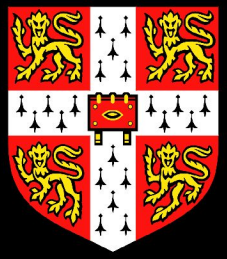
*NST IB Psychology*

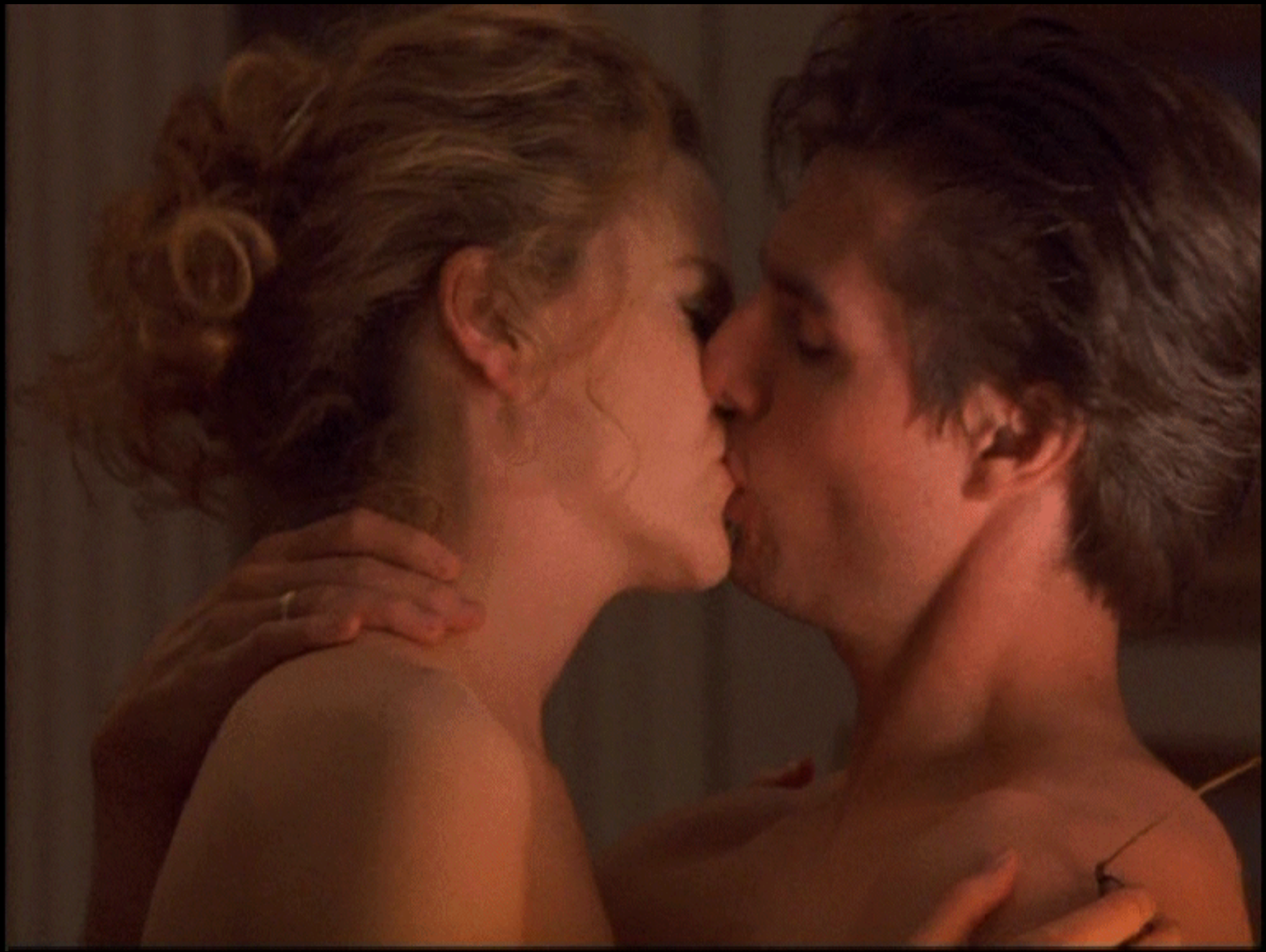
# Emotion and motivation – 3

## Psychological basis and neurobiology of motivation

**Rudolf Cardinal**
Department of Experimental Psychology



*Thursday 6, Saturday 8, Tuesday 11 March 2003; 11am*
*Lecture Theatre 3, Physiology*

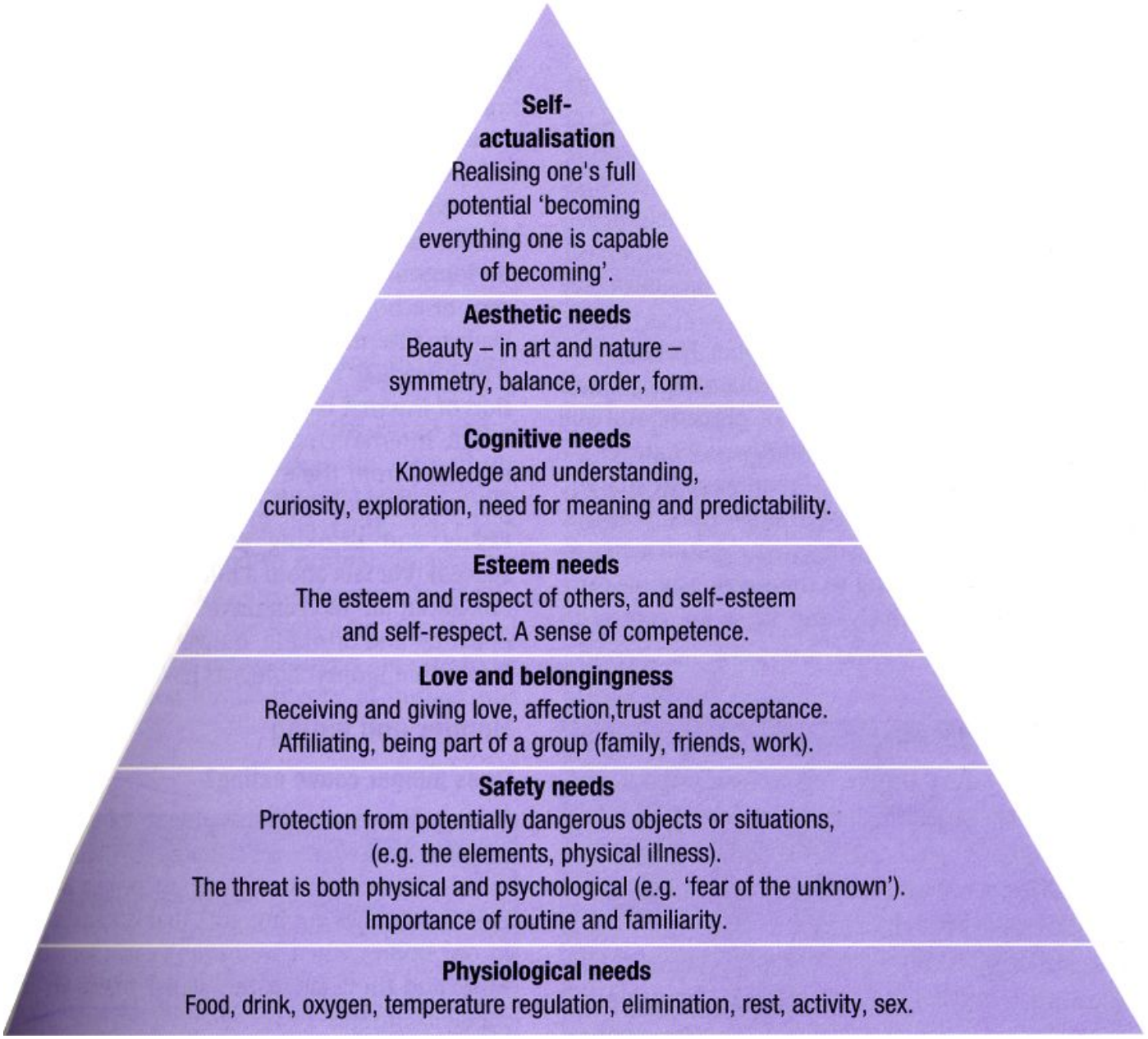


*Kubrick (1999): ‘Eyes Wide Shut’*

*Demme (2001): 'Blow'*

# *Theories of motivation*

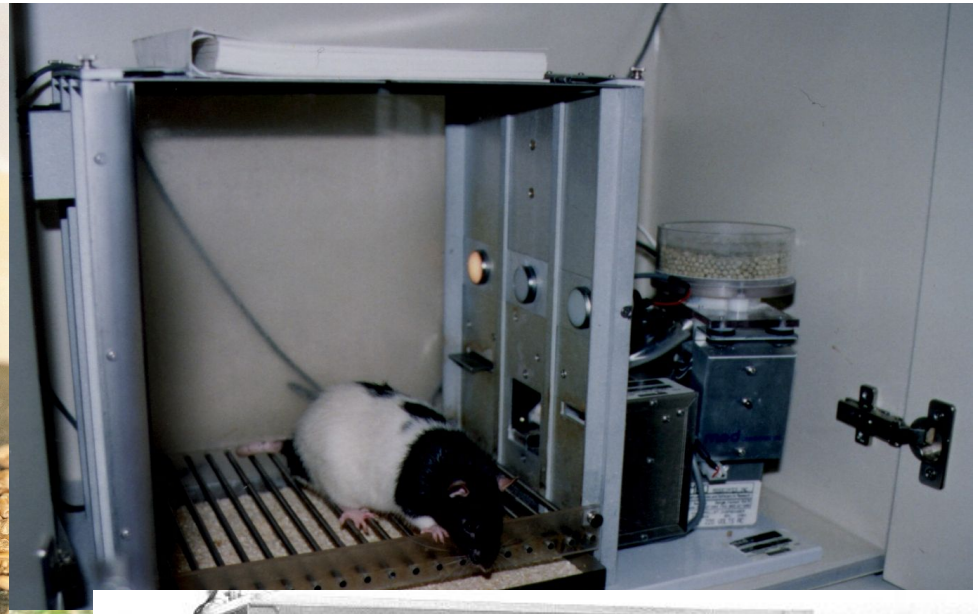
# Maslow's 'hierarchy of needs' — not very helpful

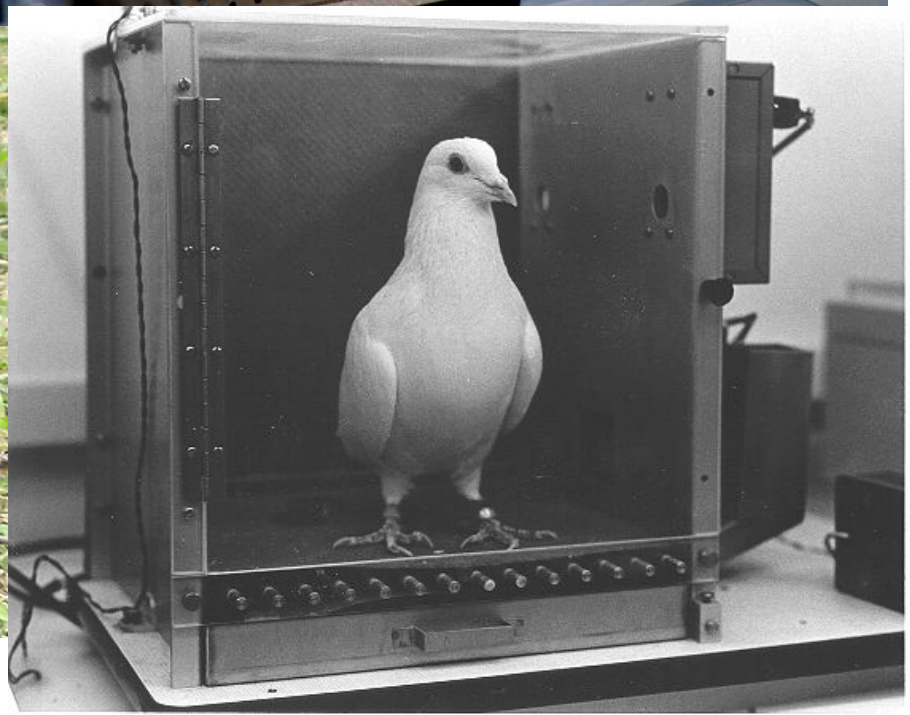



*Maslow (1954)*

*Manigault (1909) 'The Rocket'*

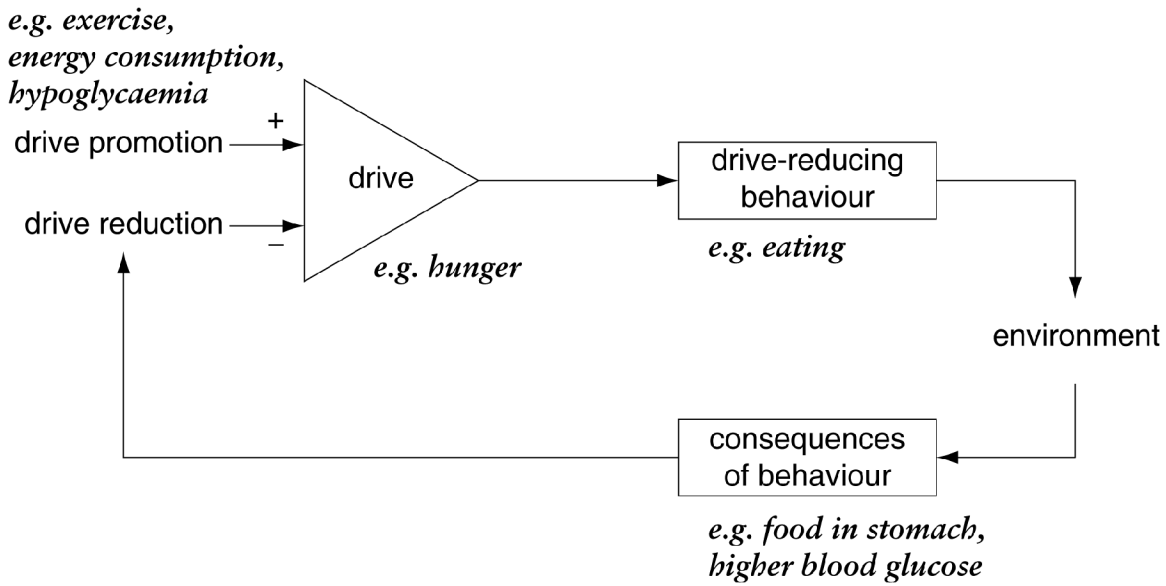
# Behaviourism: positive and negative reinforcement





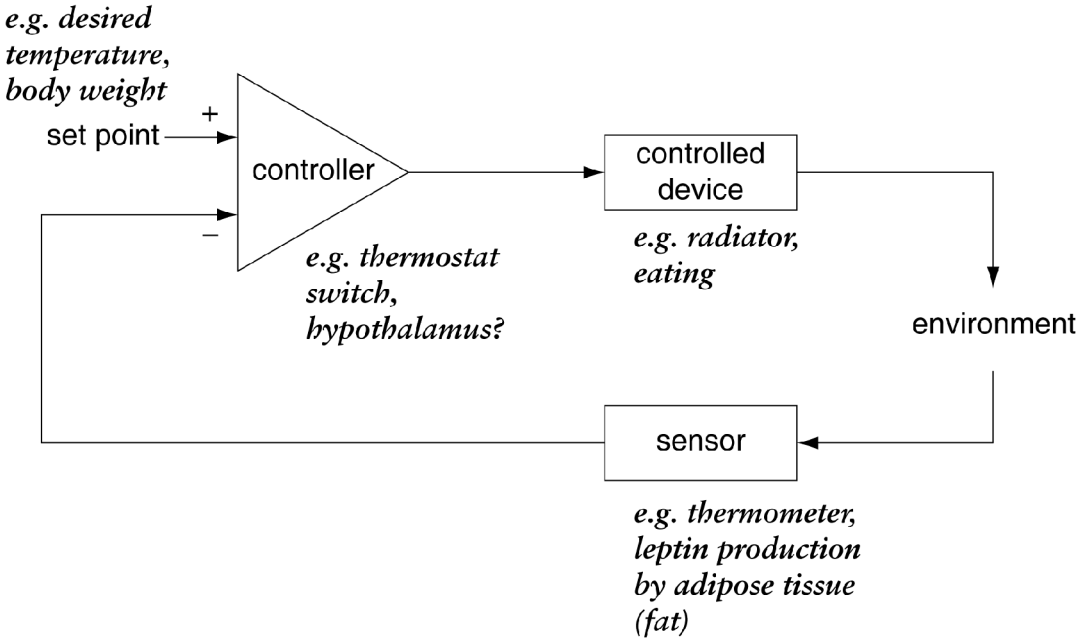
*e.g. Skinner (1938)*

# Motivational states, drives, homeostasis




*Hull (1943): events that reduce 'drives' are reinforcing.*

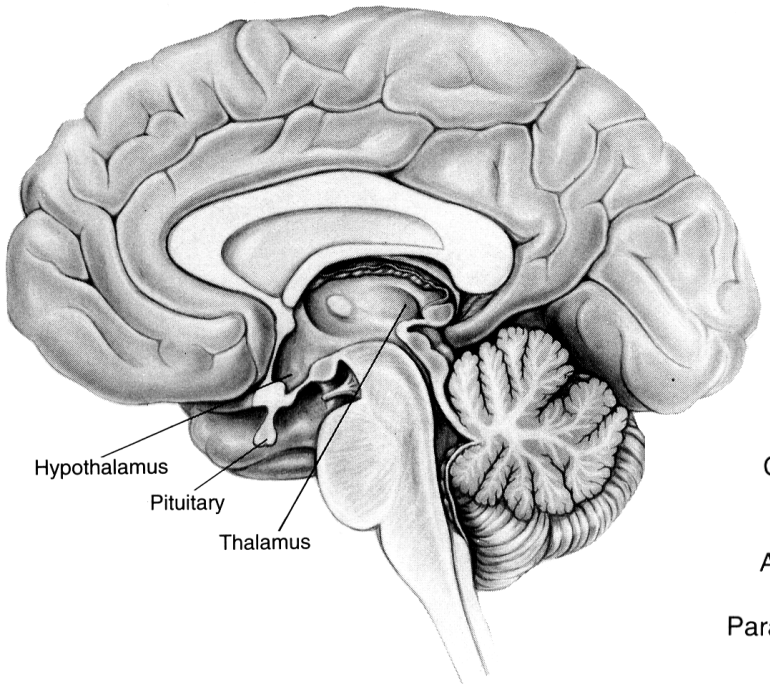
*Homeostasis (a term coined by Cannon). Negative feedback.*

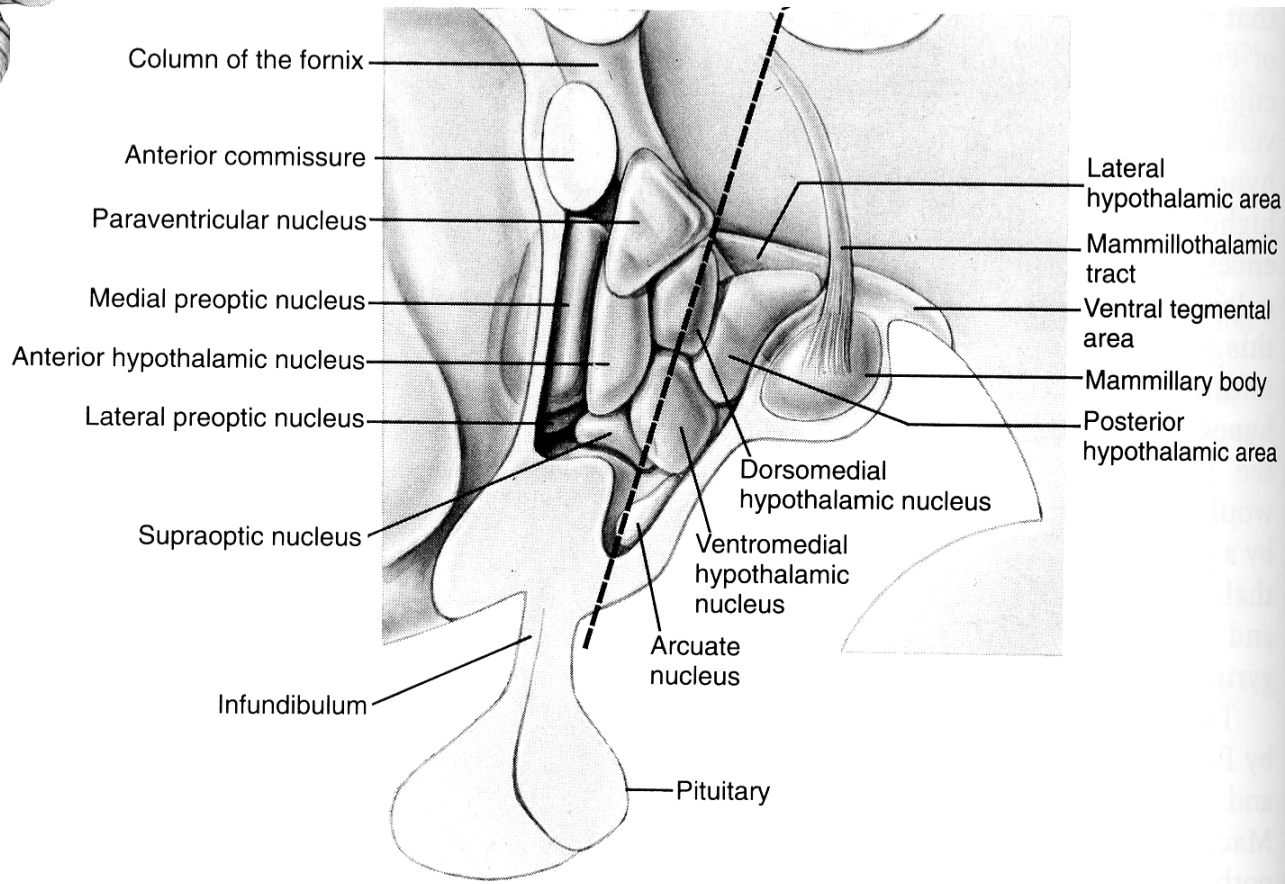


# Not all motivation is obviously homeostatic

# *The hypothalamus and consummatory behaviour*

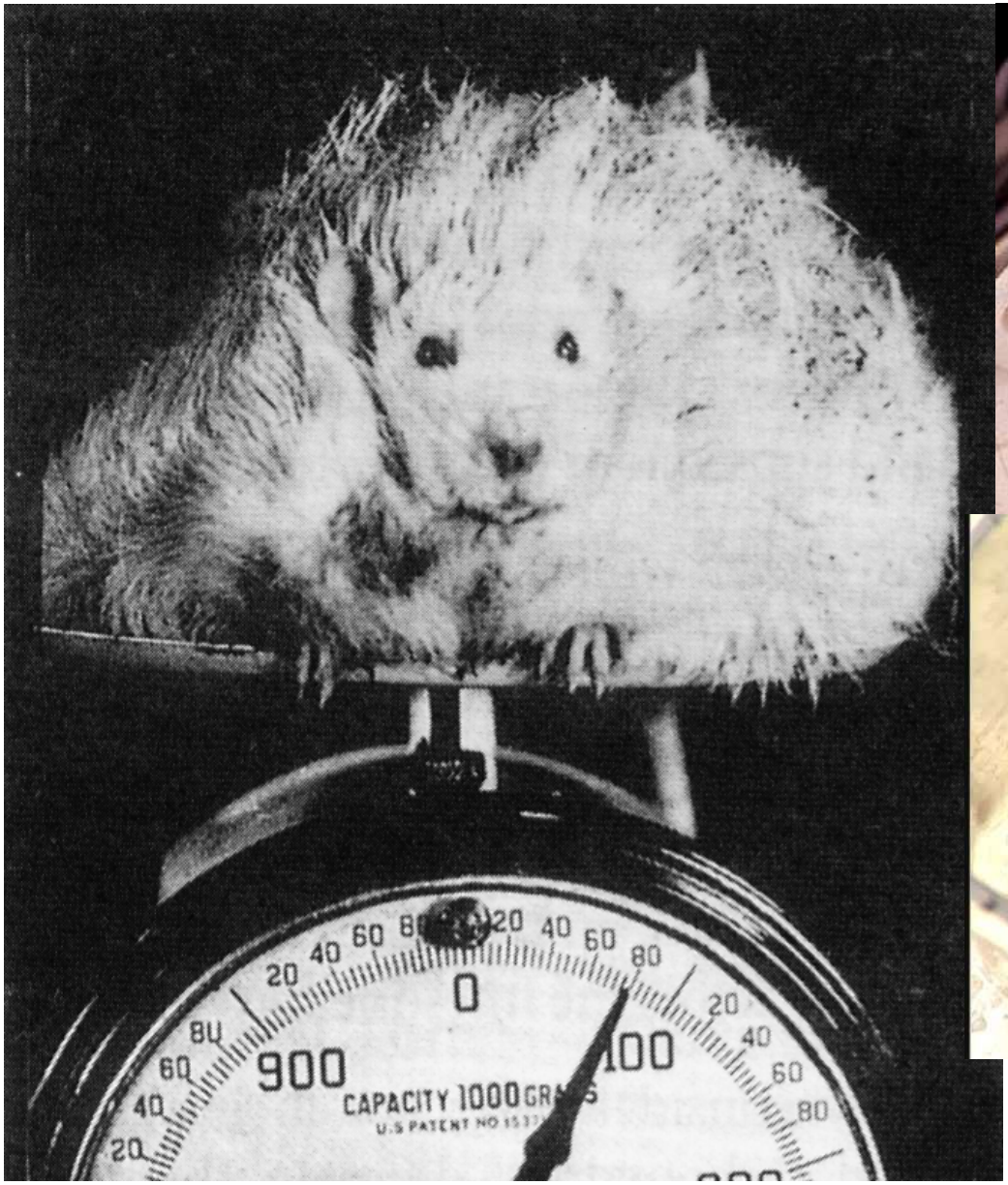
# The hypothalamus




*from Kupfermann (1991)*

# Rodents that eat all the pies



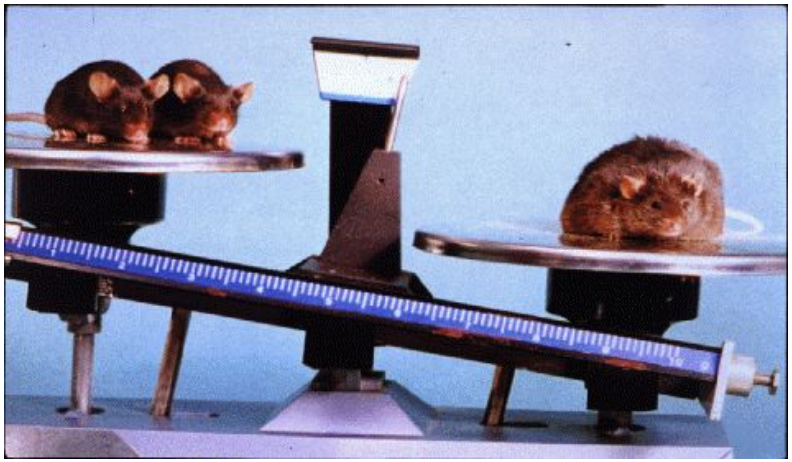

*Hetherington & Ranson (1939); Coleman & Hummel (1969)*

*Left: rat with ventromedial hypothalamic lesion; above: mice with leptin or leptin-receptor deficiency*

# Humans with leptin defiency get a bit chunky, too

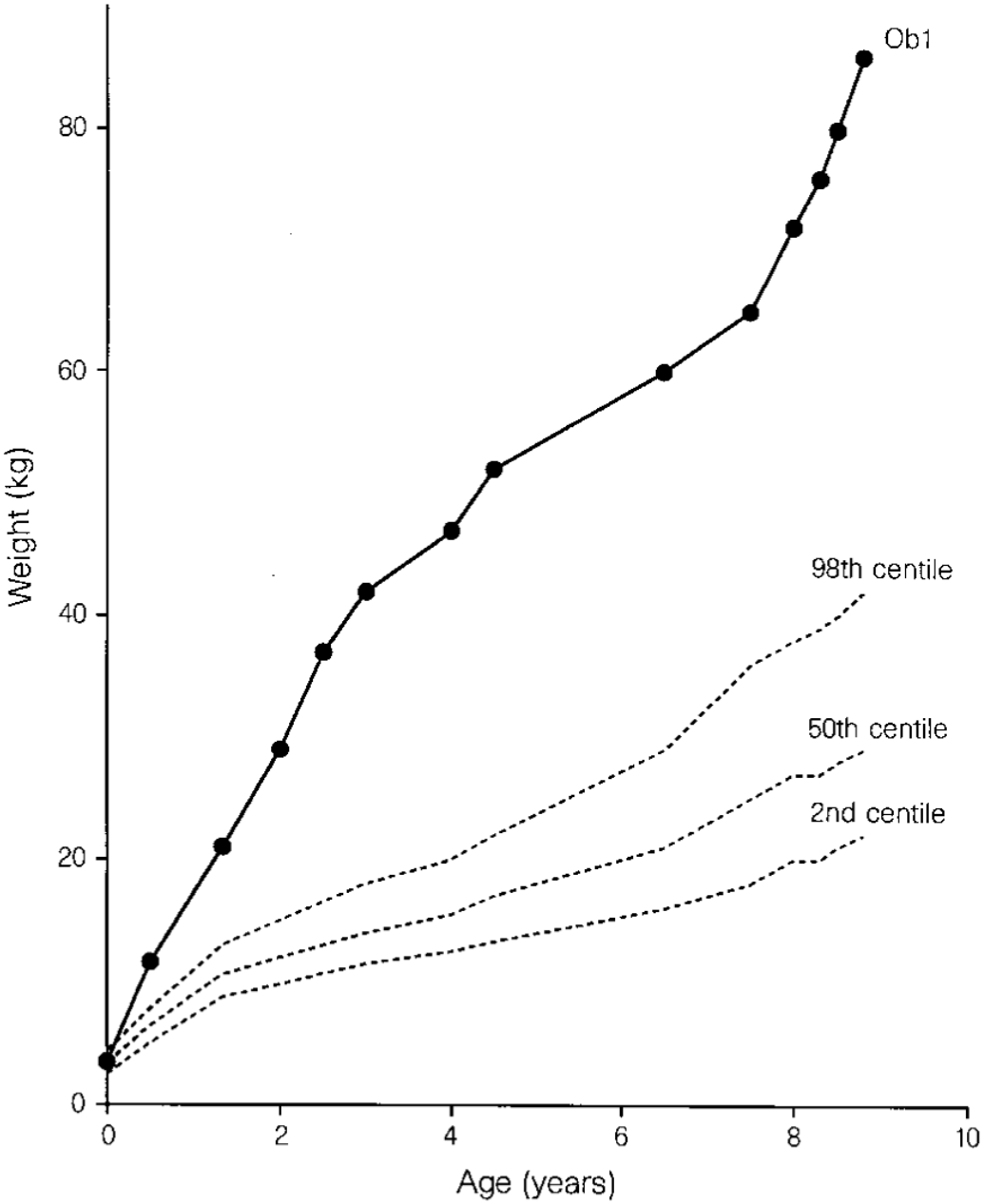
*8 year-old girl.*
*1.37 m tall (75th centile).*
*86 kg. BMI of 46.*
*Mobility severely impaired.*

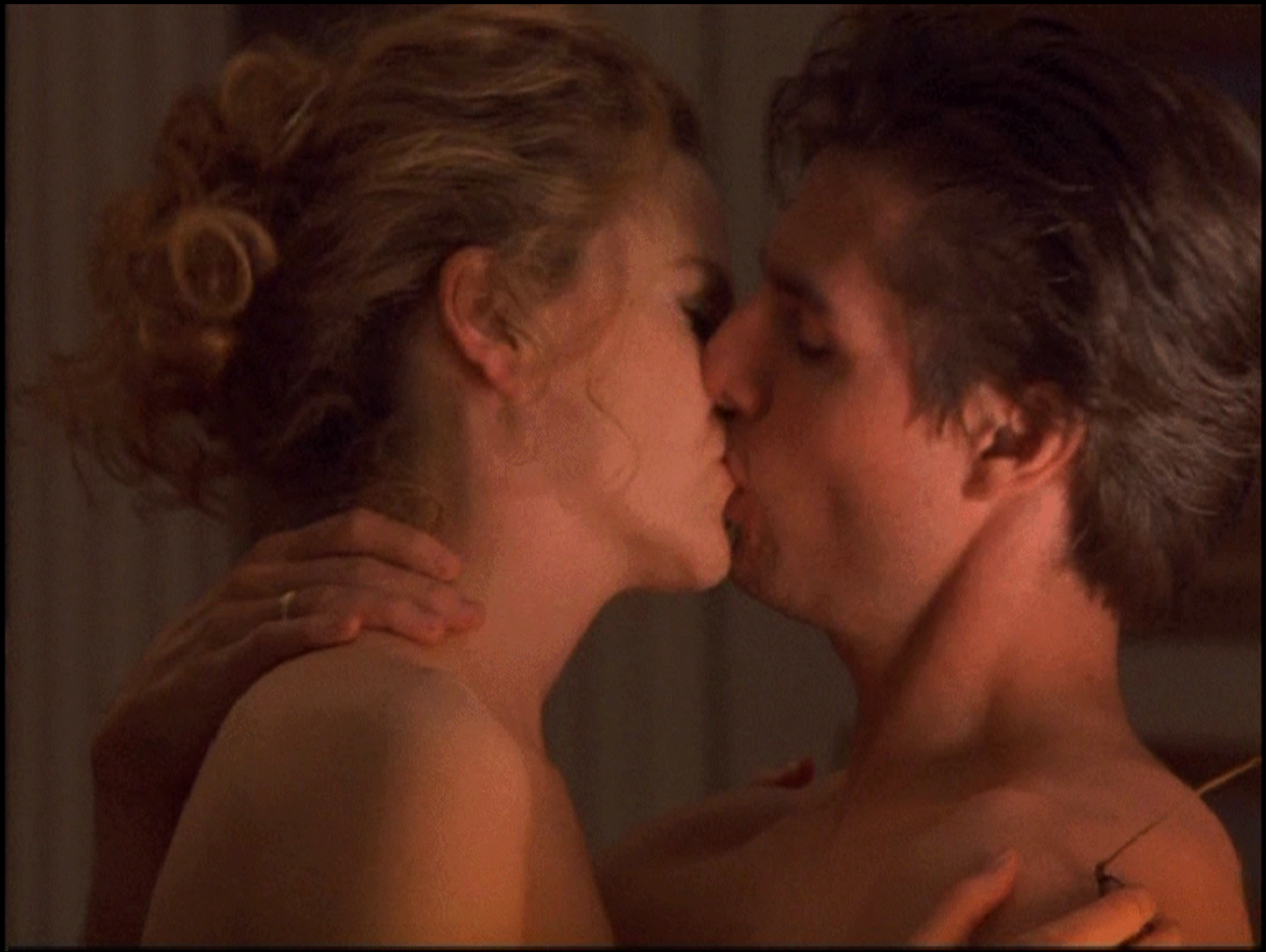
*BMI = body mass index =*
*mass in kg / (height in m)$^2$.*
*20–25 normal; >25 obese.*



*(And another picture of the mice.)*

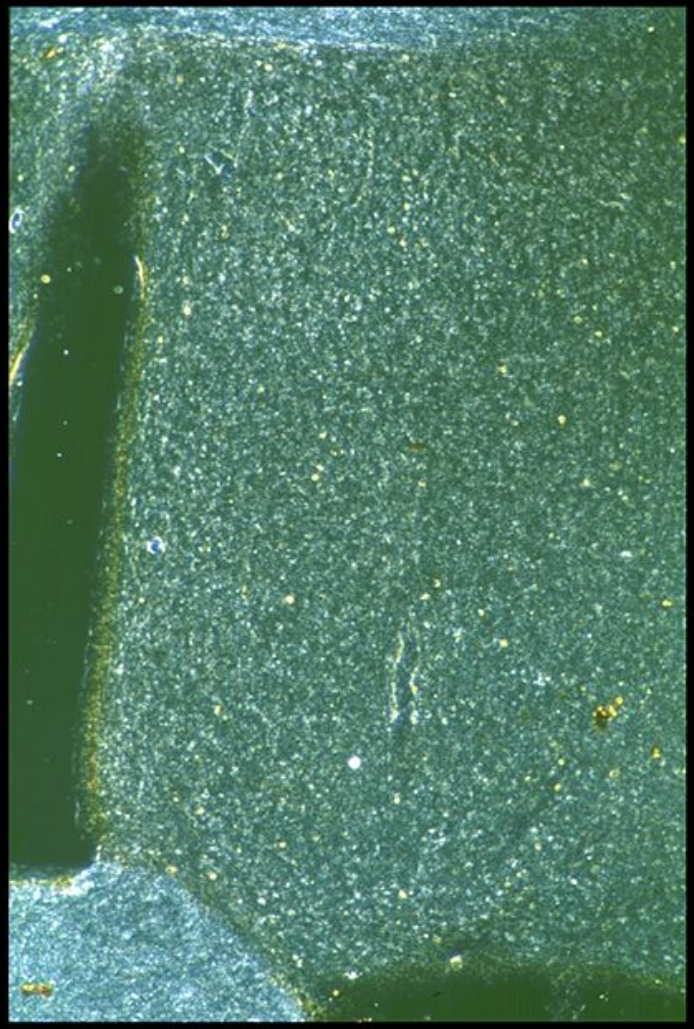
*Montague et al. (1997)*



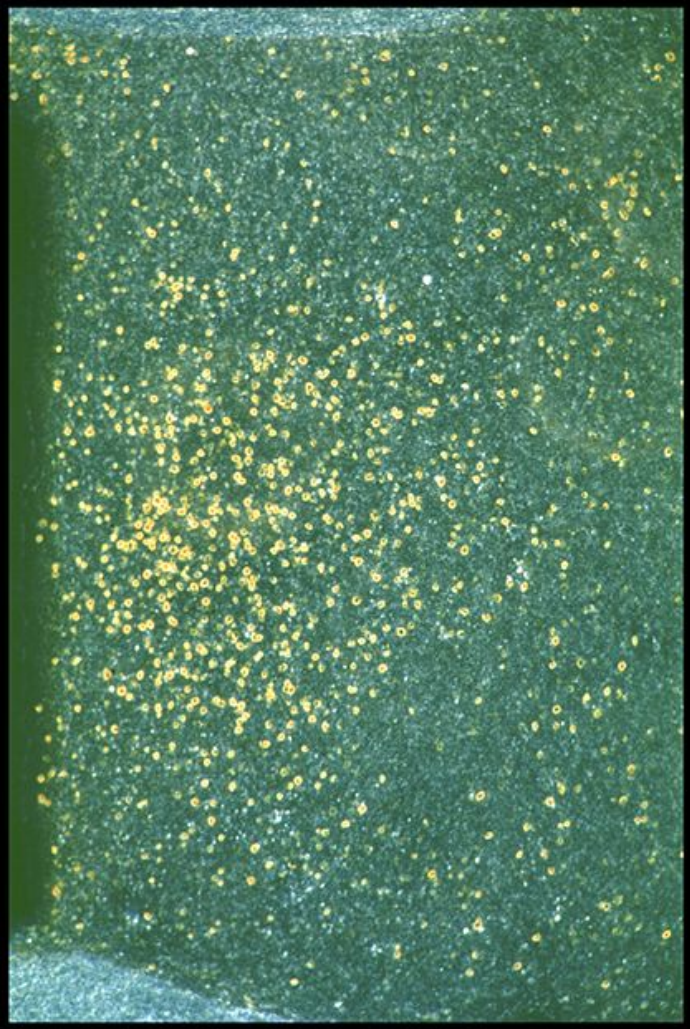


*Kubrick (1999): ‘Eyes Wide Shut’*

# Induction of *c*-fos expression in the medial preoptic area by sexual behaviour in male rats



*control*



*sexual activity*

*Everitt & Baum; see also e.g. Robertson et al. (1991)*

# Second-order schedules (e.g. of sexual reinforcement)

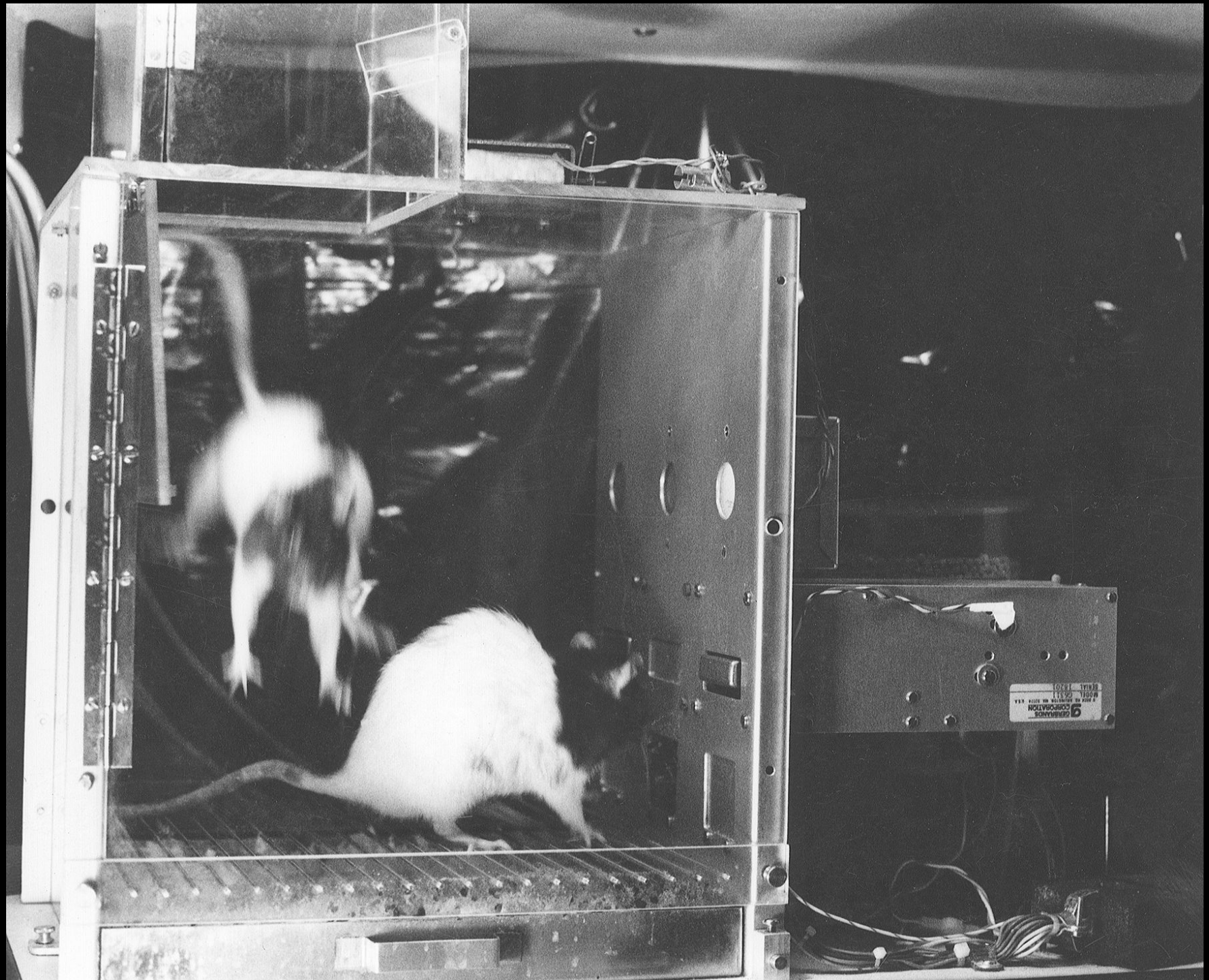
*For example,*

***FI 15 min : (FR10:S)***

*(Fixed ratio 10)*
*Every 10 responses earns one* ***stimulus***

*(Fixed interval 15 minutes)*
*The first time the subject*
*earns a stimulus after 15 minutes*
*have elapsed, it also earns* ***primary reinforcement***

*Kelleher (1966)*



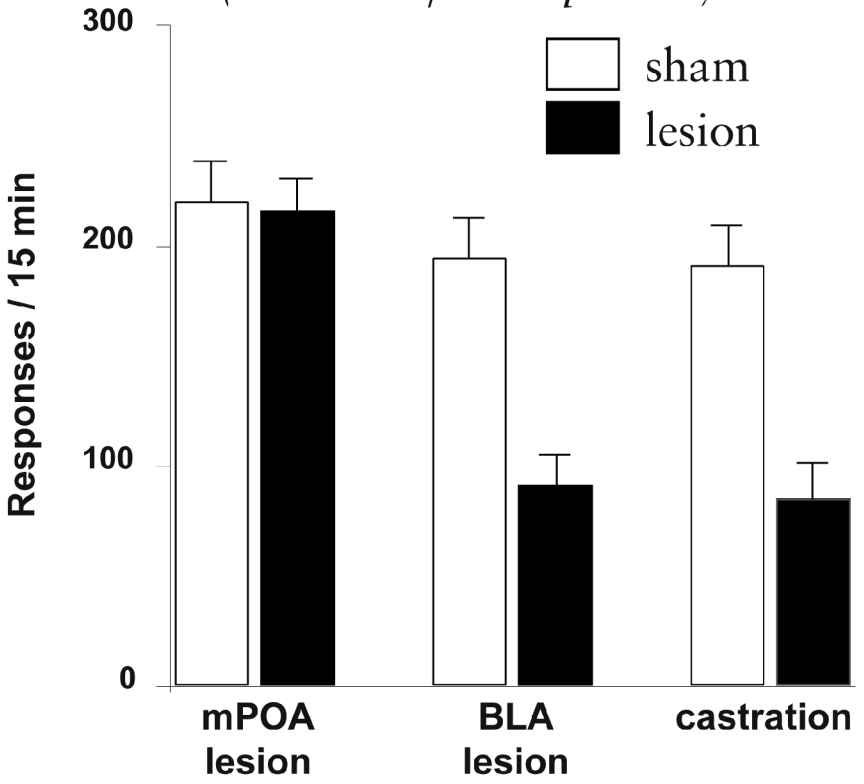
# Double dissociation of appetitive / consummatory behaviour

*Effects of*

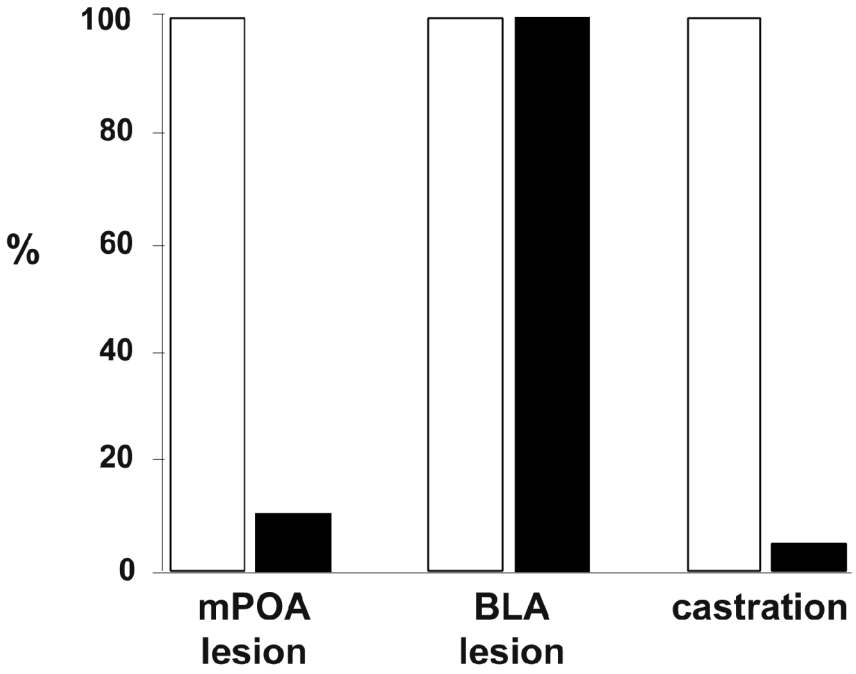
- *basolateral amygdala (BLA) lesions*
- *medial preoptic area (mPOA) hypothalamic lesions*
- *castration*

*on appetitive and consummatory sexual responses in male rats.*

***Appetitive (instrumental) responses***
*(number of lever presses)*




***Consummatory responses***
*(proportion of rats copulating)*



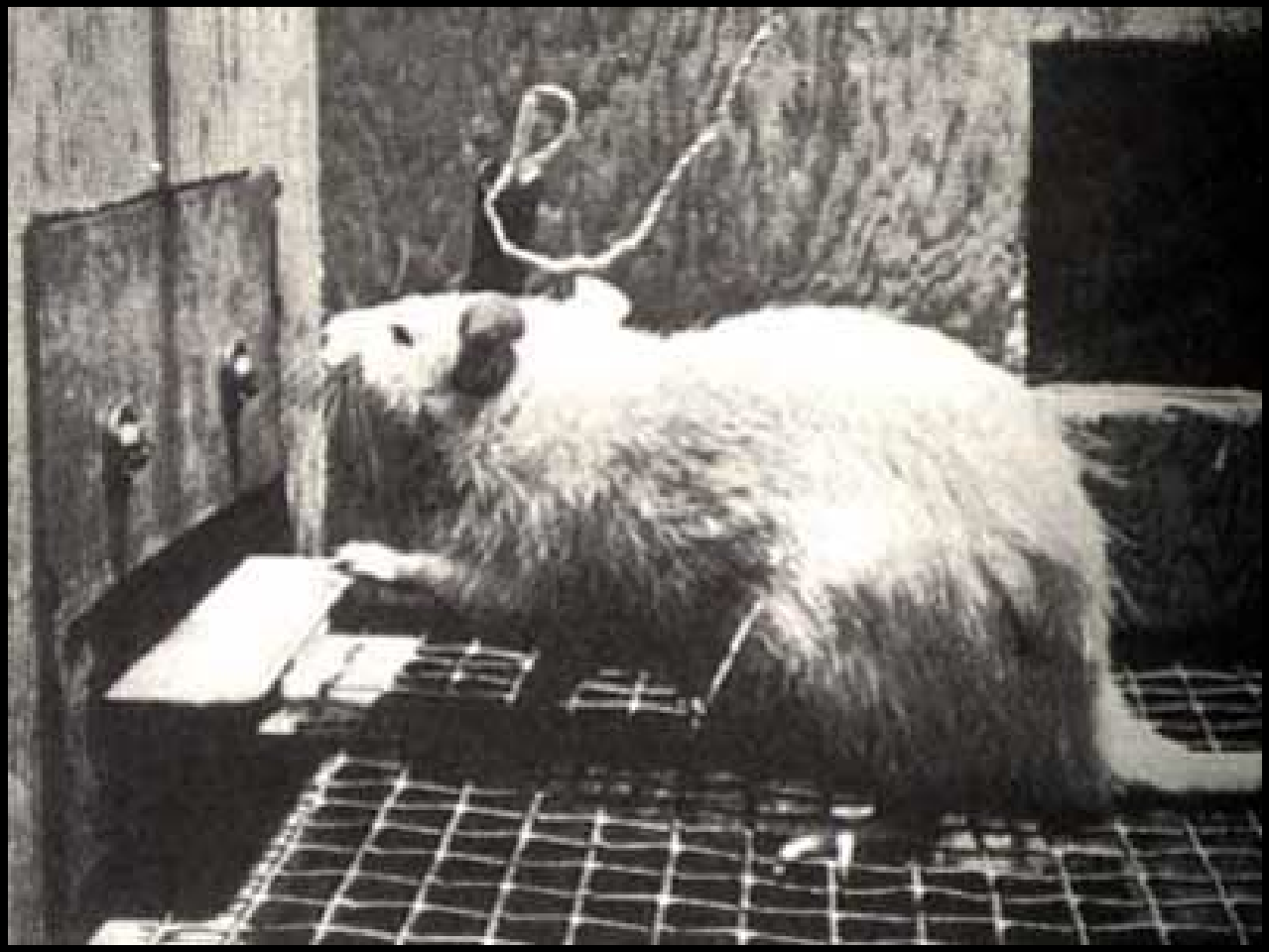

*Everitt & Stacey (1987); Everitt, Cador & Robbins (1989)*

*What's reinforcing?*
*Dopamine?*

# What's reinforcing?

*Premack (1963); Hundt & Premack (1953)*

# Electrical intracranial self-stimulation (ICSS)



***The mind is its own place, and in itself, can make heaven of Hell, and a hell of Heaven.***

(Satan, in John Milton's *Paradise Lost*, book 1, ll. 254–5)

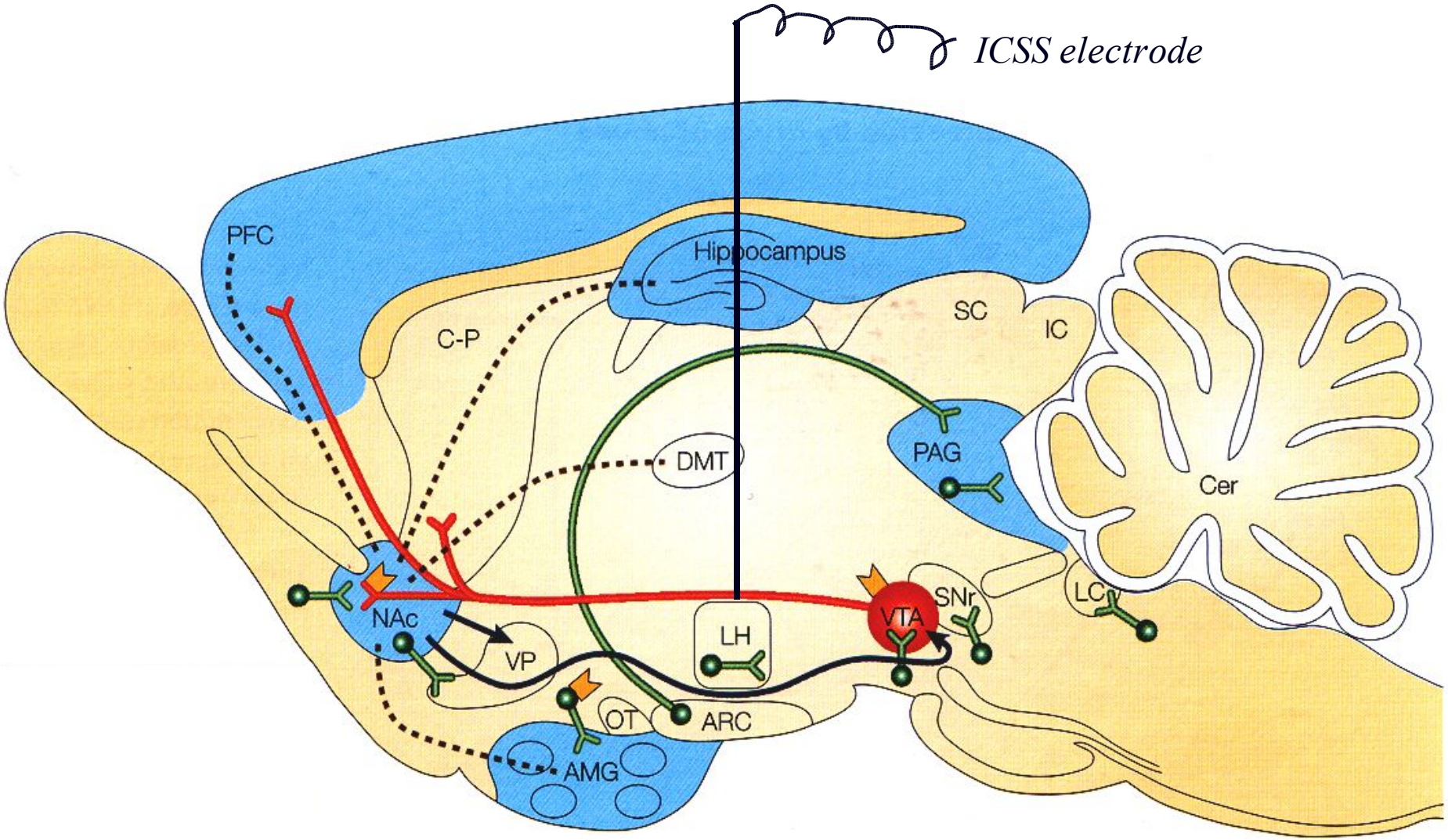
*Olds & Milner (1954)*

# Remote-controlled rats and a cocaine sniffer rat

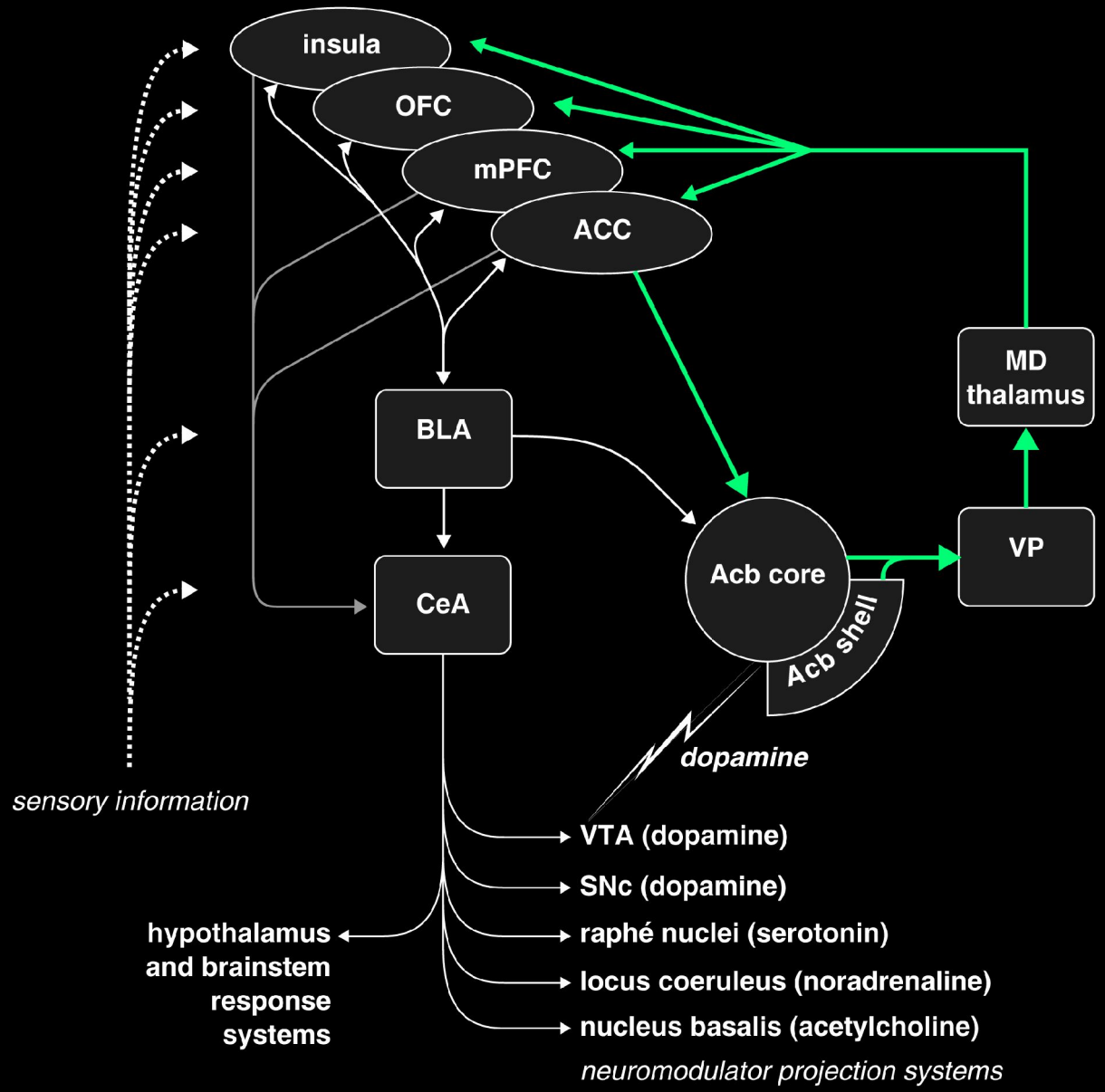
Otto *et al.* (2002). *Appl. Animal Behav. Sc.* 77: 217

Talwar *et al.* (2002). *Nature* 417: 37

# The mesolimbic dopamine system and ICSS — a ‘reinforcement pathway’ (though *not* necessarily a ‘pleasure system’)

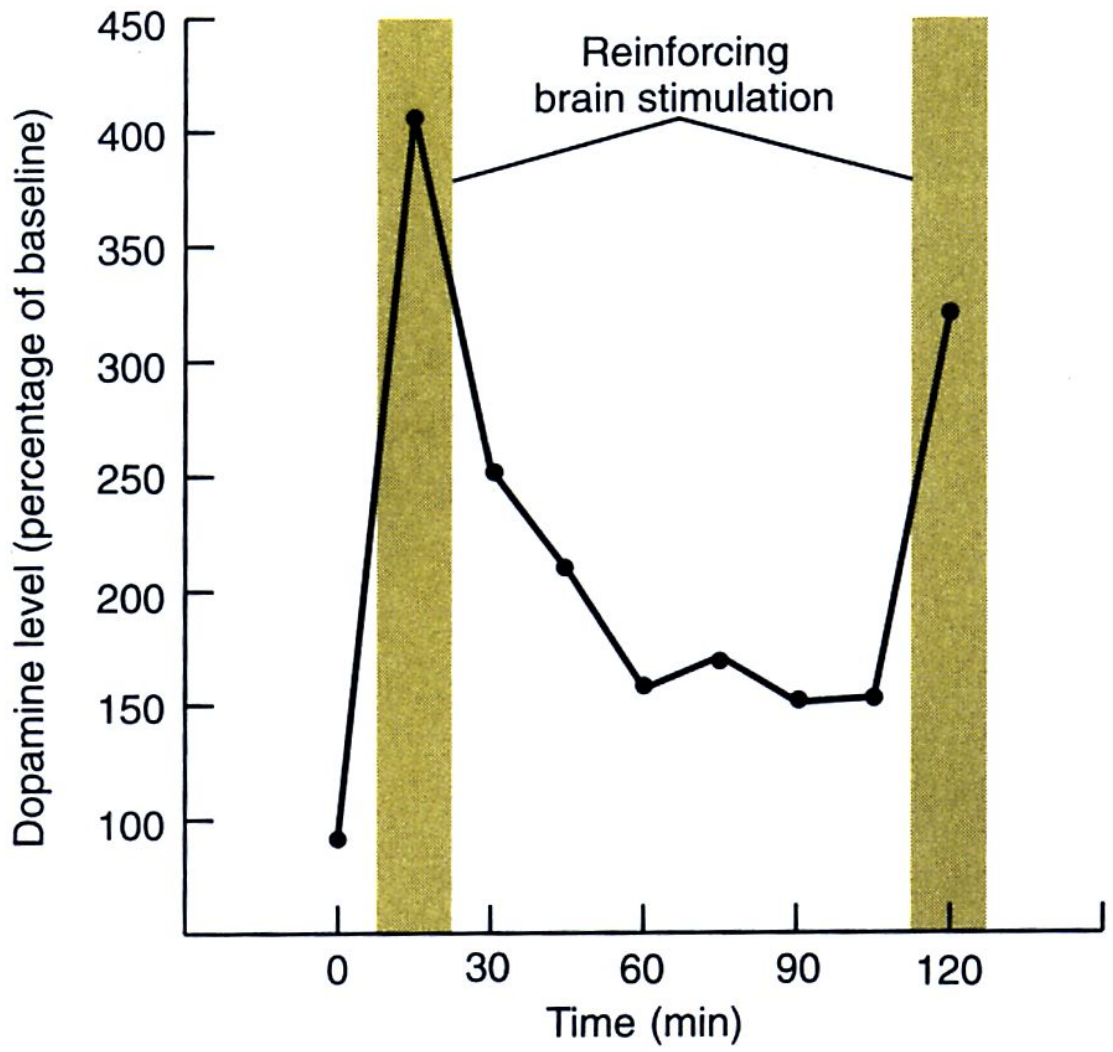


# The ‘limbic’ corticostriatal circuit

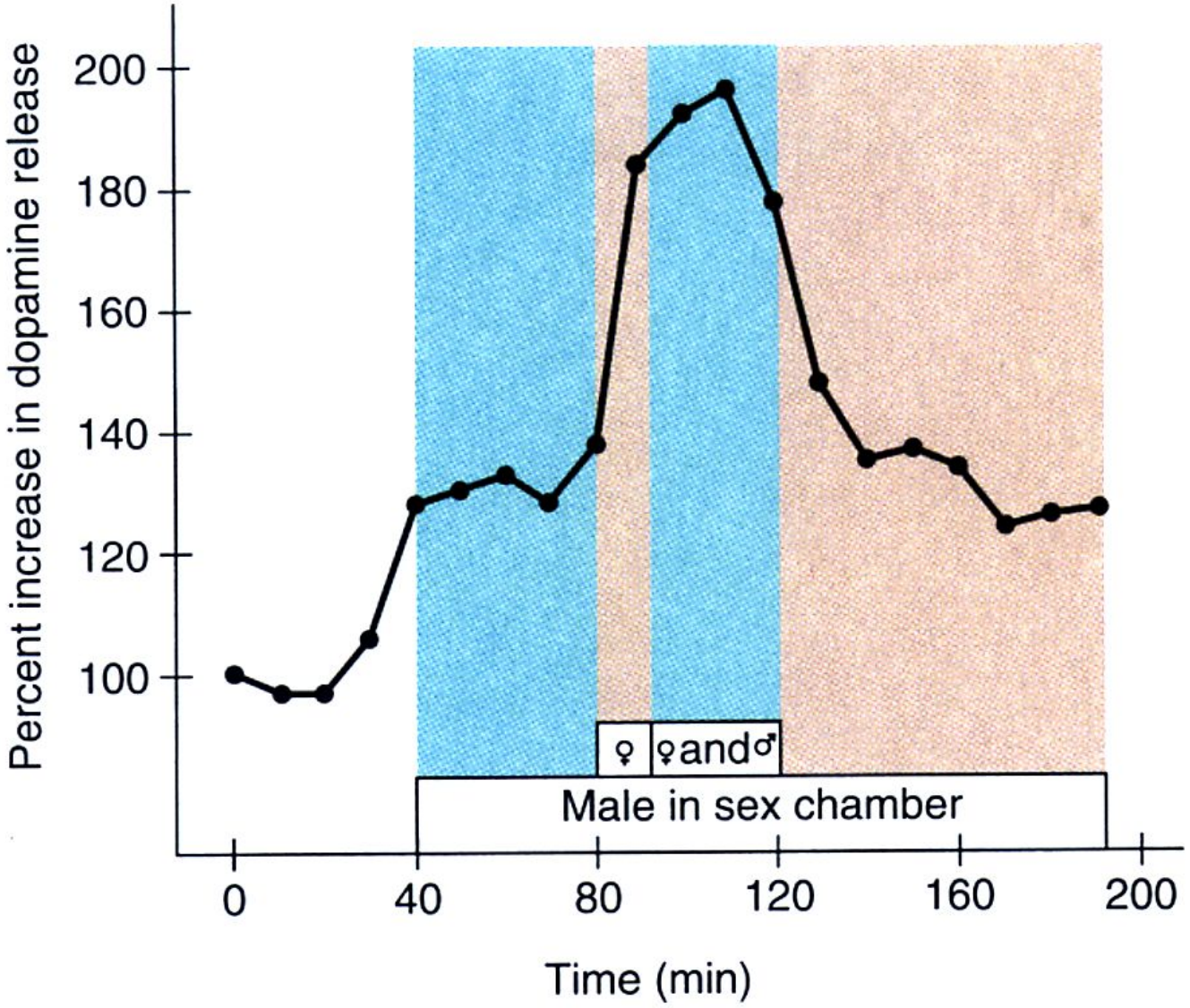



*DeLong & Georgopoulous (1981); Cardinal et al. (2002)*

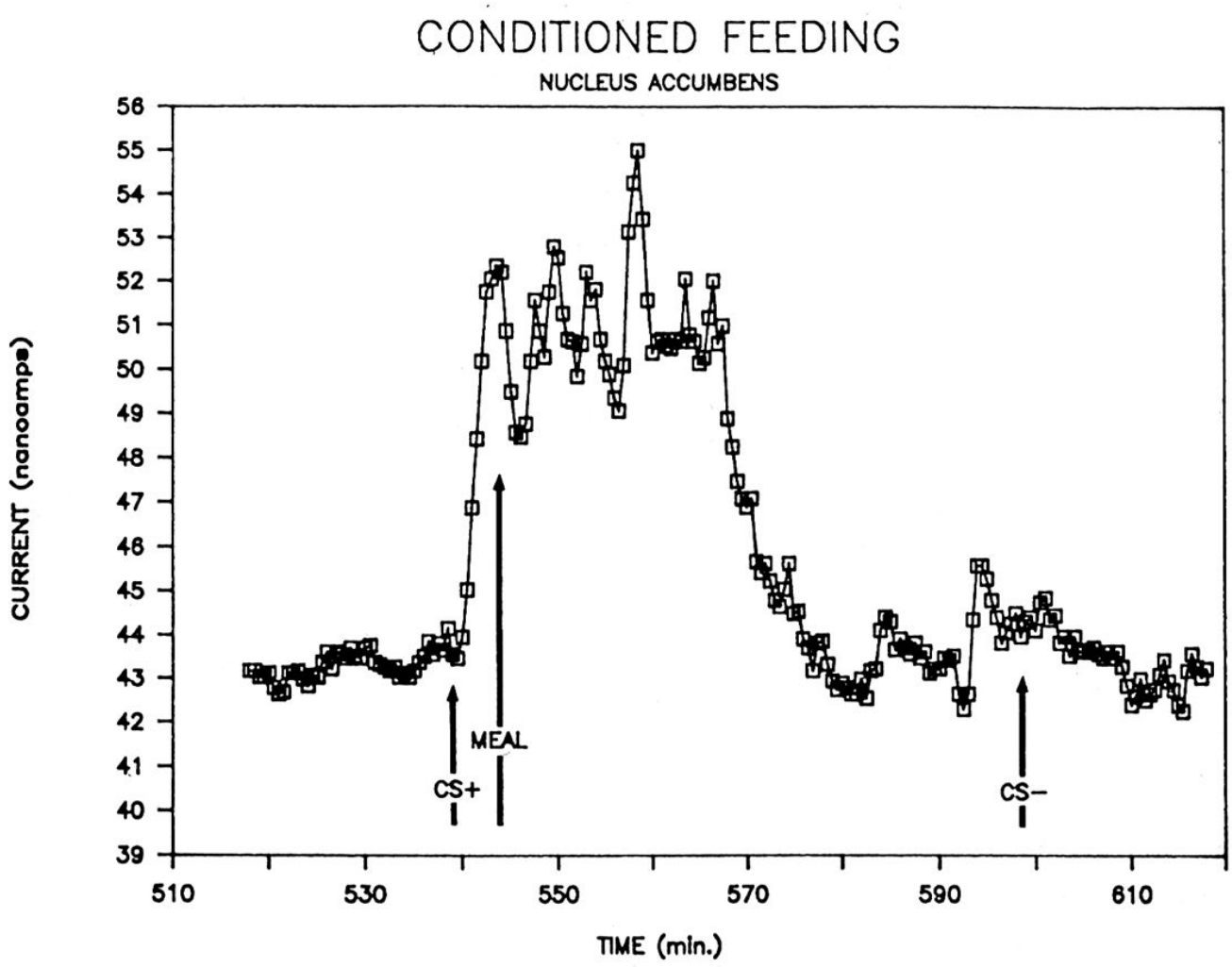
# Dopamine release in the nucleus accumbens during ICSS



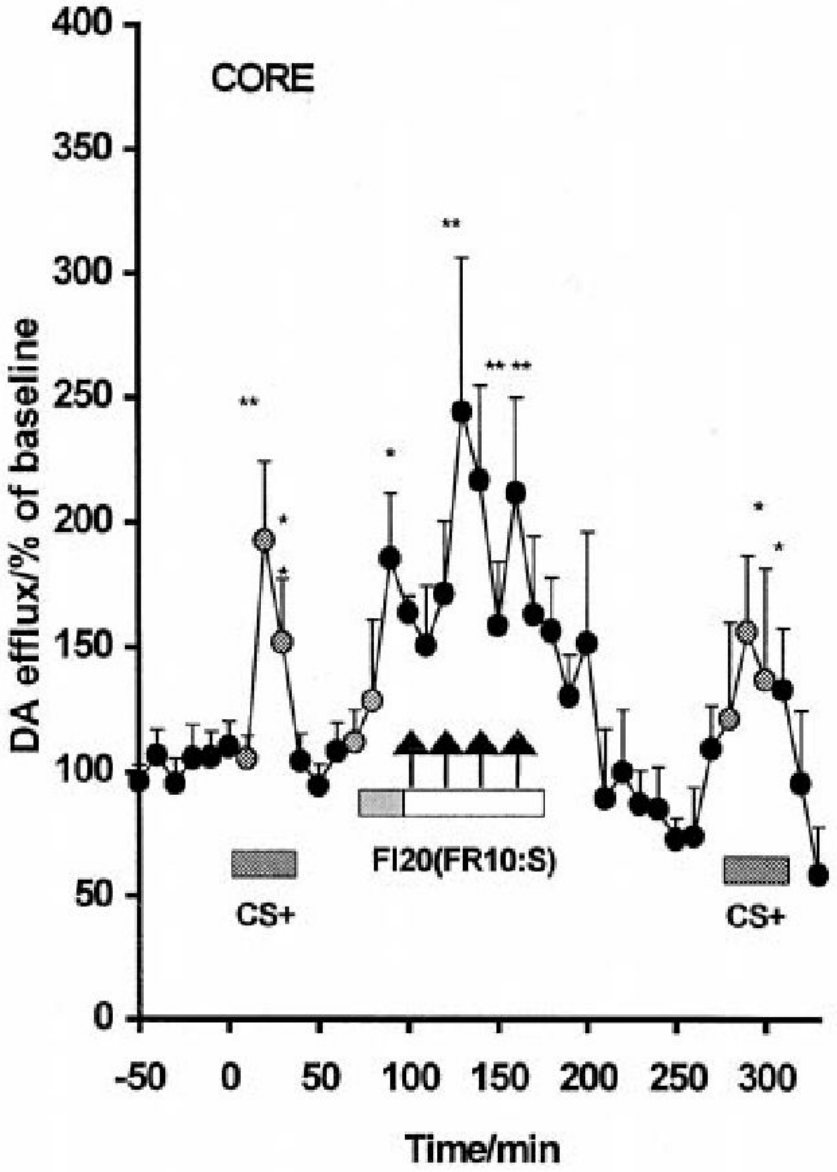
# Dopamine release in the nucleus accumbens of a male rat during sexual behaviour — and in anticipation of sex



Dopamine release in the nucleus accumbens during ingestion of a preferred food — and in response to a CS for food



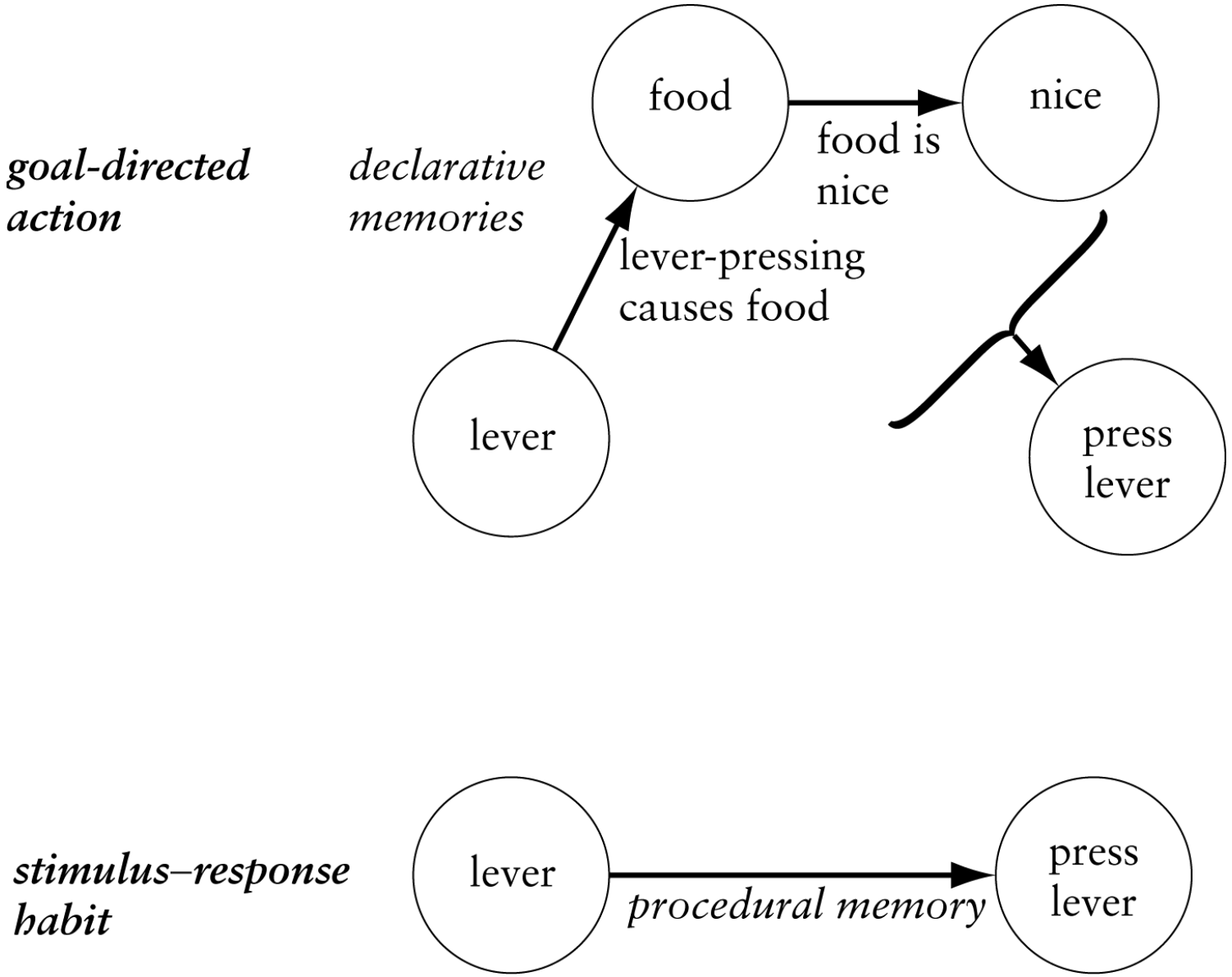
# Dopamine release in the nucleus accumbens during IV cocaine self-administration — and to a CS for cocaine




*Ito et al. (2000)*

# *Psychological basis of instrumental conditioning*

# Animals work for reinforcement for several reasons, including...




*after Dickinson (1980)*

# Learning the 'incentive value' of foods

| Stage | Controls | *Comparison* | Devalued | Change in devalued group |
|---|---|---|---|---|
| Training | L → food | | L → food | |
| Devaluation | food | | food → LiCl | hedonic change |
| Test 1 | L | = | L | |
| Re-exposure | food | | food | incentive learning |
| Test 2 | L | > | L | |

L = lever

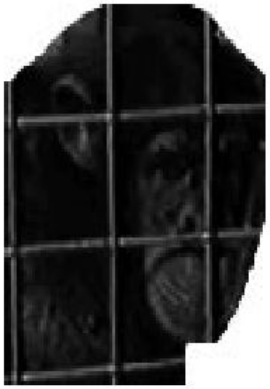
LiCl = lithium chloride

*Balleine & Dickinson (1991)*

# ‘Hedonic’ taste reactivity patterns (1)

## *Hominoids: Apes & Humans*

*Mid-face Aversion (bitter)*



*Eye squinch & nose wrinkle*

*Midface ‘Smile’ (sweet)*

*Elevation & relaxation*

*Berridge (2000)*

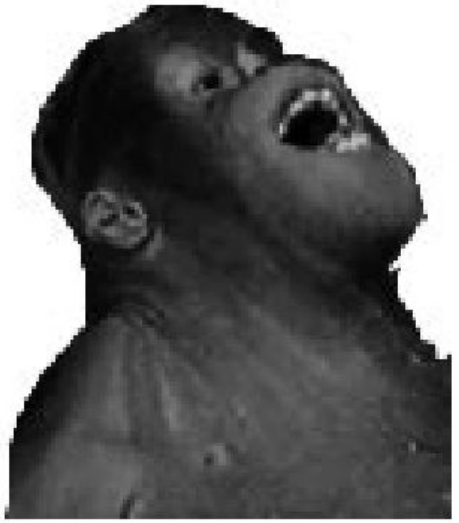
# ‘Hedonic’ taste reactivity patterns (2)

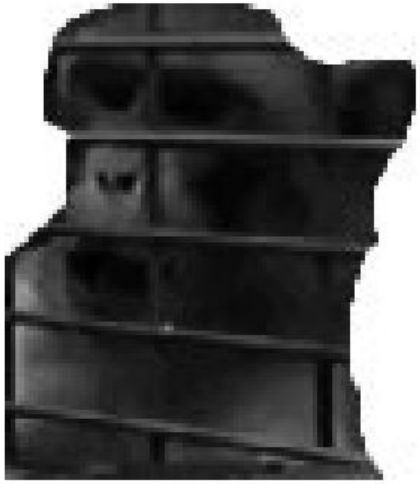
***‘Universal hedonic reaction’ — tongue protrusion to sweet substances***

*Berridge (2000)*

# ‘Hedonic’ taste reactivity patterns (3)

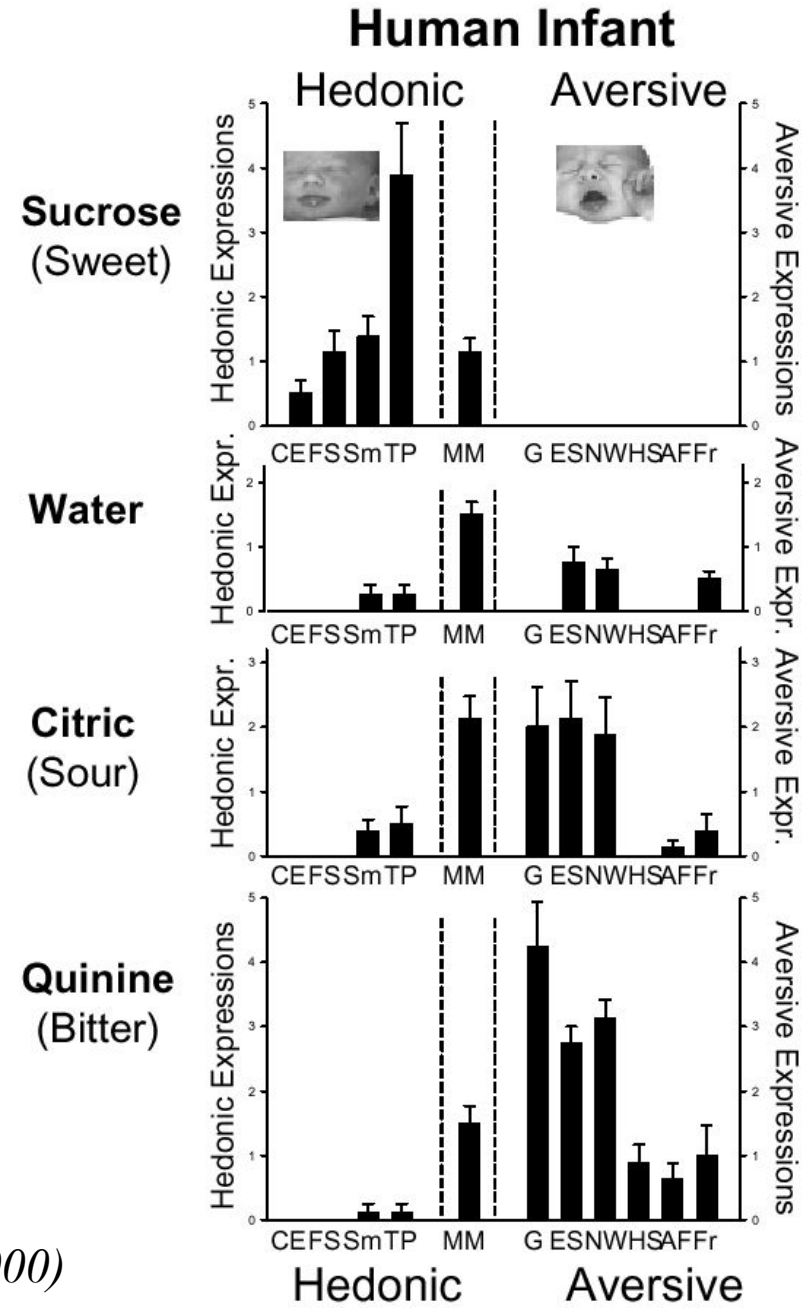
***‘Universal aversive reaction’ — gaping to bitter substances***

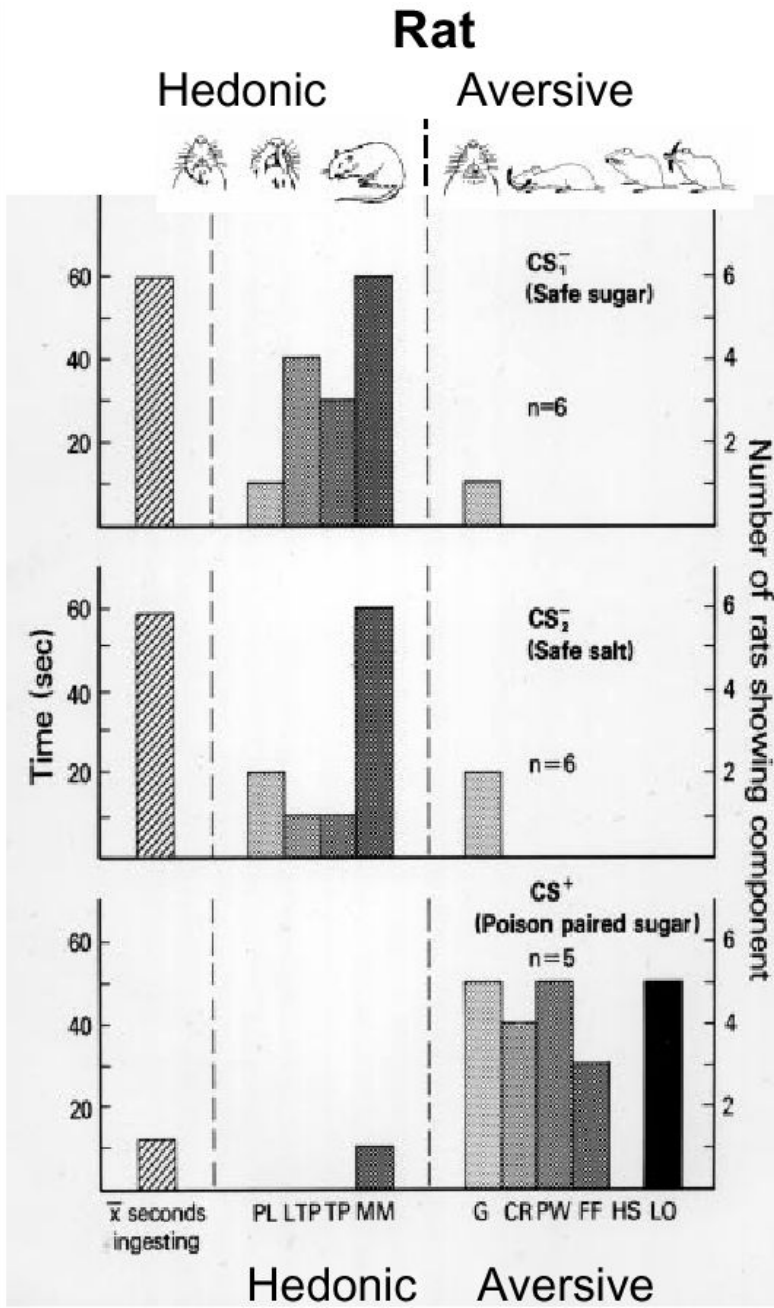




*Berridge (2000)*

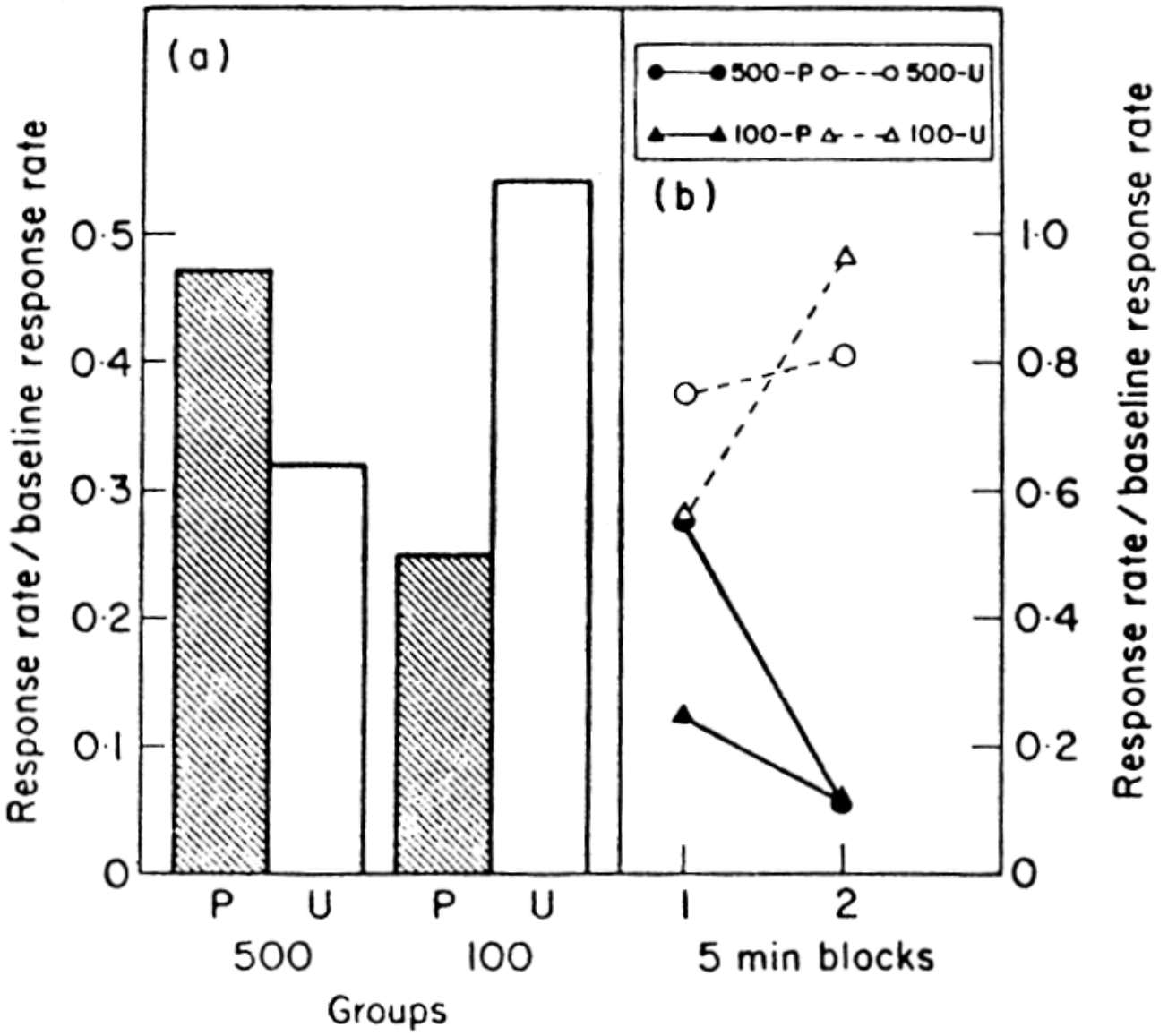
# ‘Hedonic’ taste reactivity patterns (4): they can alter




*Berridge (2000)*

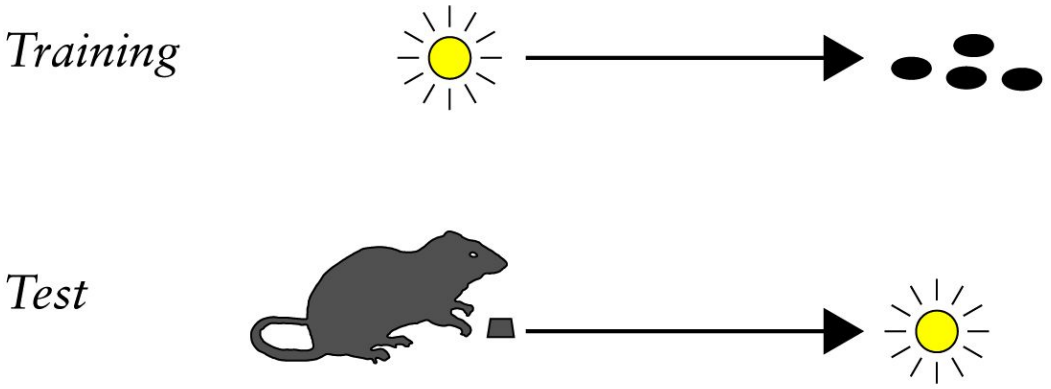
# Stimulus–response habits develop after extended training



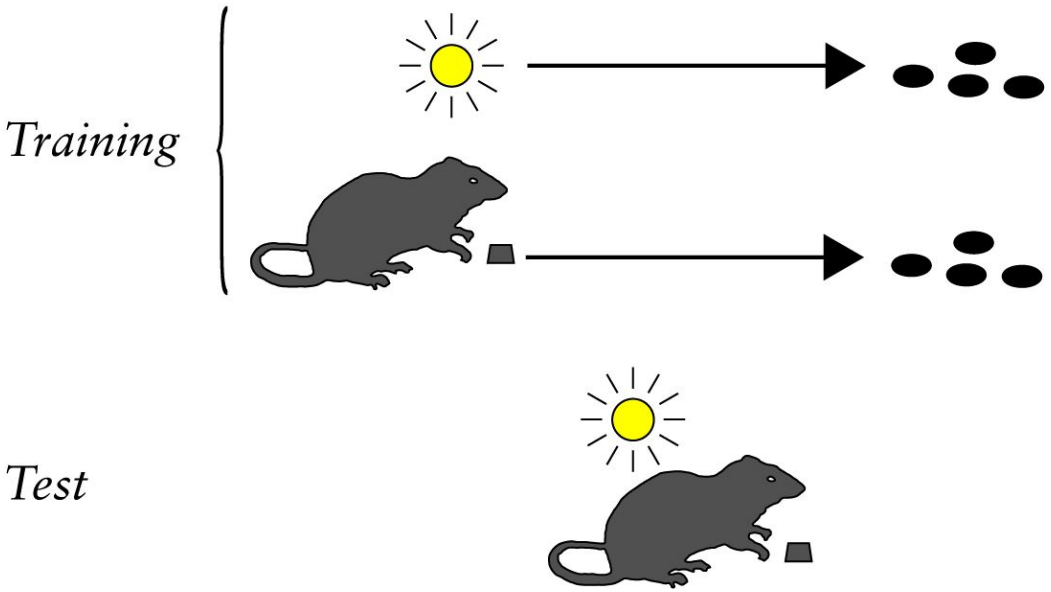

*Adams (1982)*

# Cues paired with reinforcement can also motivate

***Conditioned reinforcement***



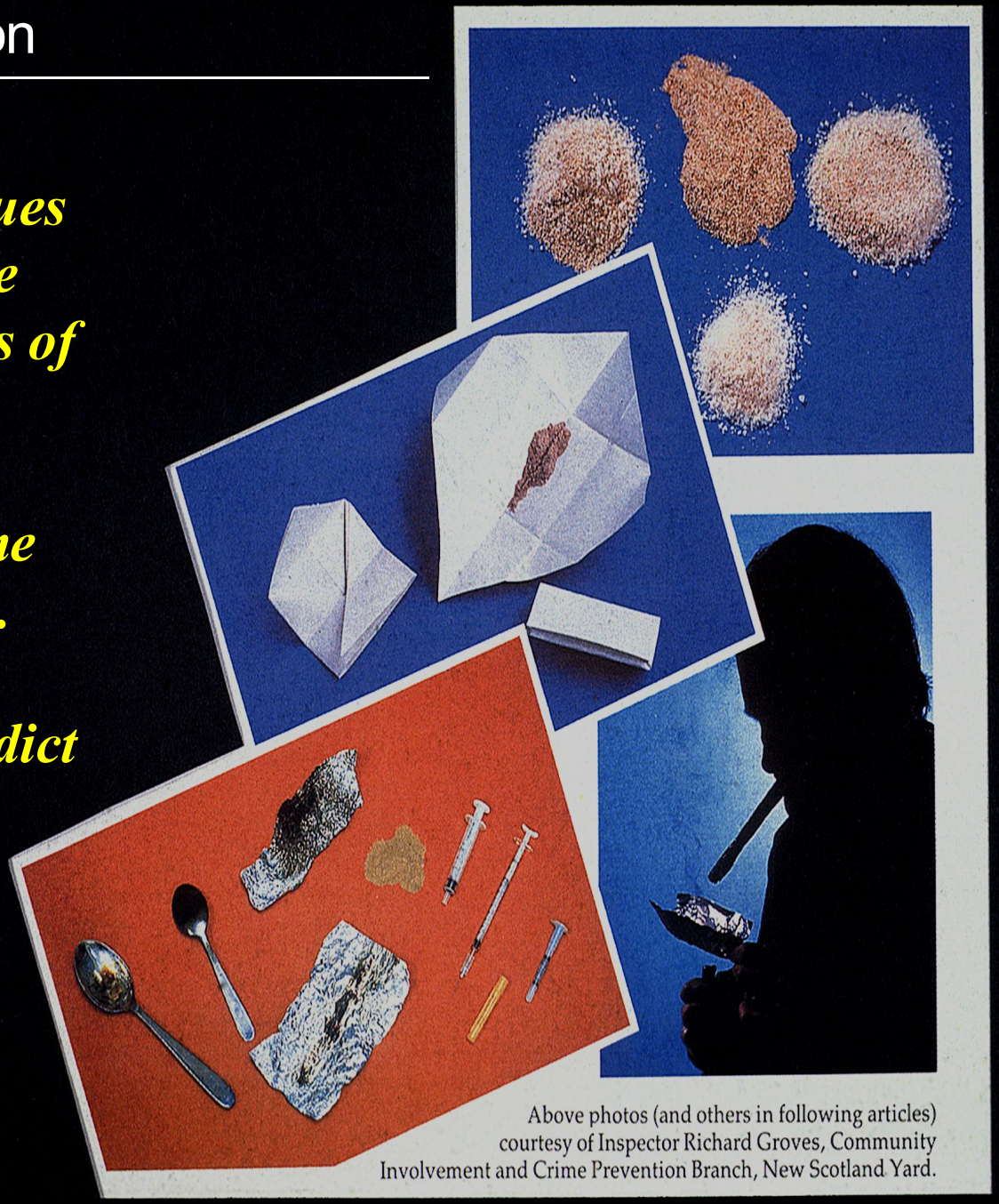

***Pavlovian–instrumental transfer (PIT)***



# Conditioning and addiction

***Environmental stimuli (cues and contexts) may become associated with the effects of drugs such as cocaine through Pavlovian conditioning. They become conditioned stimuli (CSs).***

***They may motivate an addict to seek out drugs — cue-induced (conditioned) craving.***



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

# Summary of learning theory

- Animals form multiple psychological representations during Pavlovian and instrumental conditioning.
- For example, an animal learning to respond for a reward encodes
  - the instrumental (action–outcome) contingency;
  - the value of the outcome as an instrumental goal;
  - the (dissociable) 'affective' value of the outcome;
  - direct stimulus–response 'habits';
- … and is influenced by Pavlovian processes including conditioned reinforcement and Pavlovian–instrumental transfer.
- The neural basis of some of these processes is starting to be understood.

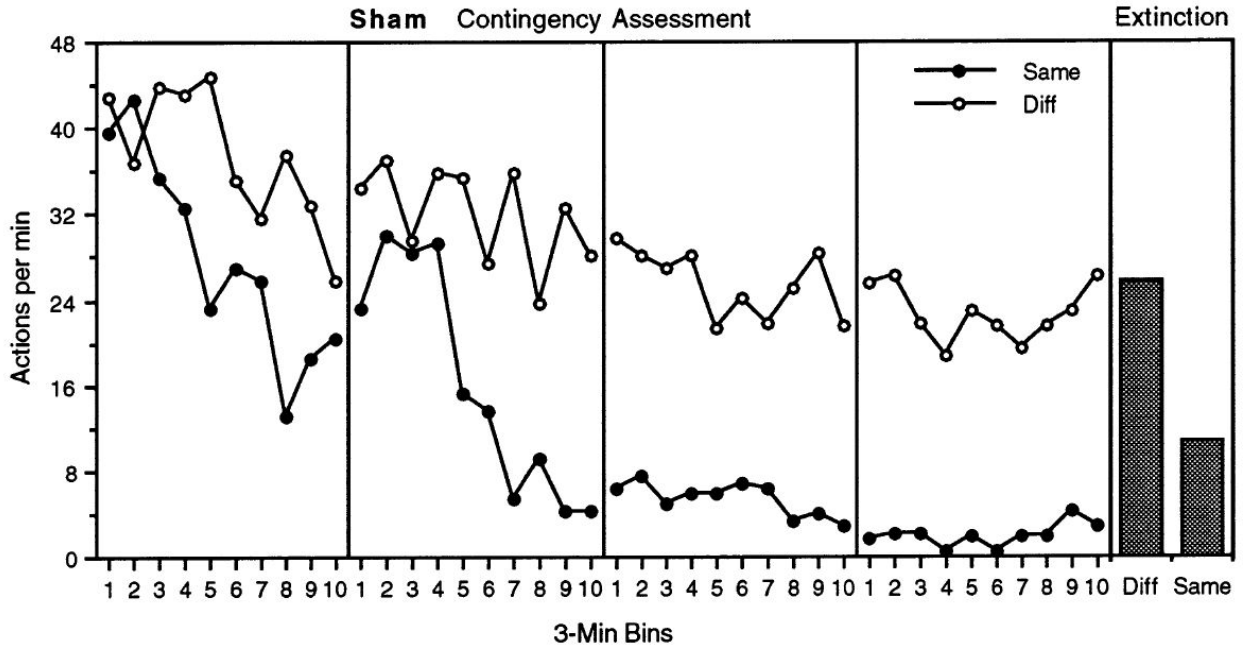
# *Neural basis of instrumental conditioning*

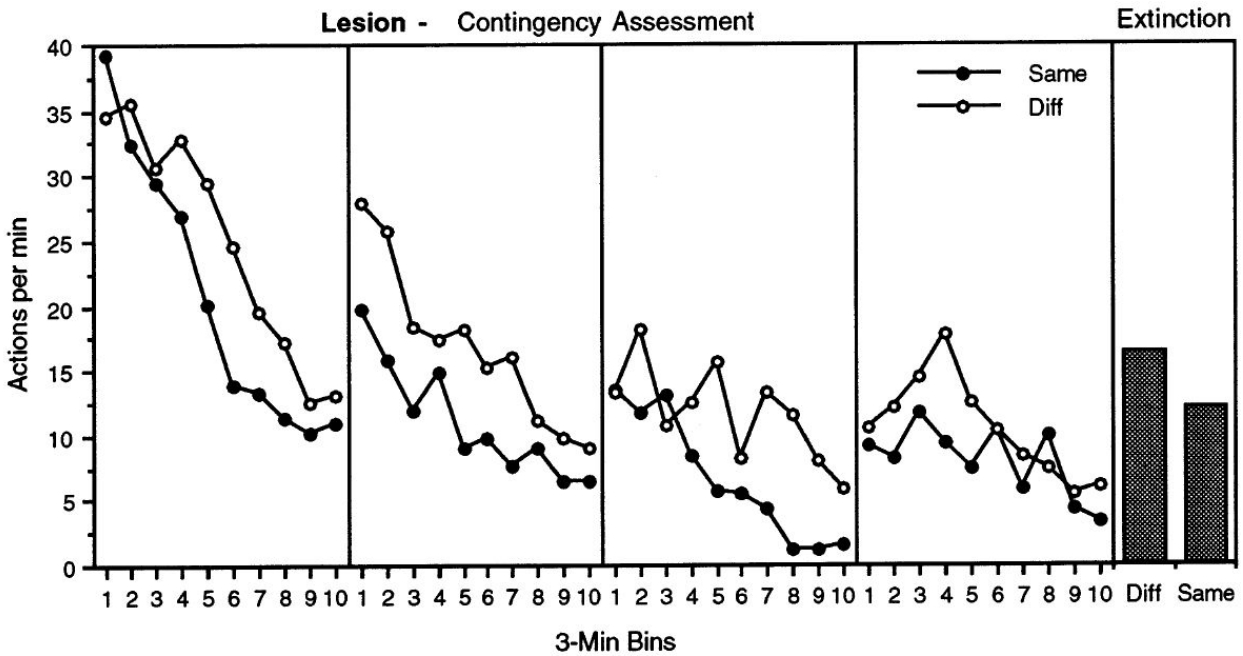
# Action–outcome contingency: prefrontal cortex?

*sham-operated rats*

***Test of action–outcome contingency knowledge***

*rats with prelimbic cortex lesions (~ equivalent to dorsolateral prefrontal cortex in primates)*

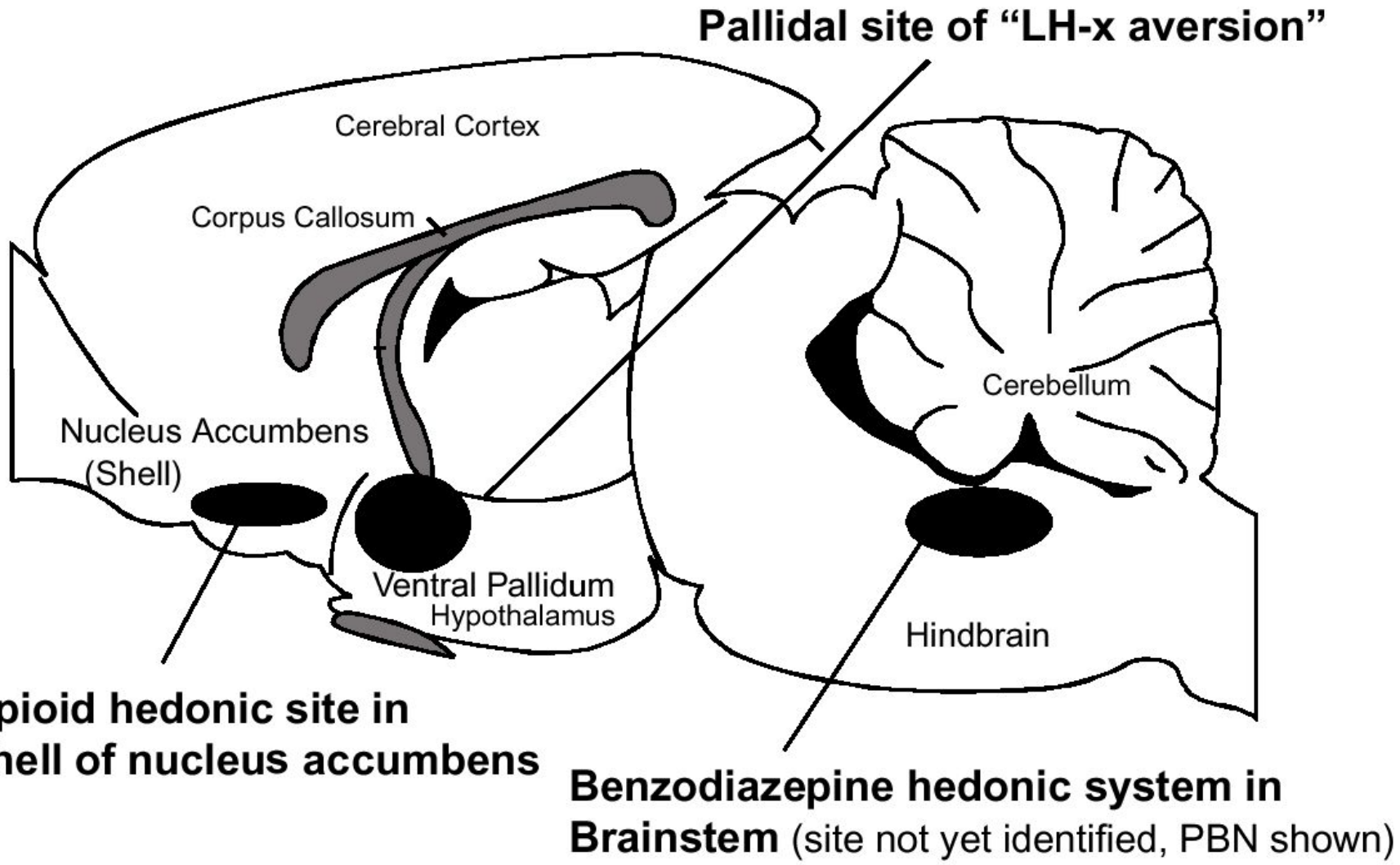



*Balleine & Dickinson (1998)*

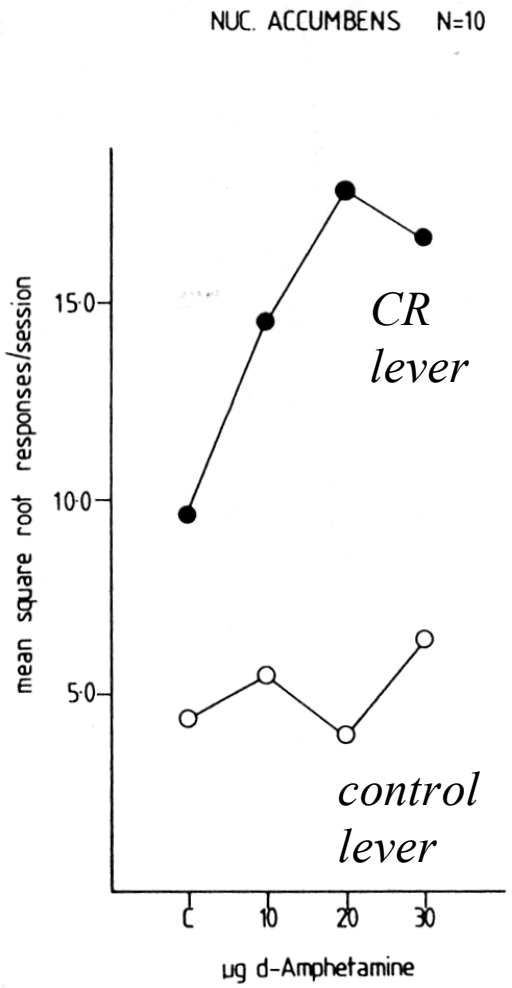
# Hedonic experience: accumbens / pallidum / hindbrain?

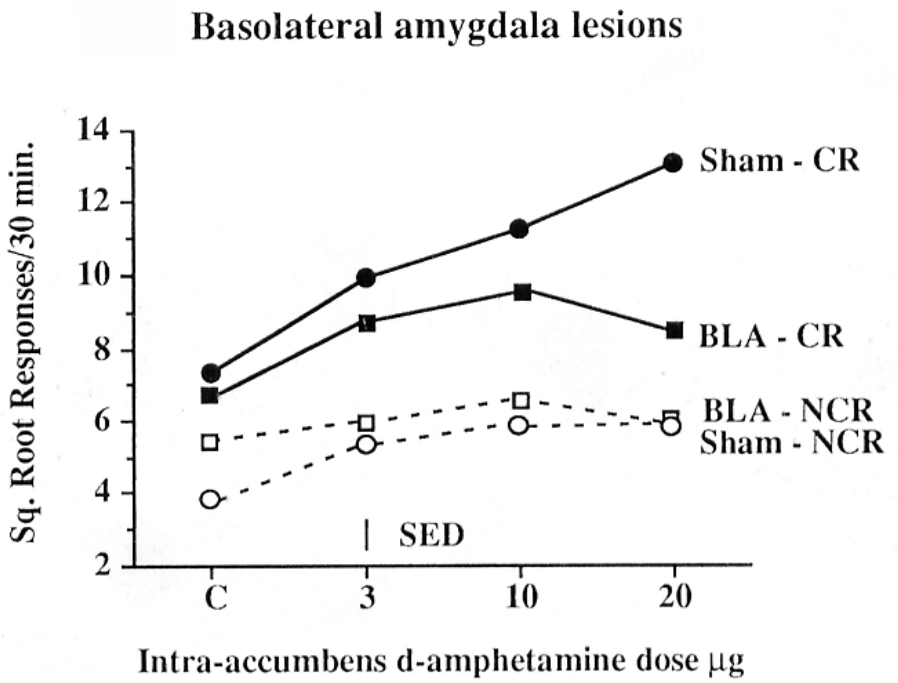
*Sites that affect taste reactivity patterns ('hedonics'?):*




*Berridge (2000)*

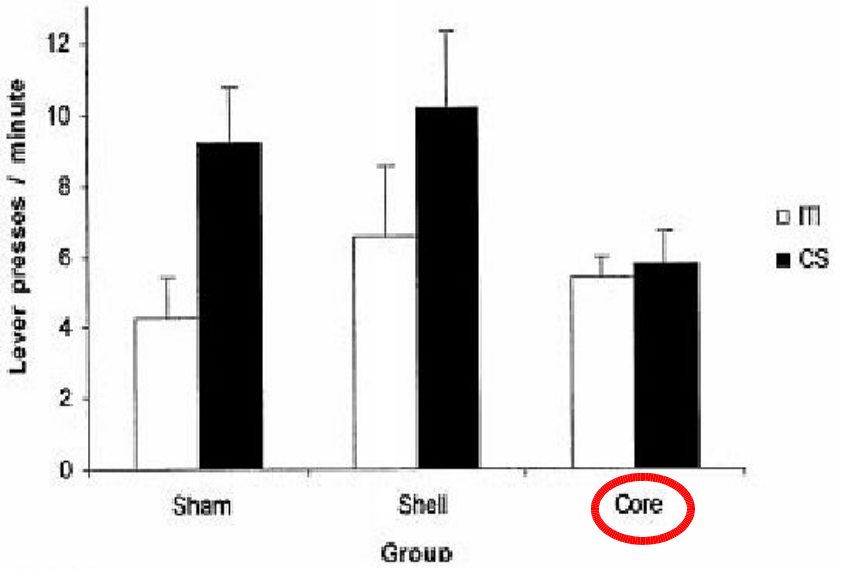
# Conditioned reinforcement depends in part upon the basolateral amygdala, and can be enhanced by intra-accumbens amphetamine

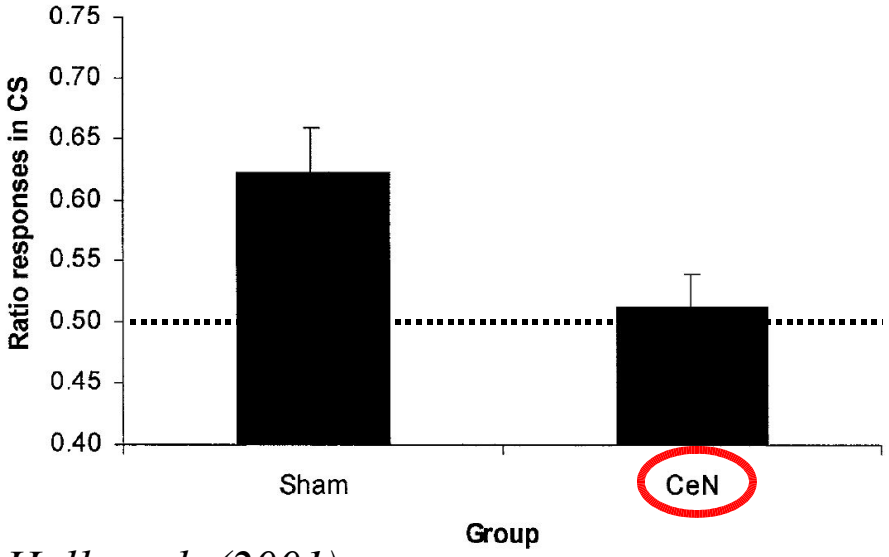


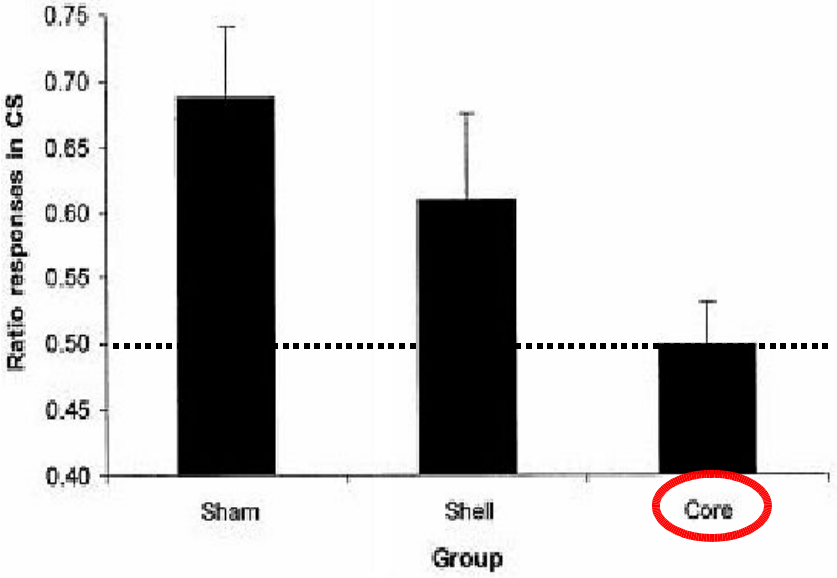




*Taylor & Robbins (1984); Burns et al. (1993)*

# Lesions of the nucleus accumbens core (or central nucleus of the amygdala) abolish PIT



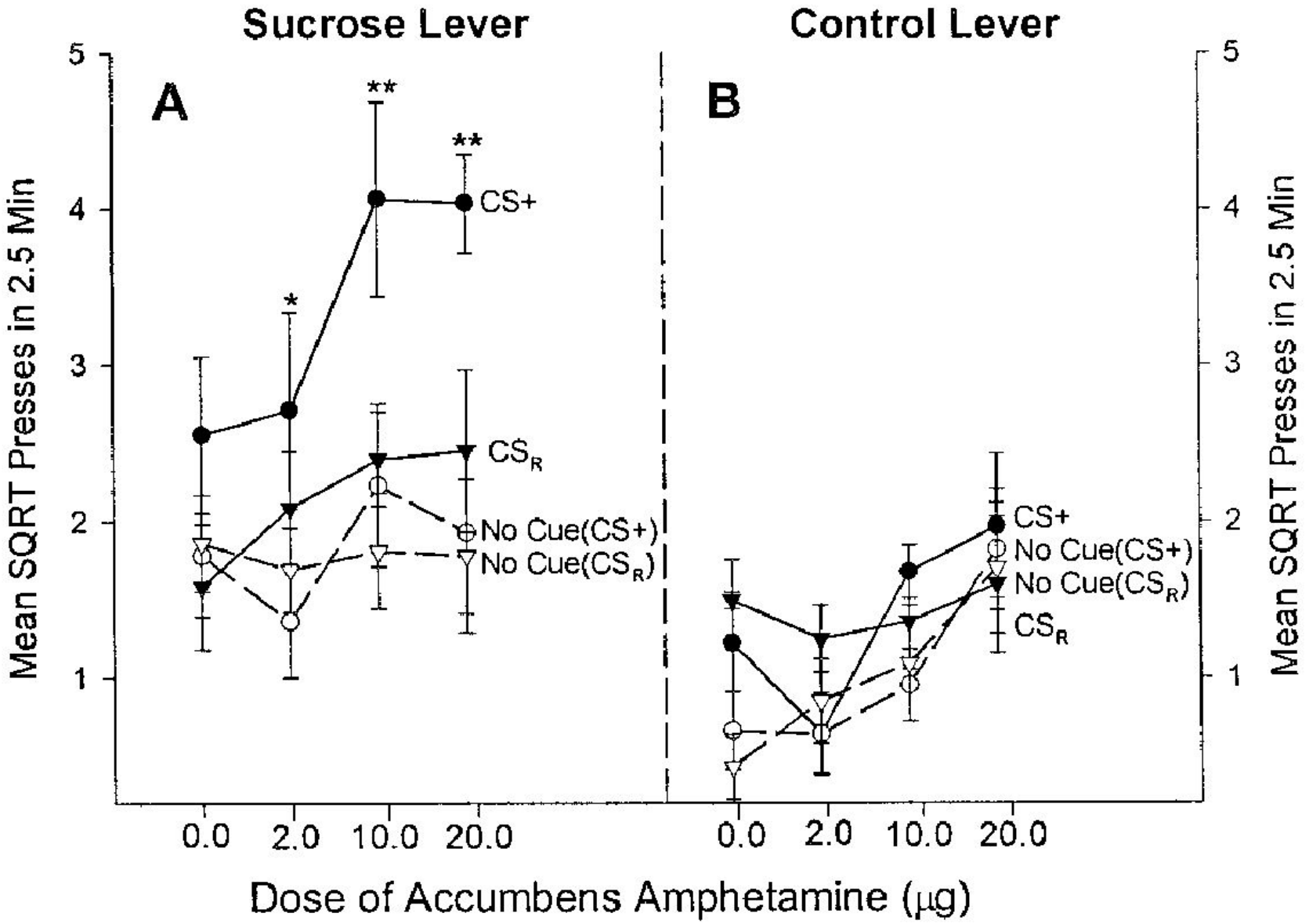




*chance*

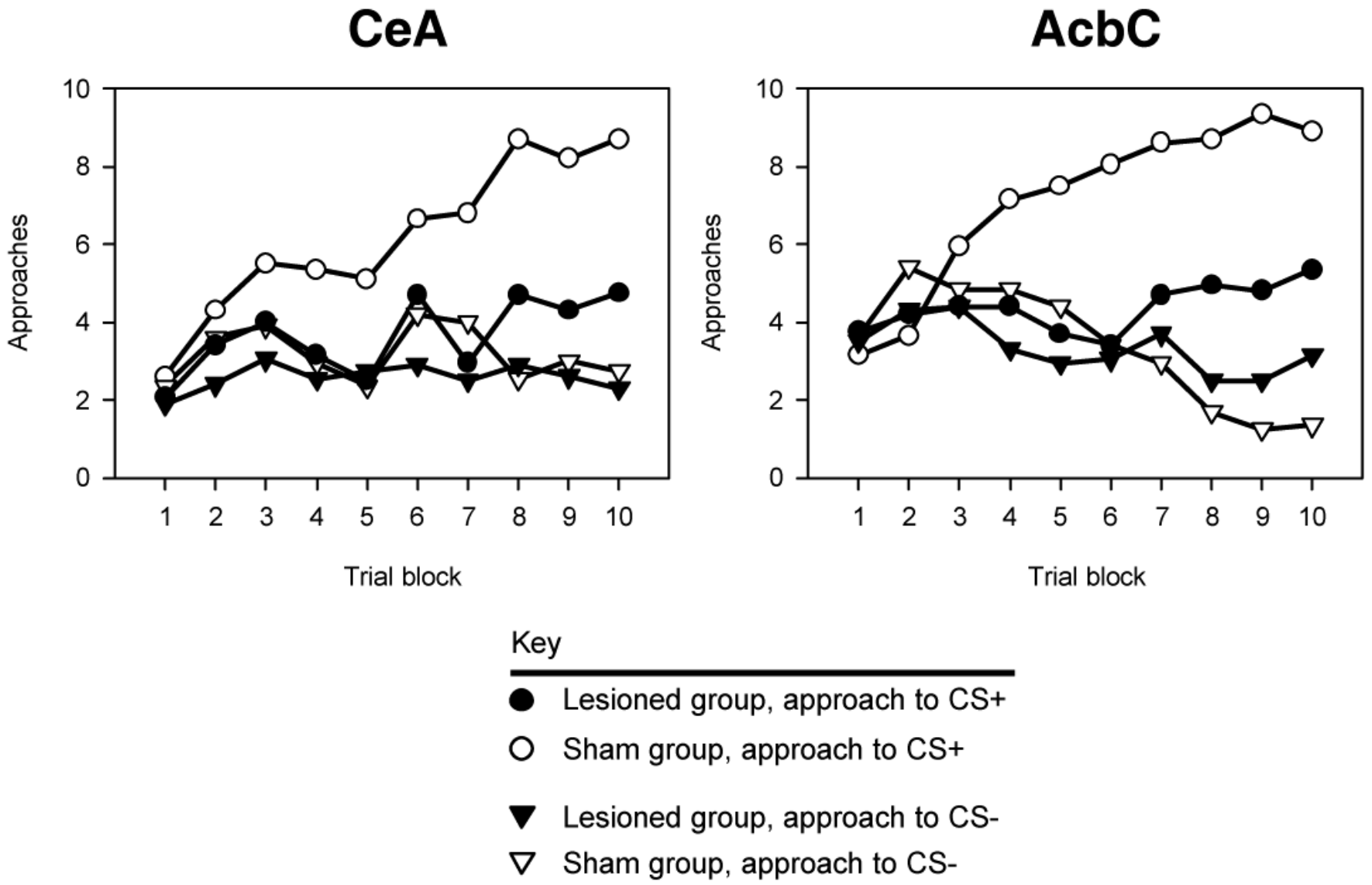
*Hall et al. (2001)*

# Intra-accumbens amphetamine enhances PIT



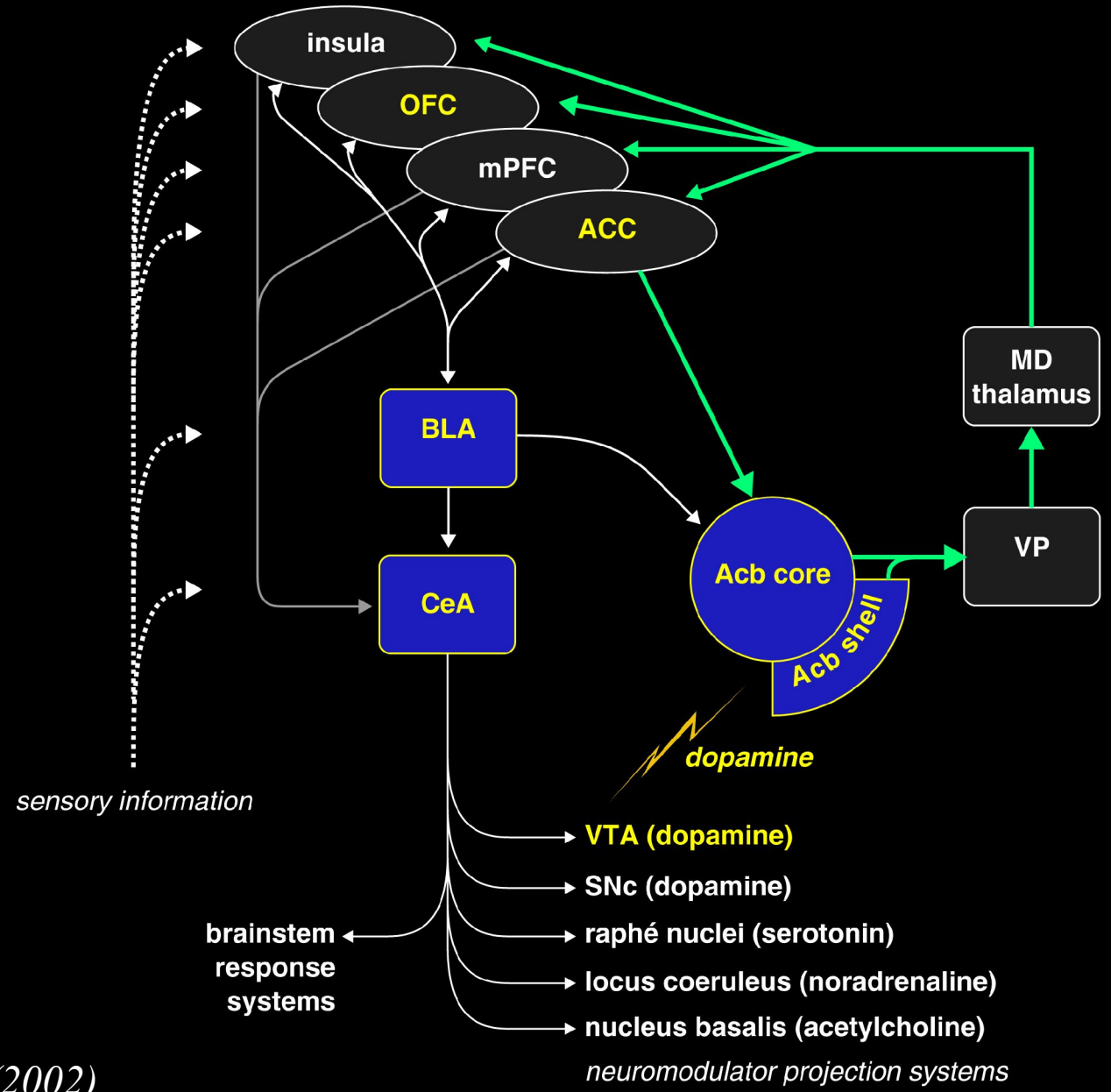

*Wyvell & Berridge (2000)*

# Conditioned approach also requires the Acb and amygdala



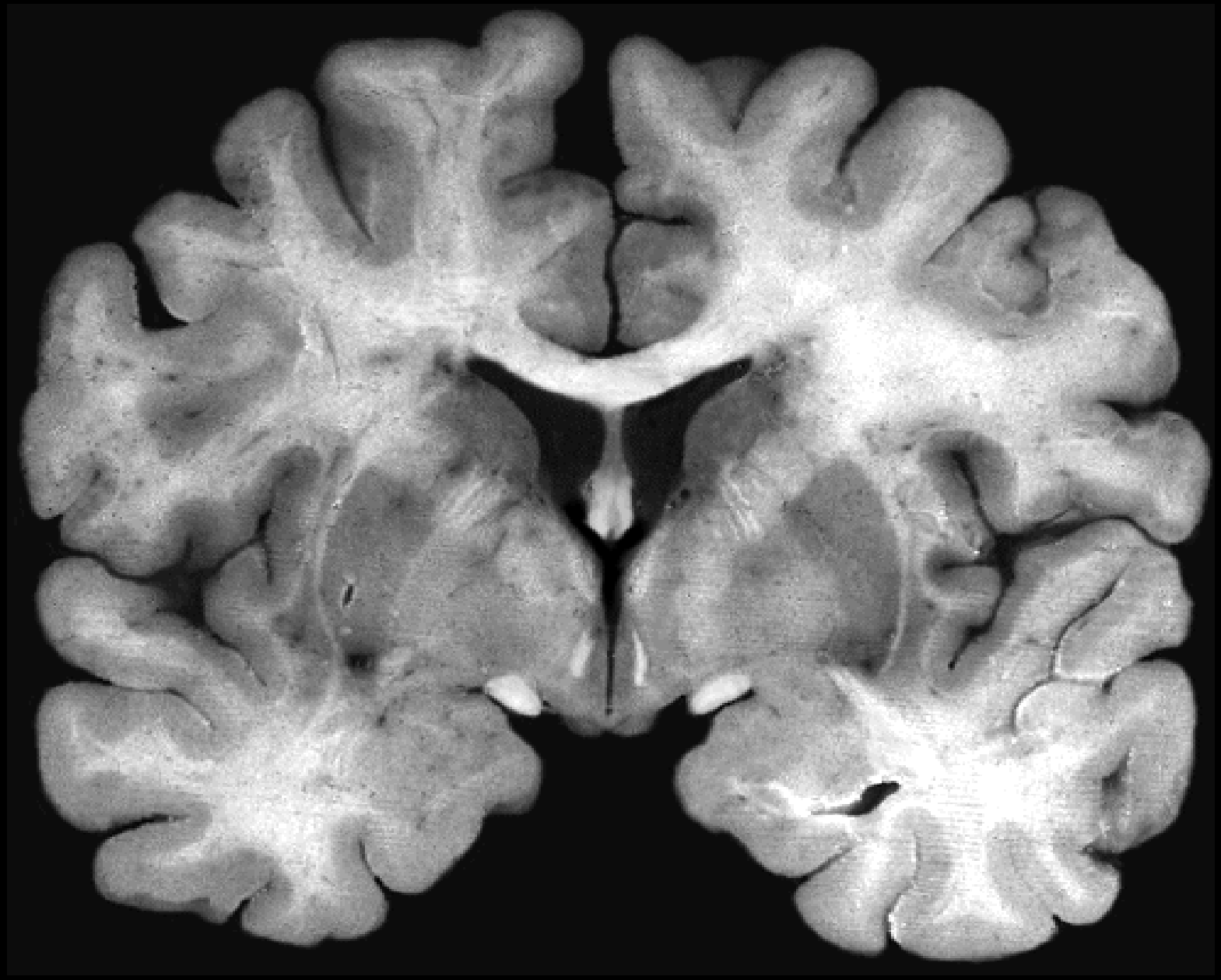

*Parkinson et al. (2000a, 2000b)*

# The limbic corticostriatal circuit: conditioned motivation

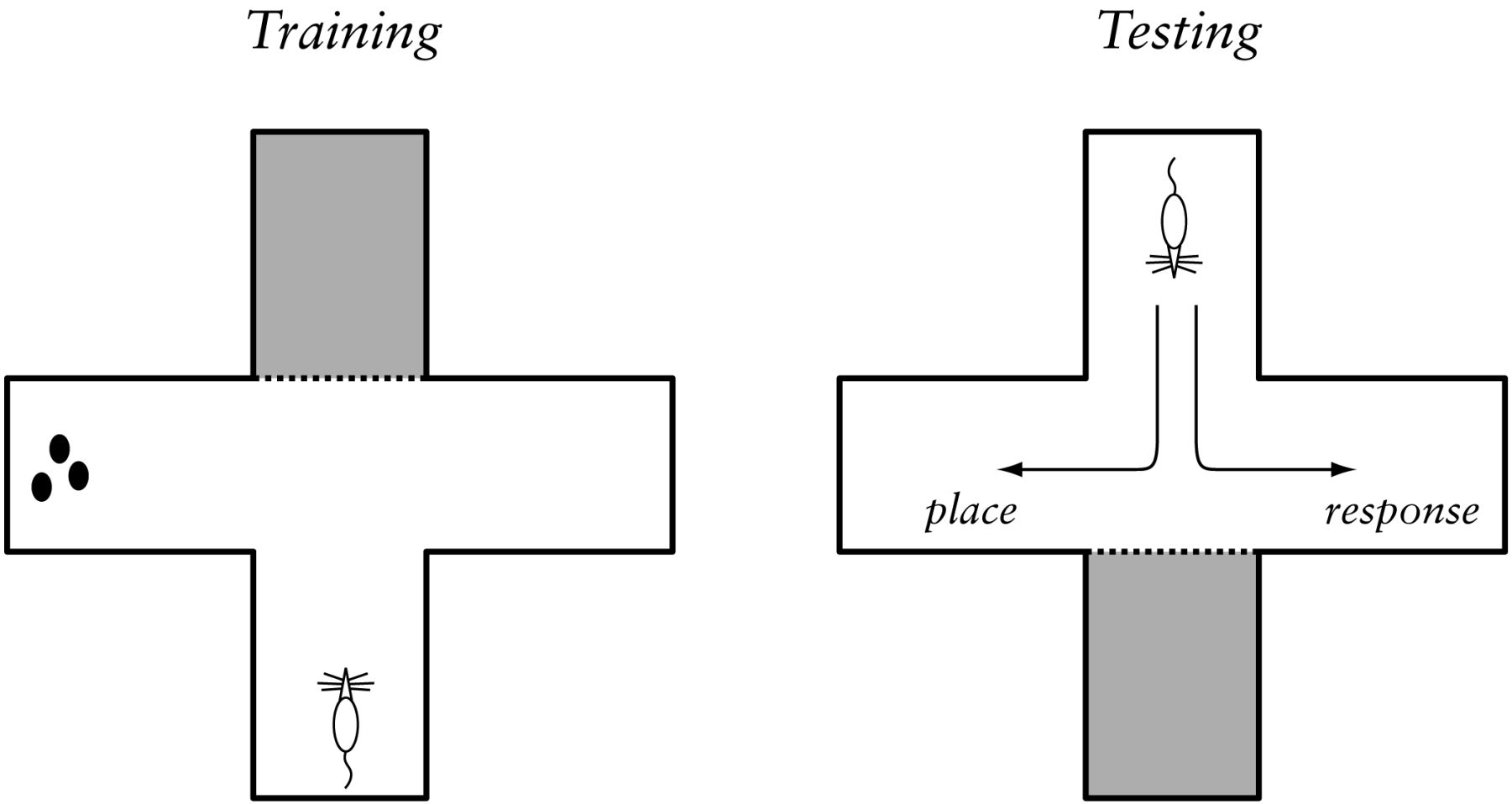



*Cardinal et al. (2002)*

# Habits: the dorsal striatum? (1)

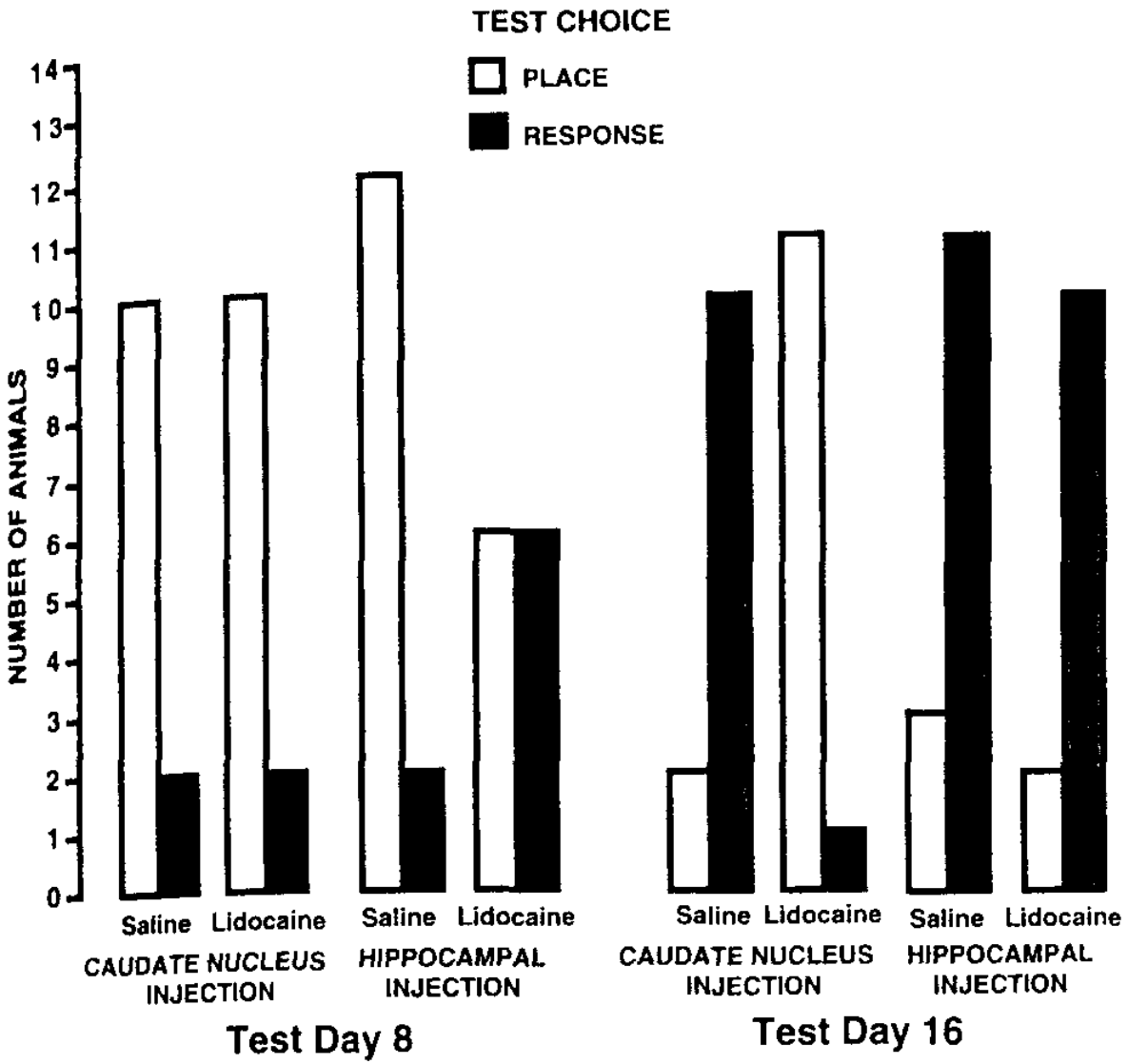


# Habits: the dorsal striatum? (2)




*Packard & McGaugh (1996)*

# Habits: the dorsal striatum? (3)




*Packard & McGaugh (1996)*

# Summary

- Knowledge of the relationship between your own actions and their outcomes may depend on prefrontal cortex.
- 'Liking' particular foodstuffs (hedonic experience) may depend on opioid and GABA receptors (e.g. in accumbens / pallidum / brainstem).
- If you discover you like a food, its instrumental incentive value becomes high (neural basis unclear).
- Pavlovian conditioned motivation (sometimes referred to as 'wanting' or 'craving') can be distinguished from true goal-directed action, and from hedonic value. It depends on an amygdala / nucleus accumbens circuit, and its dopamine innervation.
- Habits develop with time; these may depend on the dorsal striatum.
- Once your goals have been obtained, consummatory behaviour