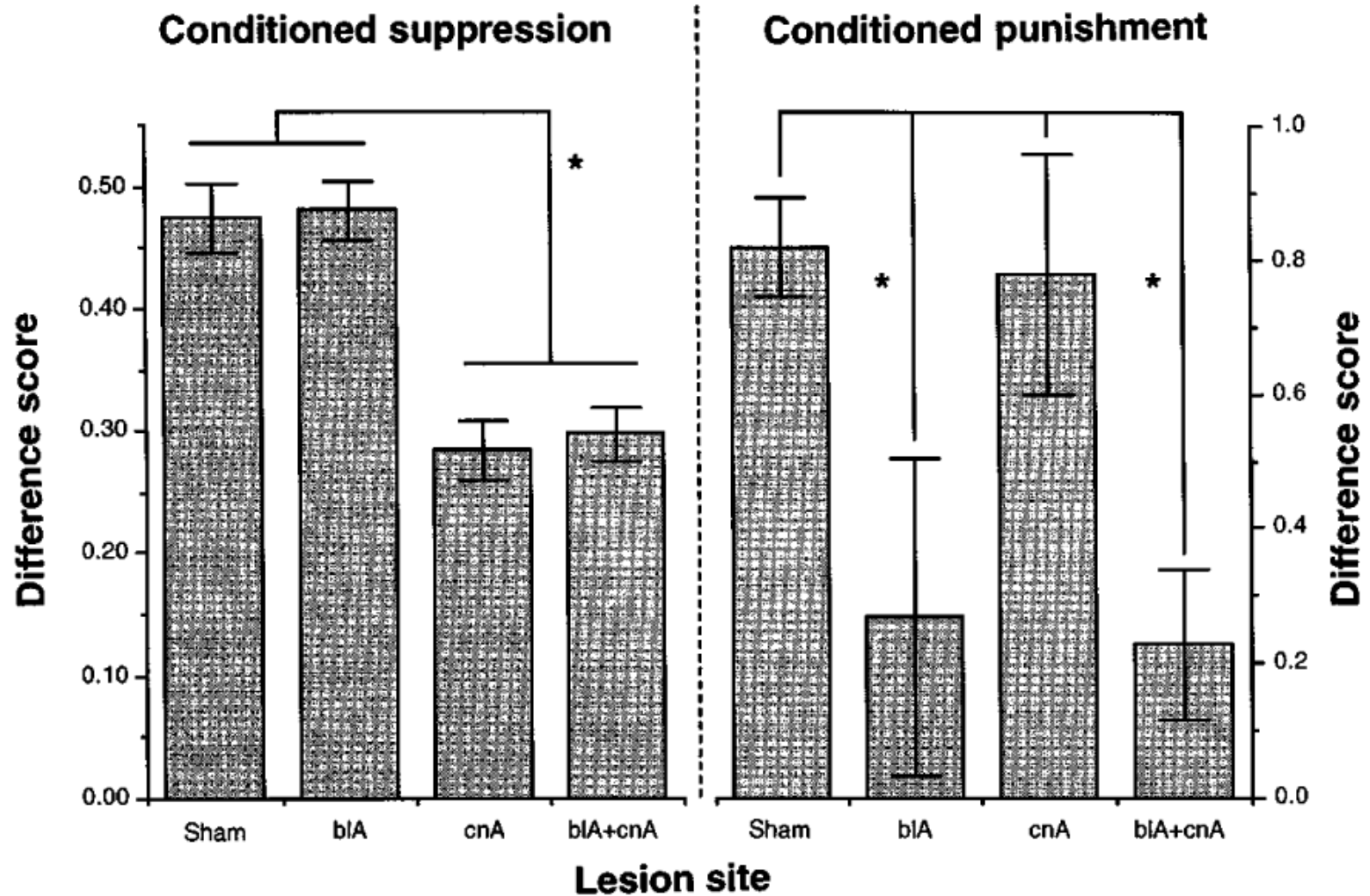
Synaptic plasticity in the BLA during CS-US pairing



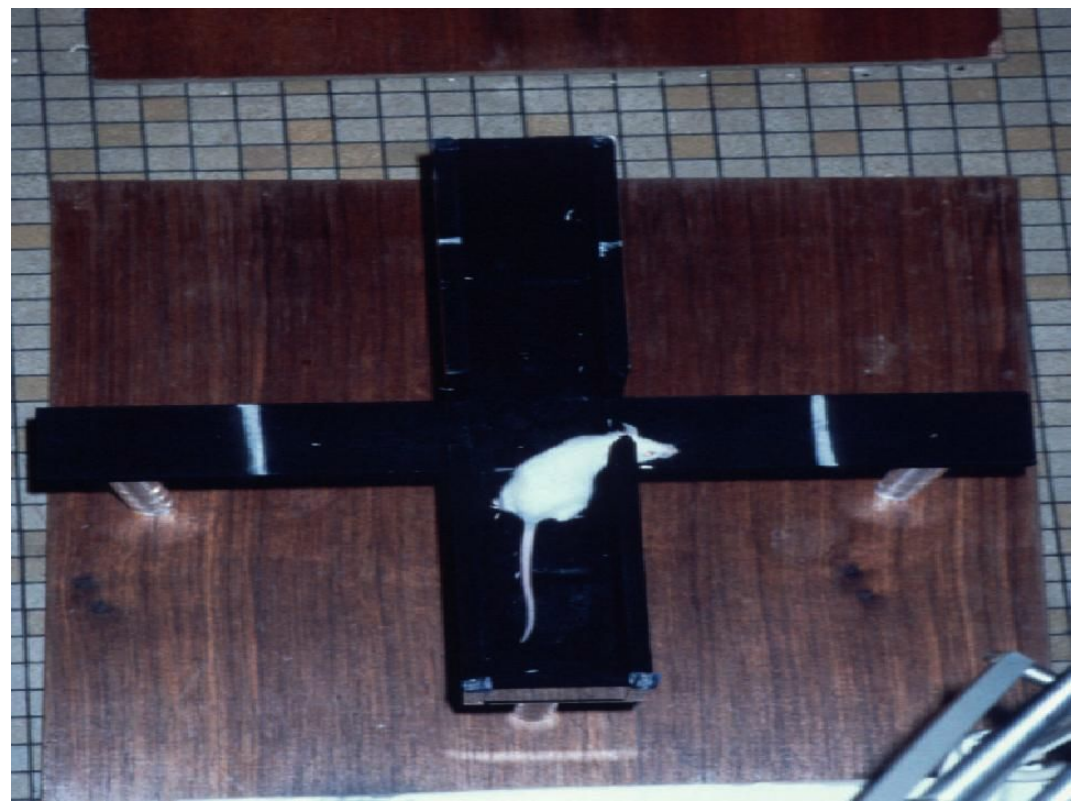
The CeA controls hypothalamic and brainstem targets



Double dissociation of BLA and CeA in aversive conditioning



Anxiolytic drugs and the amygdala



Memory modulation and the amygdala



1963 and 2001

Appetitive conditioning and the amygdala (1)

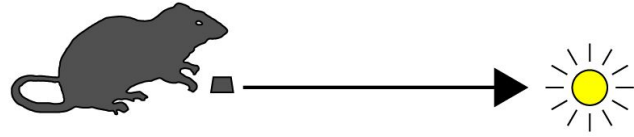
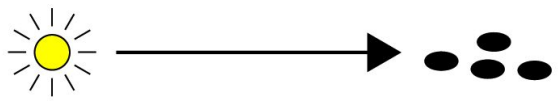


Many tests of acquired stimulus value need the amygdala

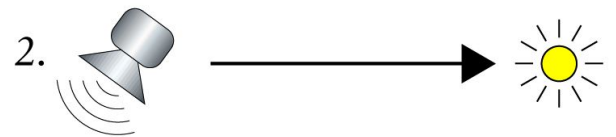
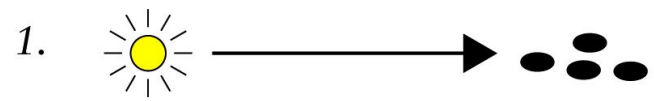
Training

Test

Conditioned reinforcement

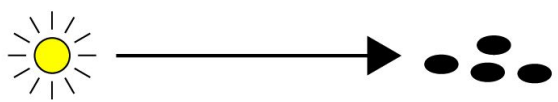


Second-order conditioning



*Acquisition
of these tasks
requires the
BLA*

Conditioned approach ("autoshaping")



*Requires the
CeA*

... for example, second-order conditioning needs the BLA

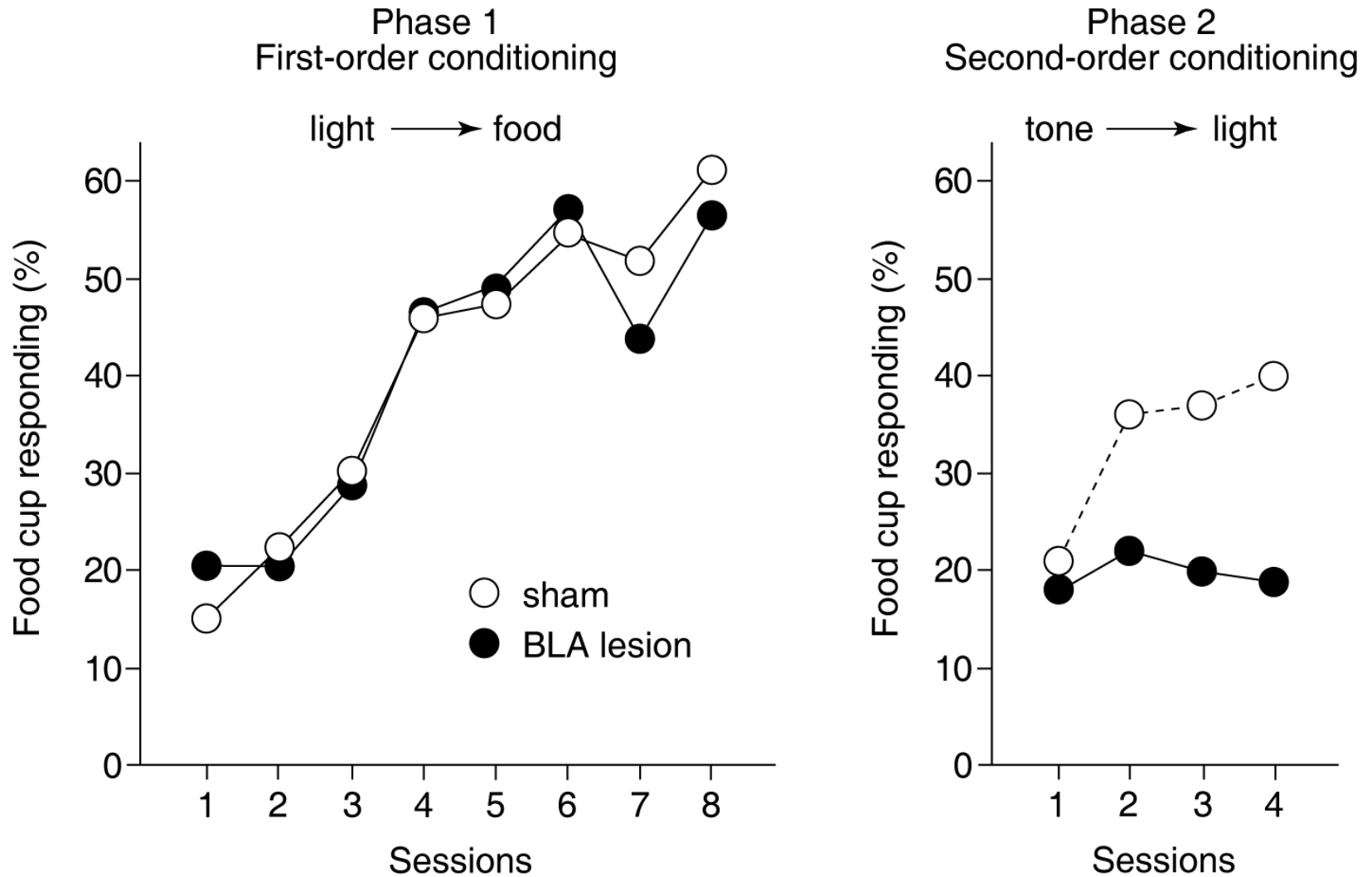
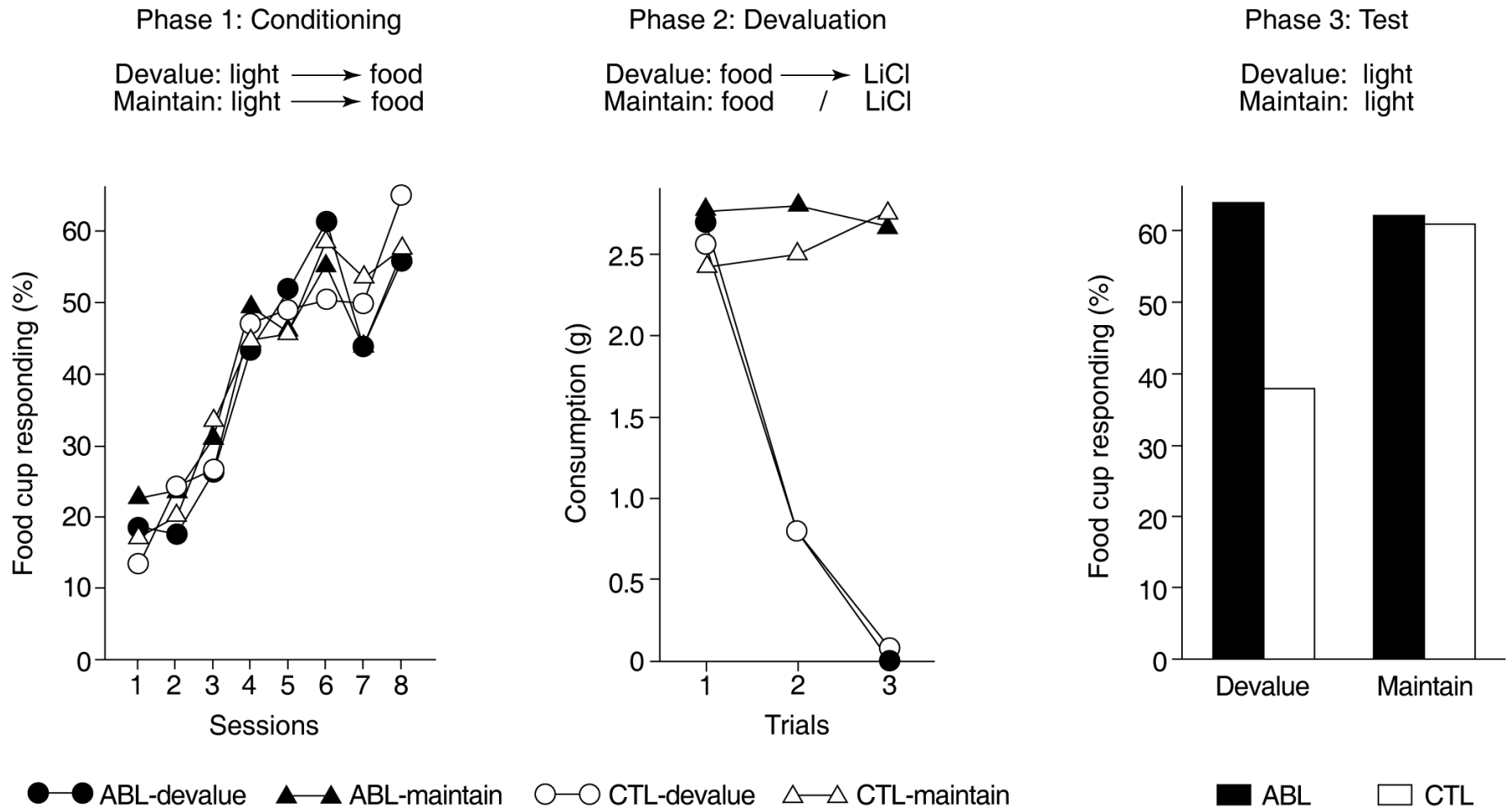


figure from Holland & Gallagher (1999)

Changing the conditioned response when the US is devalued

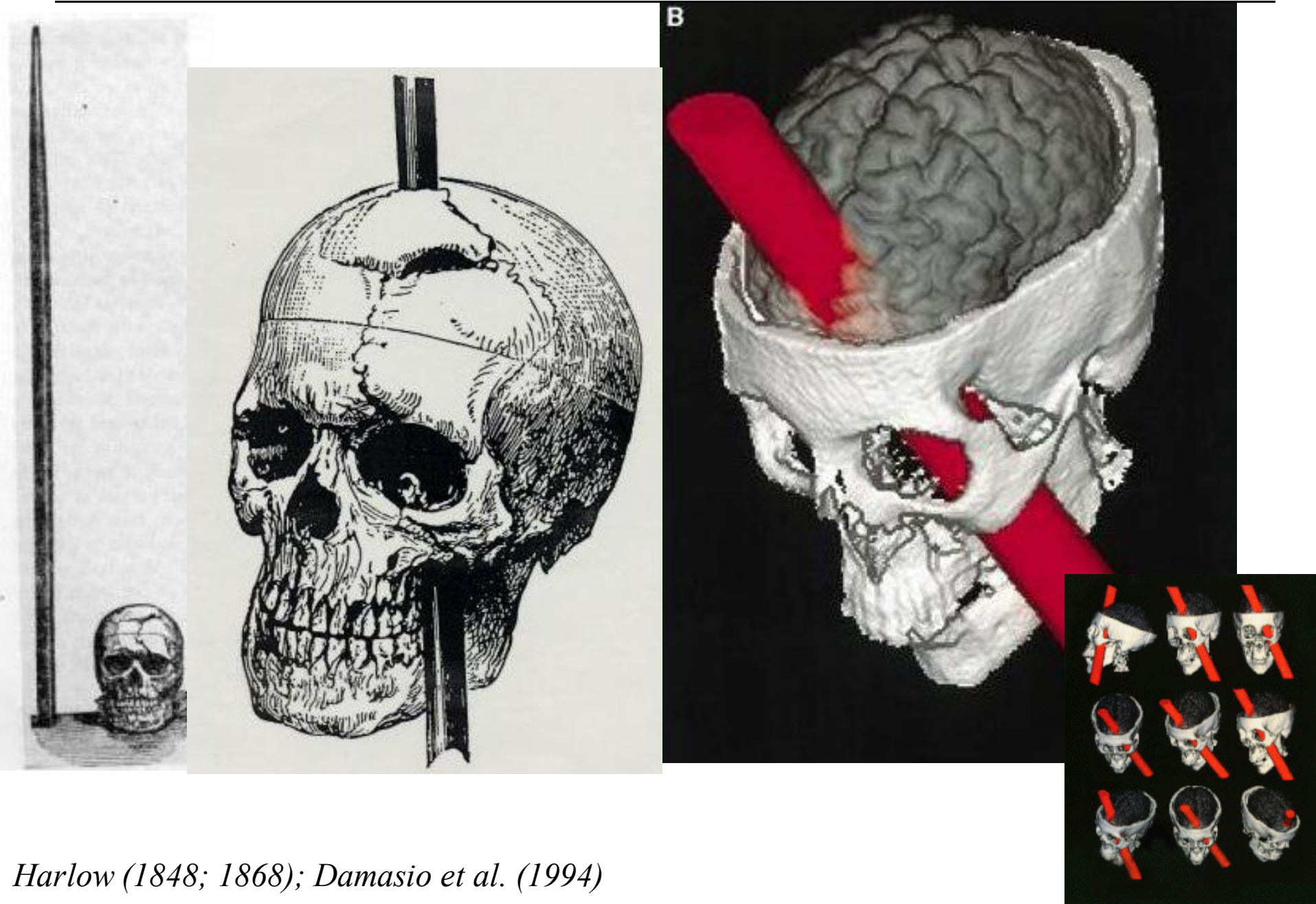


The amygdala: summary

- 1. The BLA is required to change the motivational value of a CS. (It uses this to control **choice** behaviour, and some other behaviours such as freezing.)*
- 2. The CeA is a controller of brainstem structures (for the BLA). It also learns some simple 'emotional' conditioned responses, but doesn't affect choice.*
- 3. The BLA also has a role in modulating memory storage.*
- 4. The CeA also has a role in attention.*

Orbitofrontal cortex

Orbitofrontal damage: the case of Phineas Gage



Harlow (1848; 1868); Damasio et al. (1994)

Orbitofrontal damage: the case of Phineas Gage



Orbitofrontal damage: the case of Phineas Gage



Earl Miller (a prefrontal cortex researcher) with the tamping iron

The Iowa gambling task

GAMBLING TASK

“Bad” Decks

“Good” Decks

A

B

C

D

Payoff /Card

\$100

\$100

\$ 50

\$ 50

Loss /10 Cards

\$1250

\$1250

\$250

\$250

Profit/10 Cards

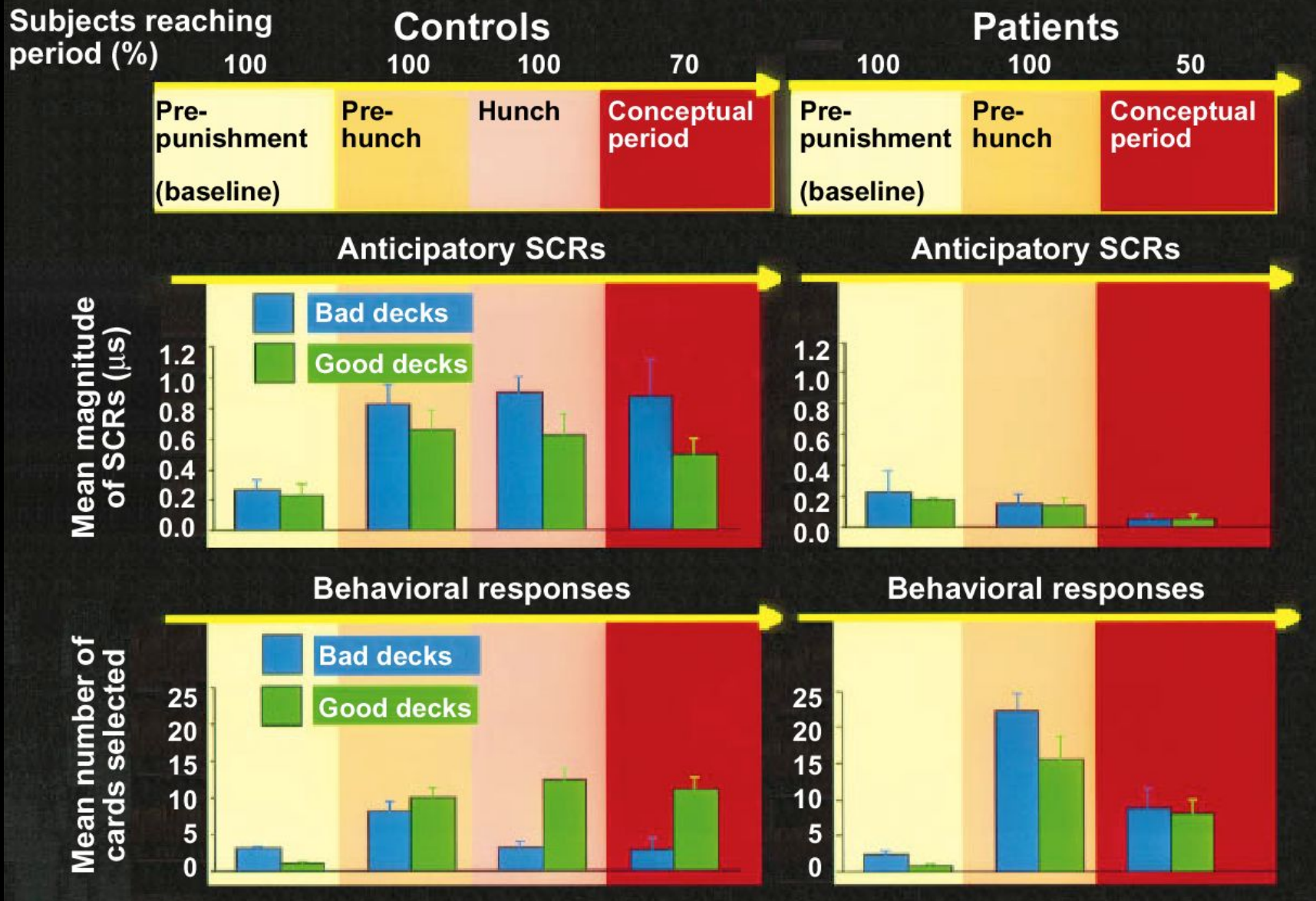
-\$250

-\$250

\$250

\$250

Anticipatory SCRs precede knowledge



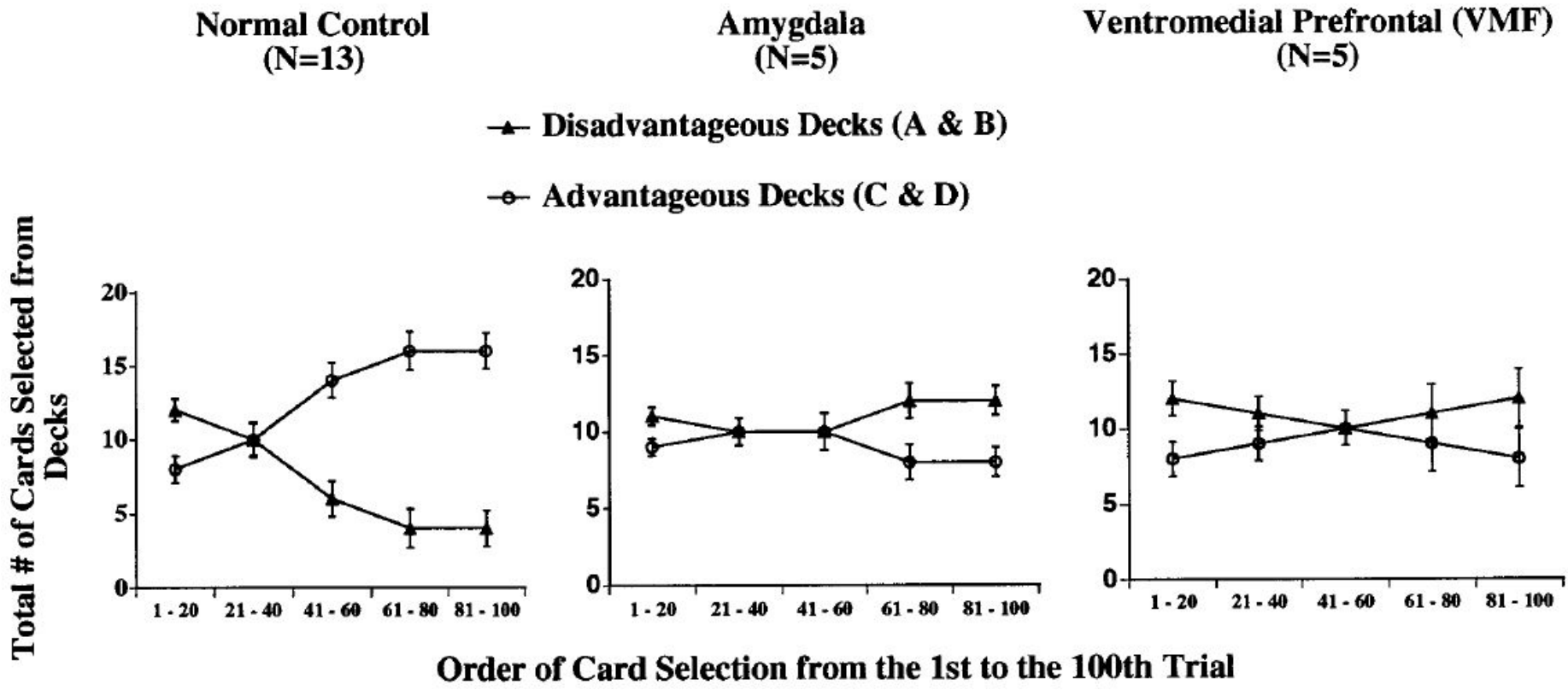
Bechara et al. (1997); normals and patients with ventromedial PFC (OFC) damage

“He chose poorly.”

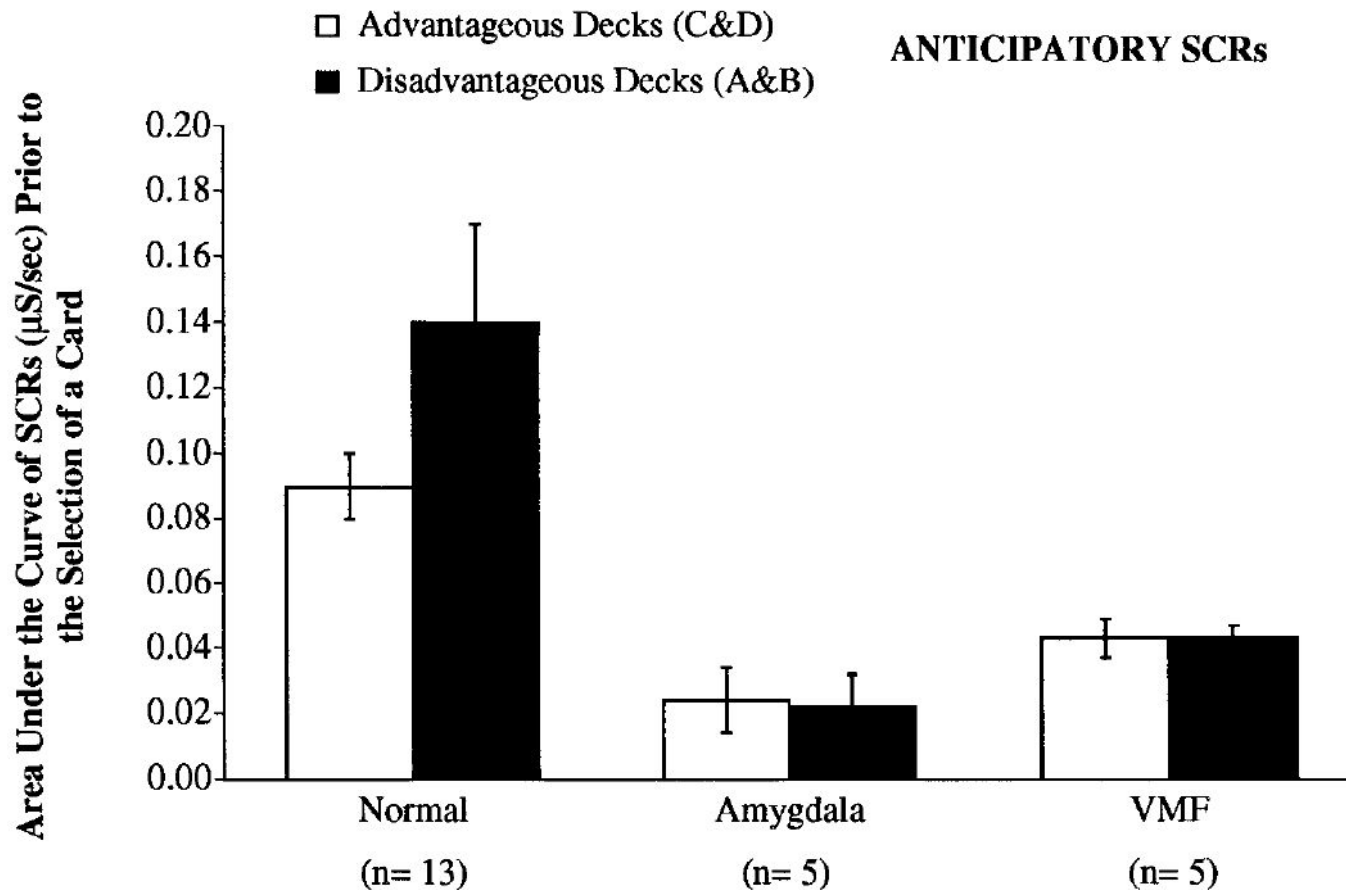


Spielberg (1989): 'Indiana Jones and the Last Crusade'

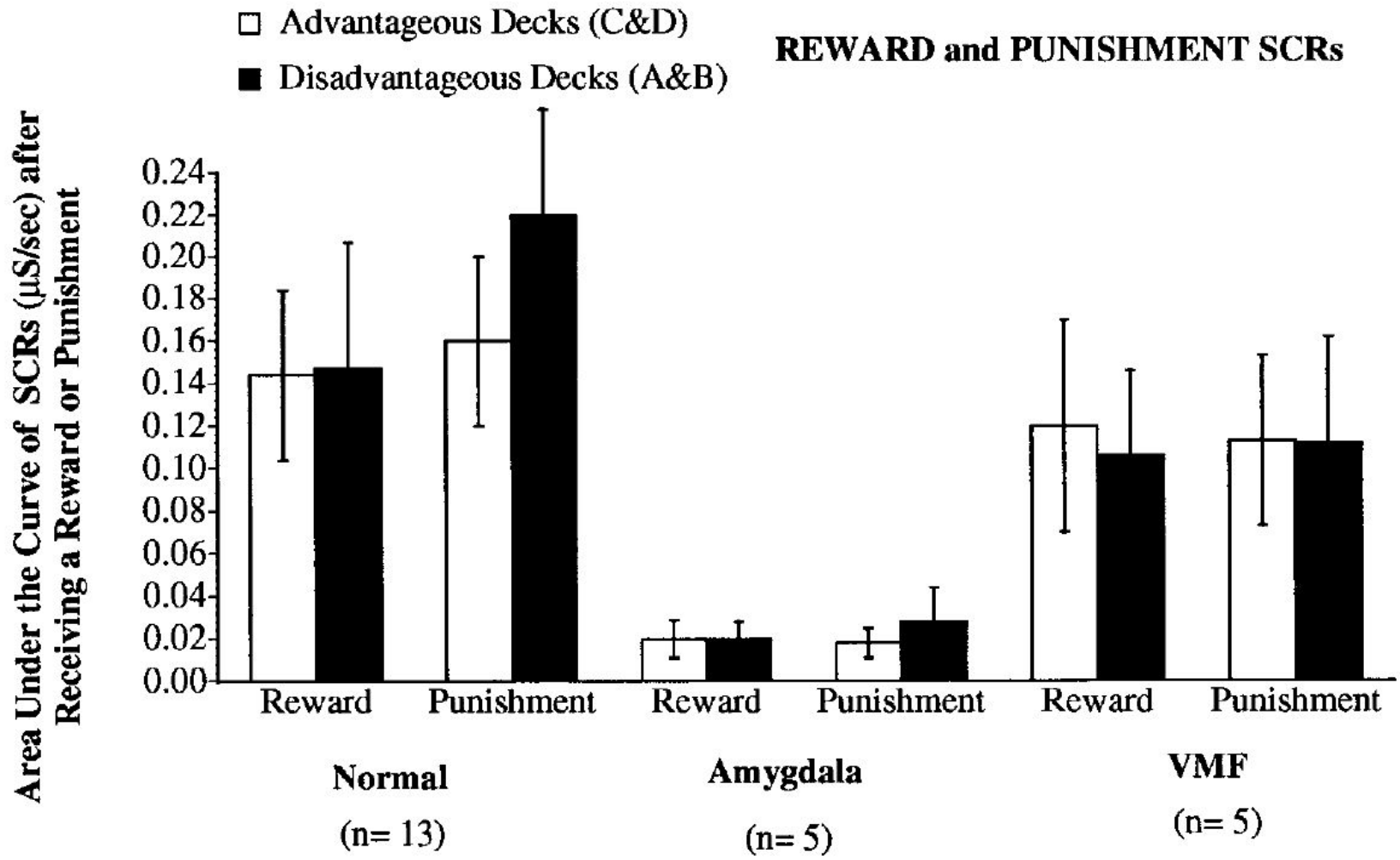
OFC and amygdala lesions on the Iowa gambling task (1)



OFC and amygdala lesions on the Iowa gambling task (2)

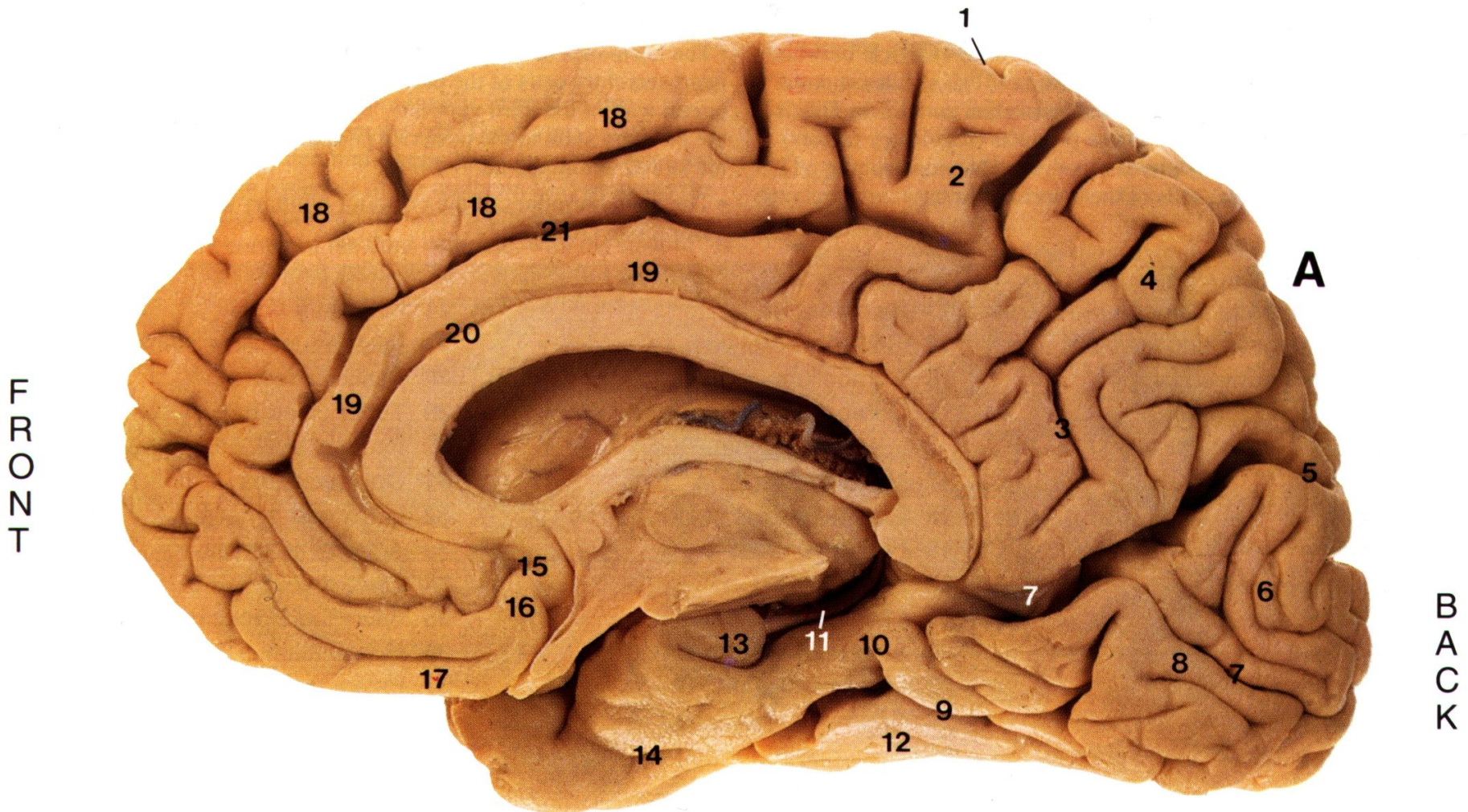


OFC and amygdala lesions on the Iowa gambling task (3)



Anterior cingulate cortex

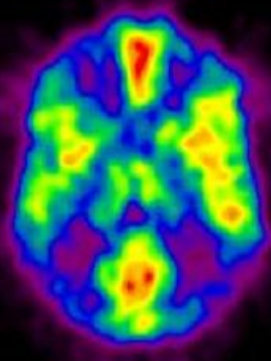
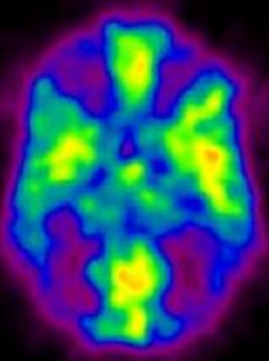
Cingulate cortex



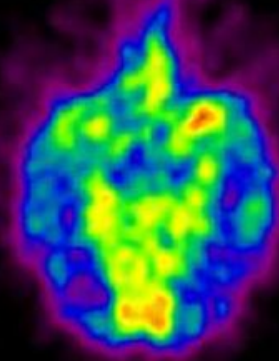
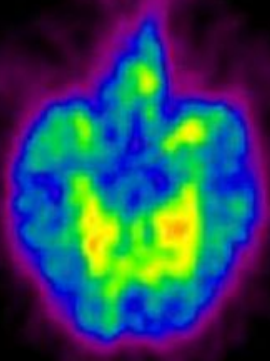
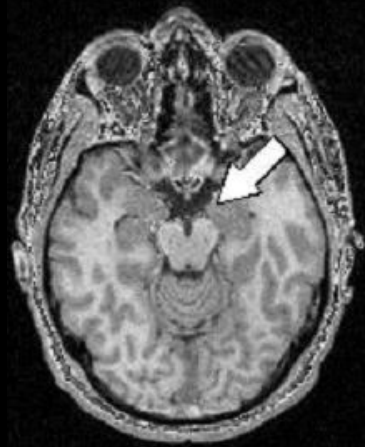
(The numbers don't mean anything!)

Sexual stimuli activate the ACC

Anterior Cingulate



Amygdala

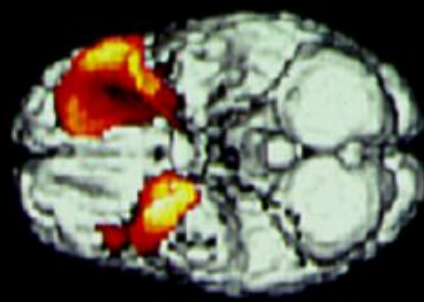


Nature Video

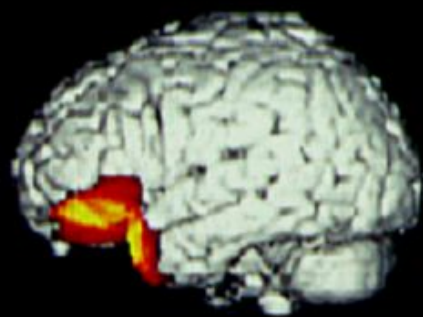
Sexual Video

Cue-induced cocaine craving activates the ACC and OFC

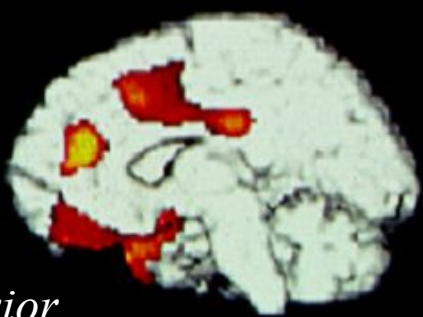
Cocaine addicts watching a cocaine video; activations correlated with subjective reports of craving



*medial temporal lobe
— amygdala*



OFC



ACC

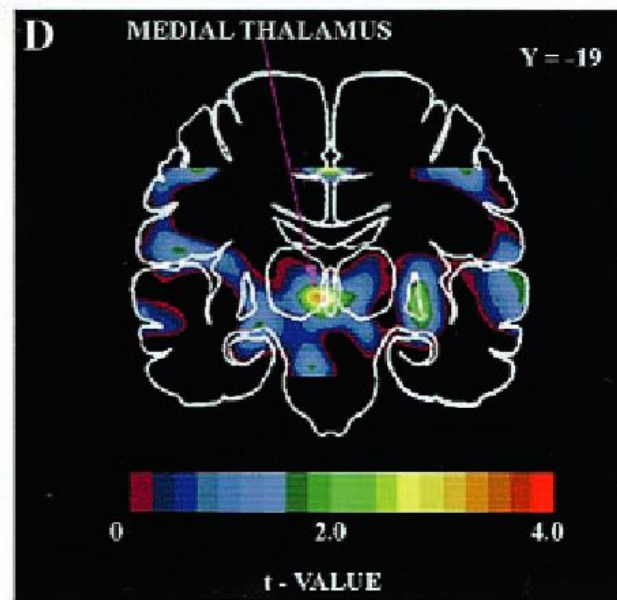
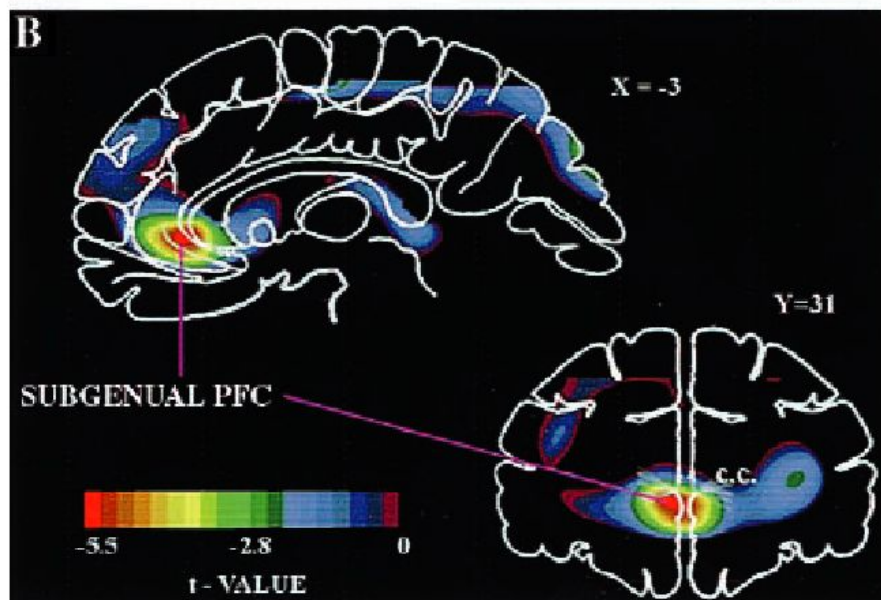
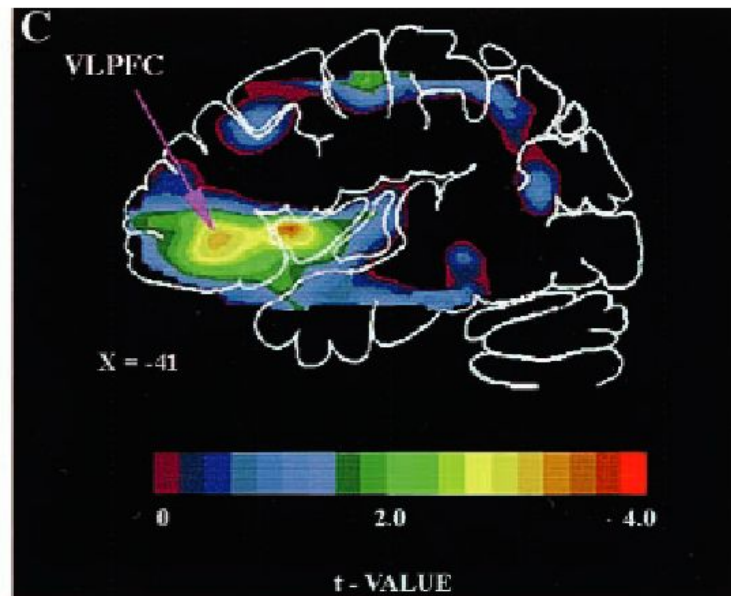
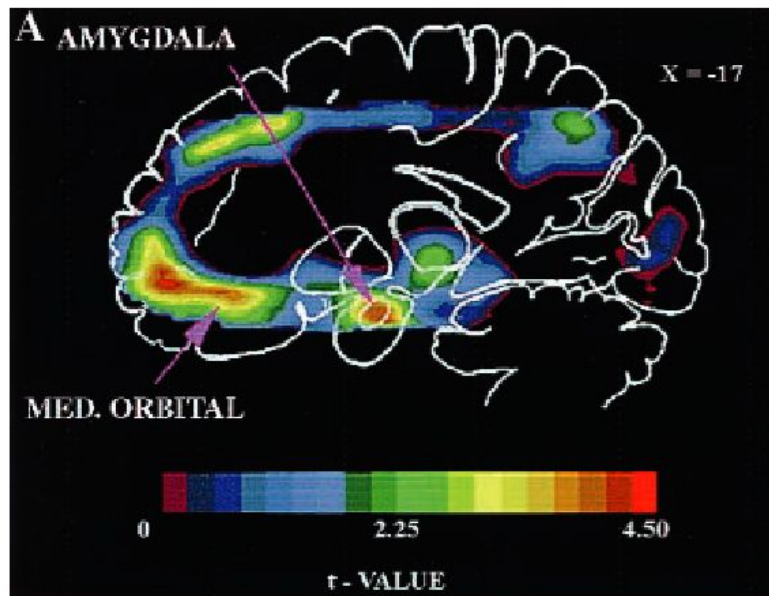
anterior

posterior



Above photos (and others in following articles) courtesy of Inspector Richard Groves, Community Involvement and Crime Prevention Branch, New Scotland Yard.

ACC hyperactivity in depression



ACC

