MRCPsych (Part 1)

Memory

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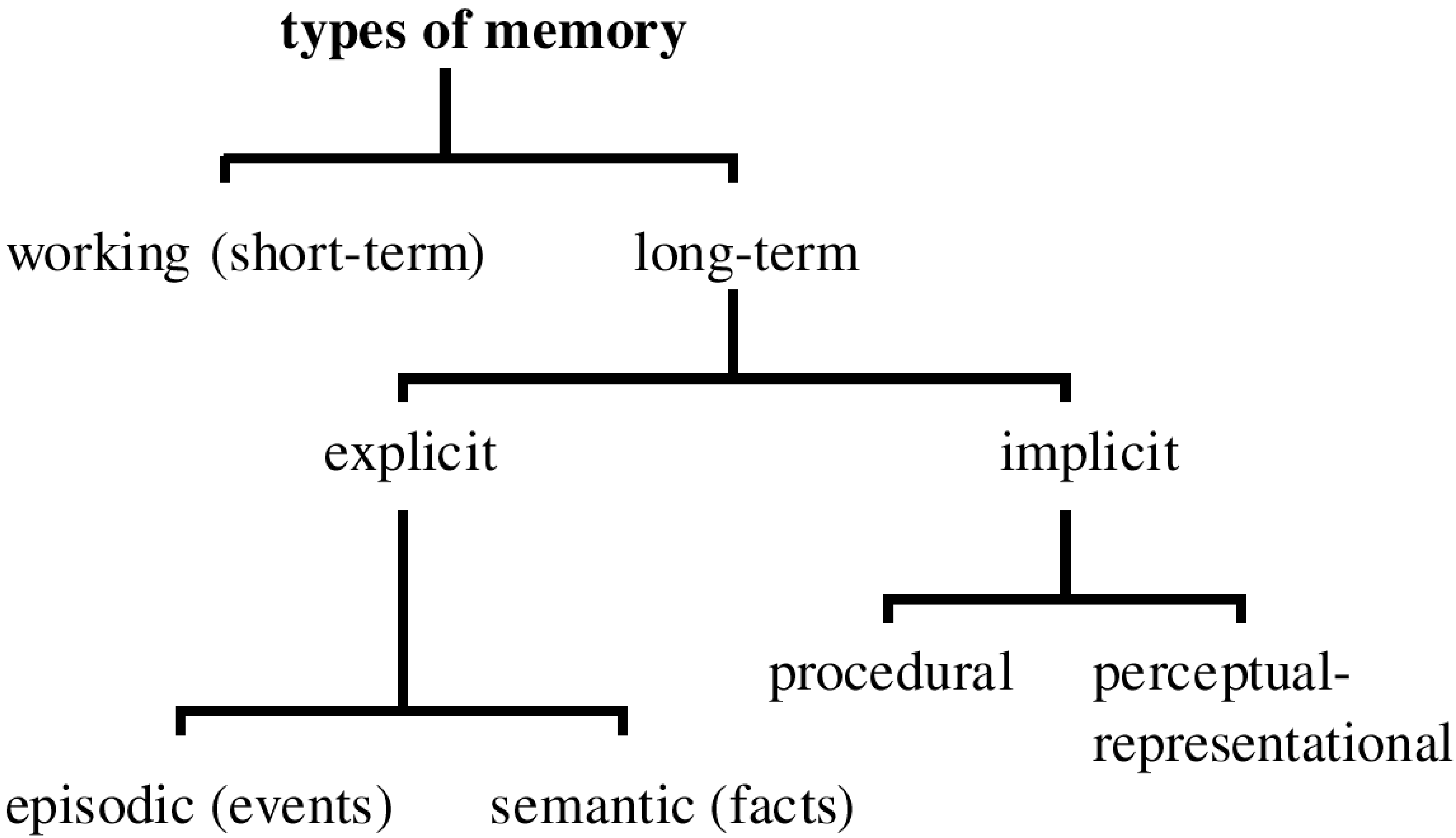
Tuesday 25 March 2004, 3pm
Fulbourn Hospital, Fulbourn, Cambridge

Types of memory



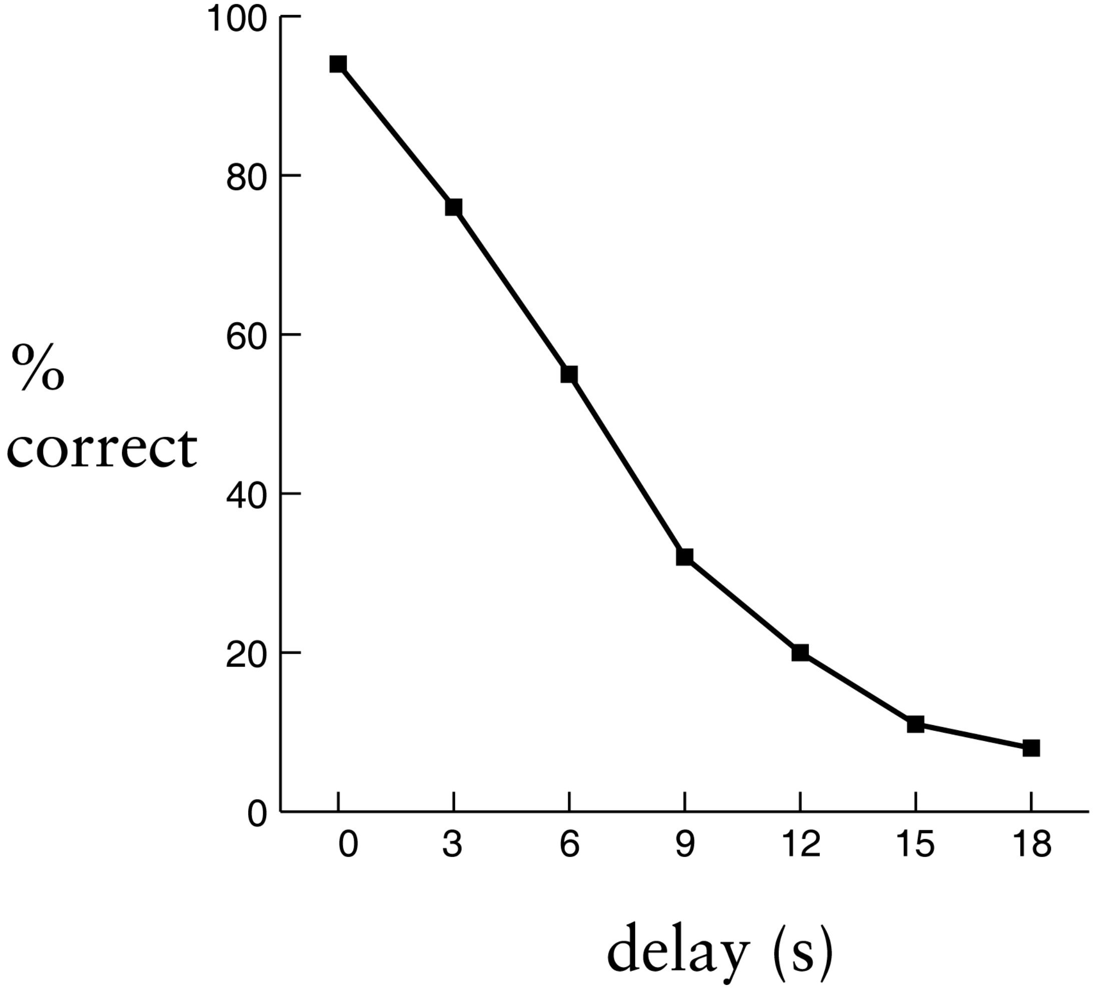
Morris (2001), after Tulving

The ‘sensory store’ — e.g. visual ‘iconic’ memory

Sperling (1960)

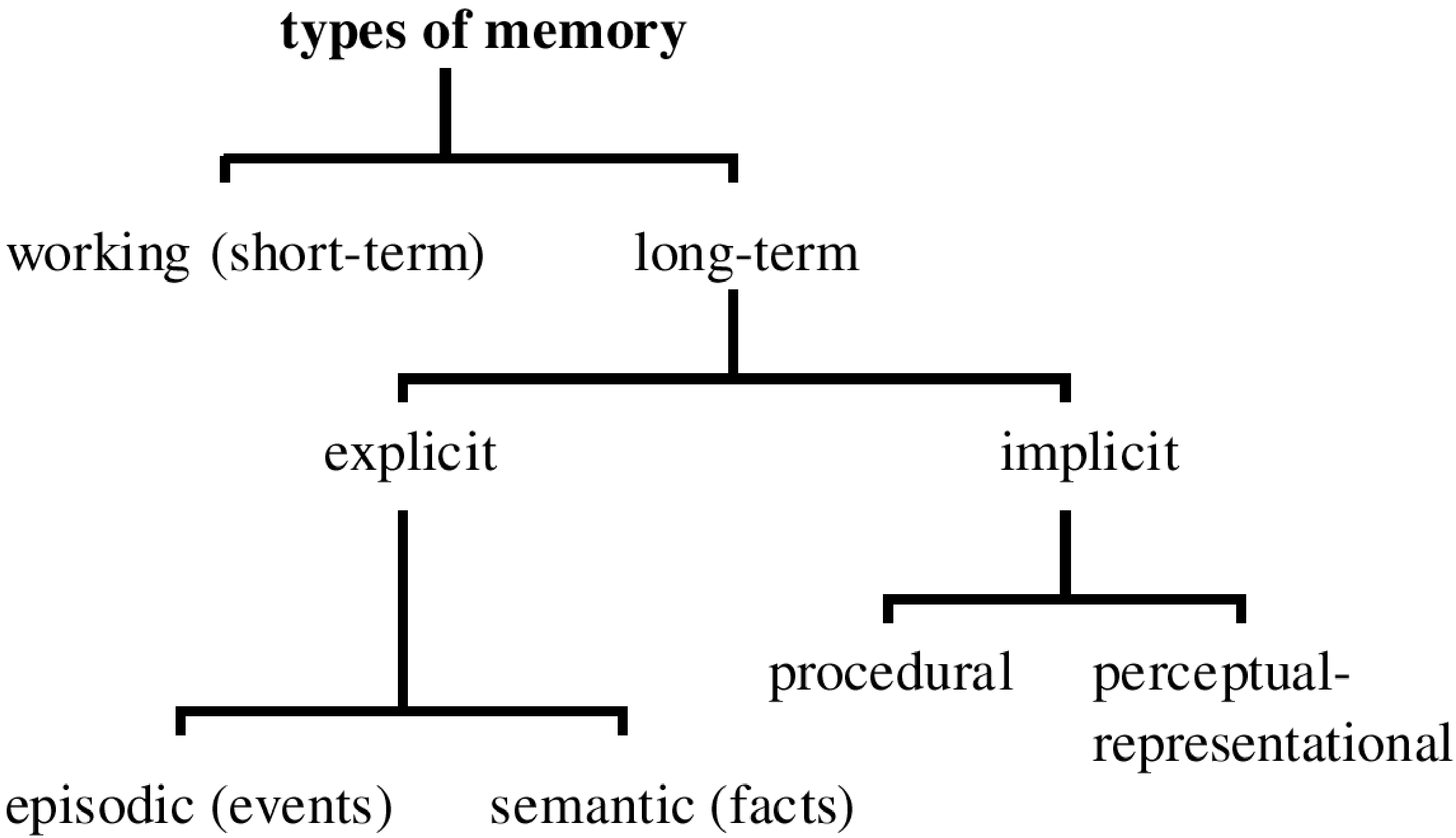
STM is very S

hear 'QKN'... delay with distractor task... recall?



Peterson & Peterson (1959)

Types of memory



Morris (2001), after Tulving

Episodic versus semantic memory

'The accident rate while parachuting is 30 per 100,000 jumps.'

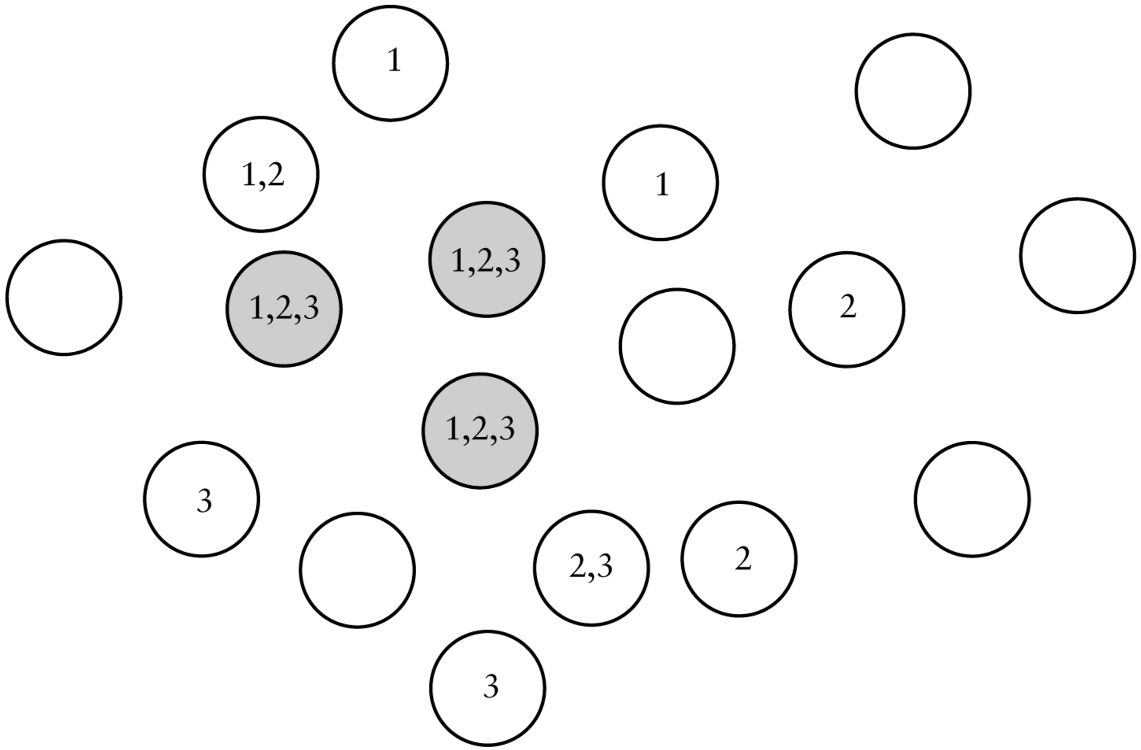
Semantic

Episodic

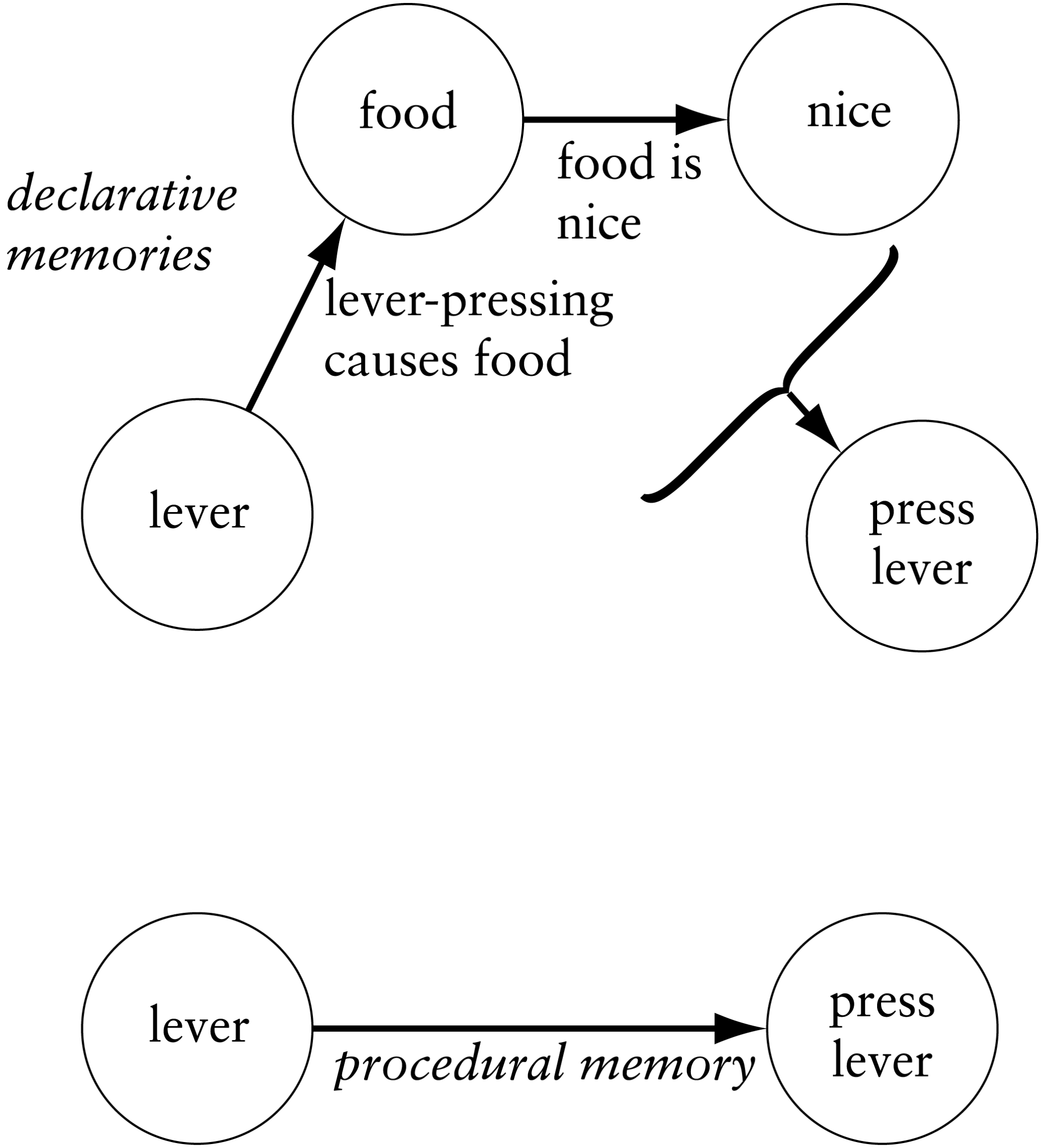
Semantic memory… categories

Semantic memory: cortical, distributed, related to perception?

Extracting general properties by the consistent activation of common elements.
If a network perceives three cats, there will be elements unique to each cat (1) (2) (3) and elements common to all cats (1,2,3). Is this *catness?*



Procedural versus declarative memory



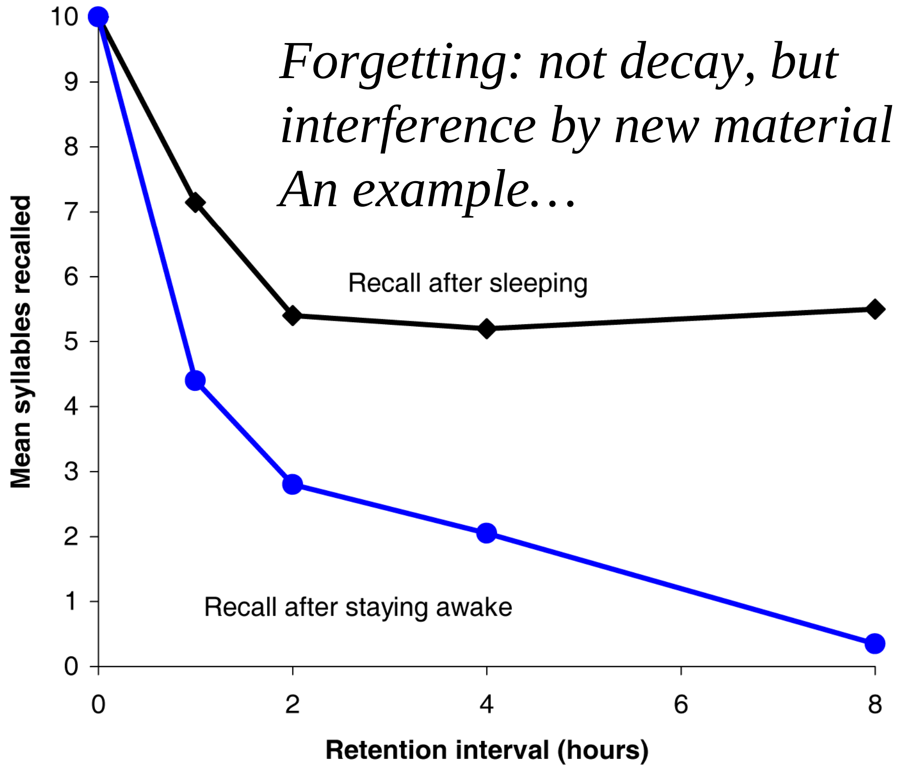
after Dickinson (1980)

Priming

Preceding stimulus	Target to be classified (RT is measured)	
north	doctor	
nuber	doctor	
nurse	doctor	*shorter RT - semantic priming*

Meyer & Schvaneveldt (1971)

Forgetting, and state-dependent memory

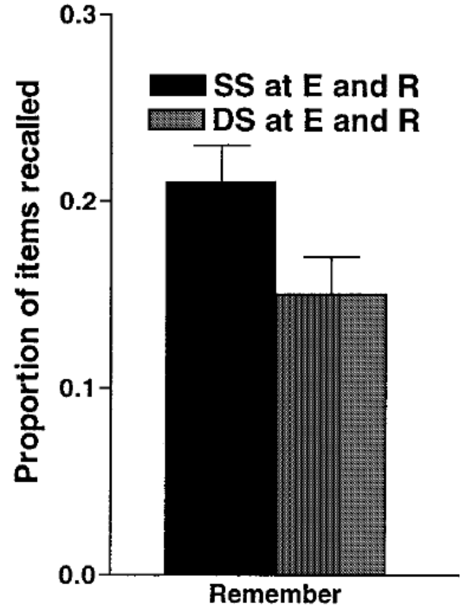


Forgetting: not decay, but interference by new material? An example…

*Does the **context** become part of the memory? Recall is easier if you're in the same **state or context** as that in which you learned. Referred to as **state-dependency.***

Examples:

- room 1 versus room 2
- on land versus underwater
- sober versus drunk (for tests of explicit memory) →



e.g. Jenkins & Dallenbach (1924); Waugh & Norman (1965); Abernathy (1940); Godden & Baddeley (1975); Duka et al. (2001)

Schemata and memory distortion

Bartlett (1932); Allport & Postman (1947)

Human amnesia

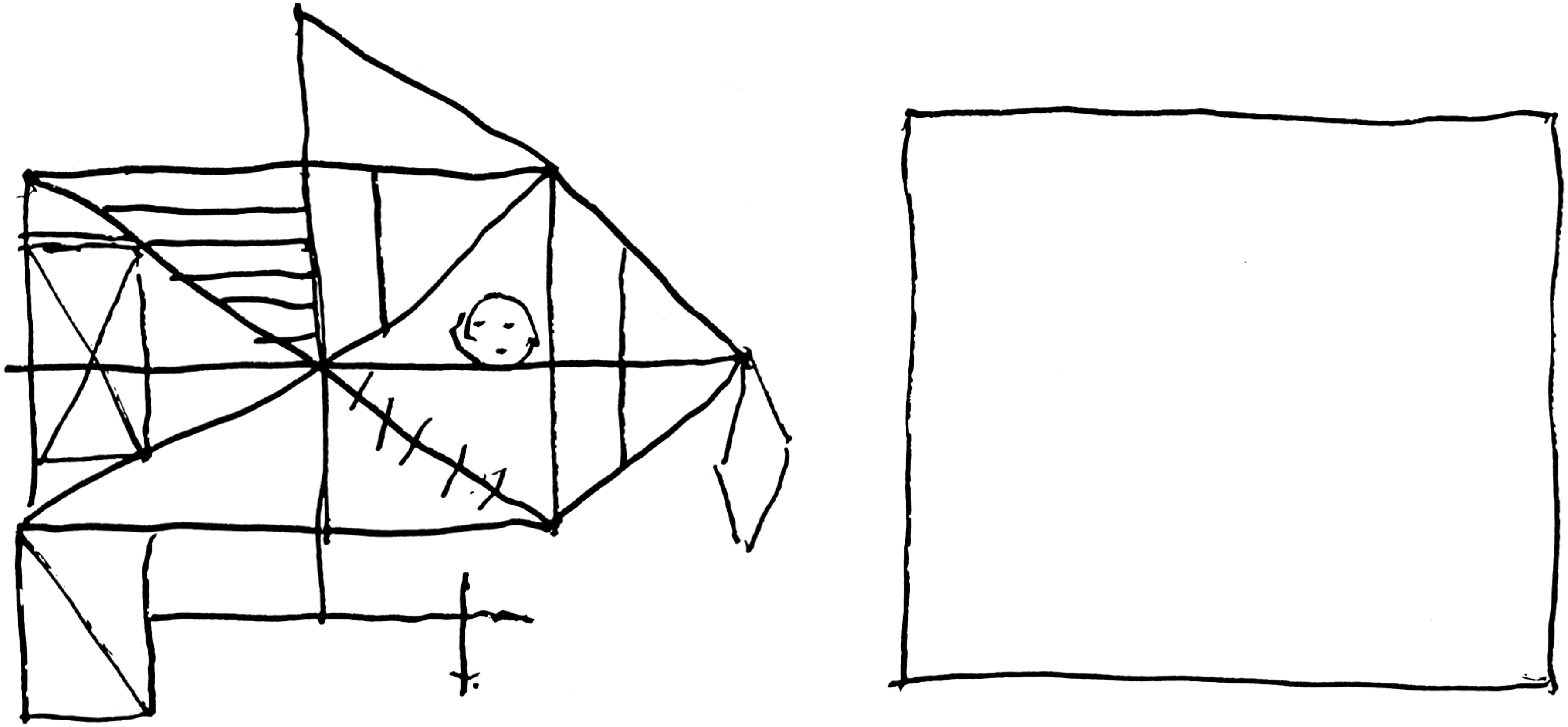
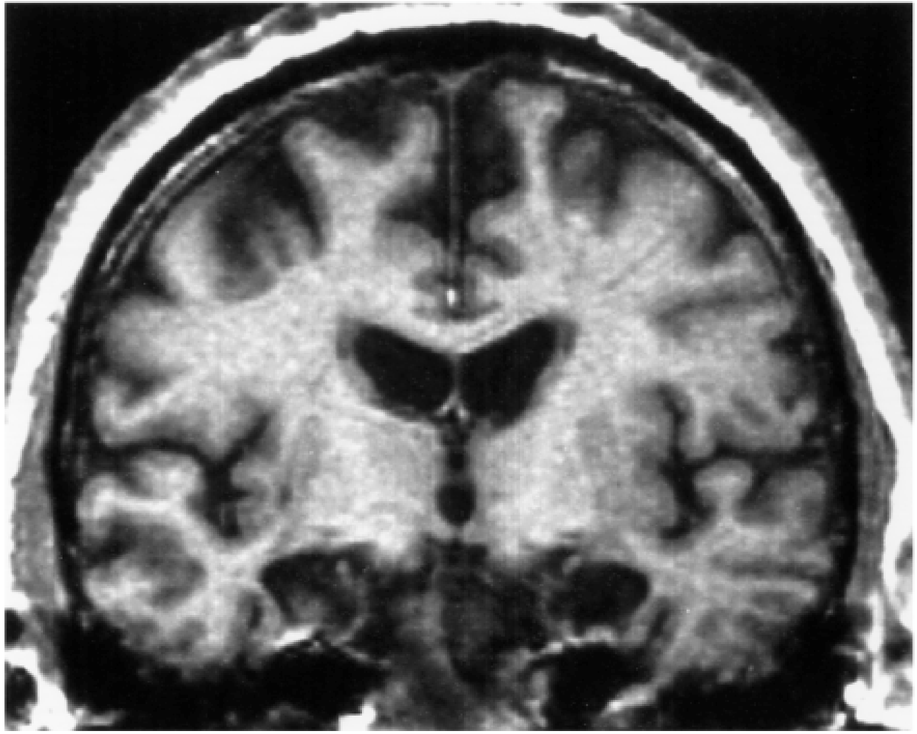


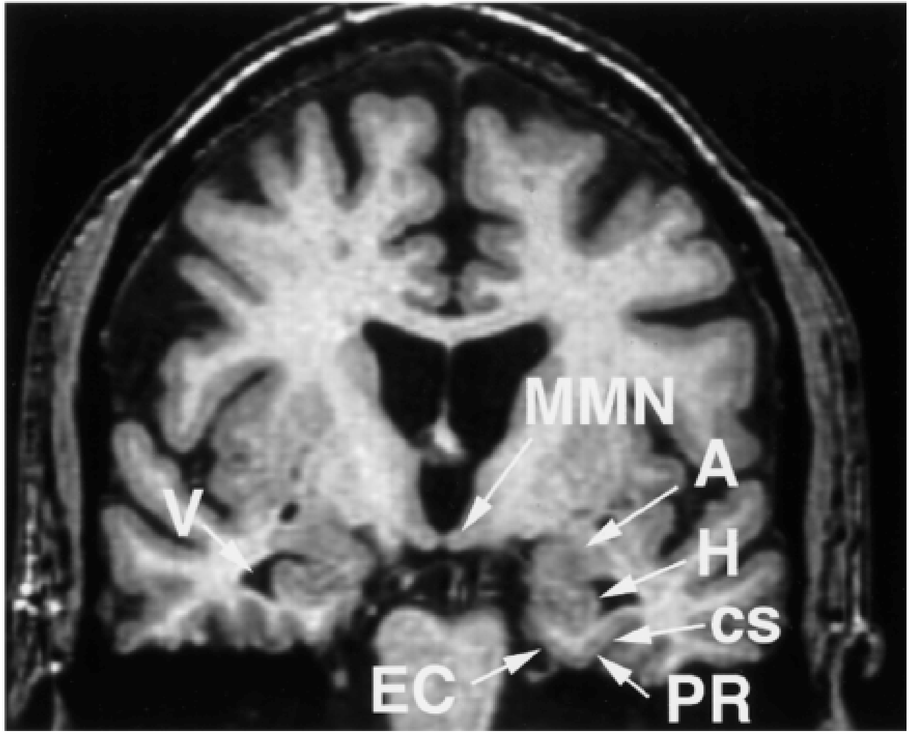
FIGURE 48.6 The performance of a bilateral diencephalic damaged patient with dense amnesia in copying the Rey-Osterrieth figure (top) and his attempt at redrawing it by heart immediately after having seen and copied it. (Results on case A. B. of Markowitsch, von Cramon, and Schuri, 1993.)

from Markowitsch (1995)

H.M.'s bilateral medial temporal lobe resection on MRI



H.M.



normal brain

EC entorhinal cortex, MMN medial mammillary nucleus; A amygdala; H hippocampus
CS collateral sulcus; PR perirhinal cortex
1953 operation: Scoville & Milner (1957) J Neurol Neurosurg Psych 20: 11
MRI: Corkin et al. (1997) J Neuro 17: 3694

Preserved abilities in medial temporal lobe amnesia

Profound anterograde amnesia. Impaired recognition. Some retrograde amnesia (temporally graded).

But

• **IQ** normal

• Could learn mirror-writing (Milner 1962, 1965) and similar **motor skills** day-by-day, despite inability to remember that he'd done it before.

• Learned a perceptual learning task (recognition of words from incomplete fragments)

• Improved with practice on the Tower of Hanoi task (Cohen 1984)

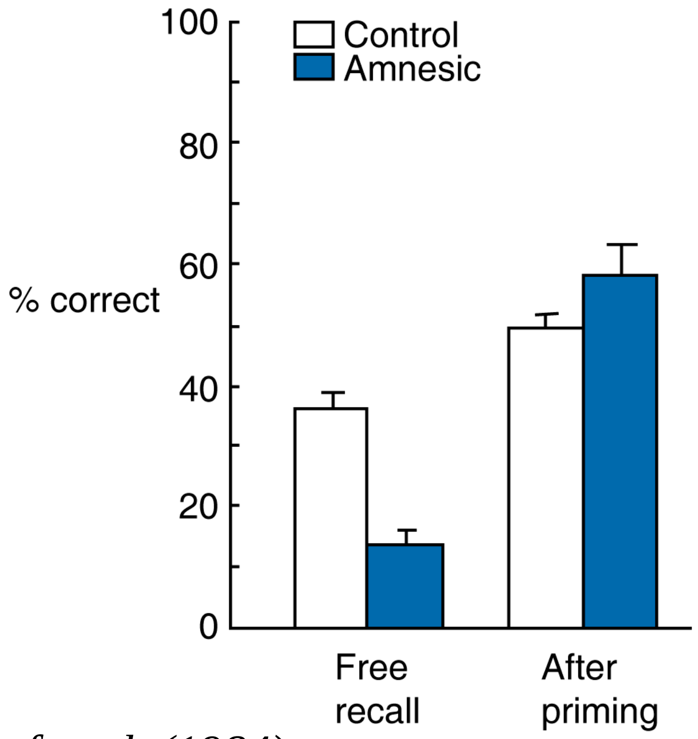
• **Short-term memory:** normal digit span and visual immediate memory

• **Priming** normal (typical of amnesiacs, see Aggleton & Brown 1999)

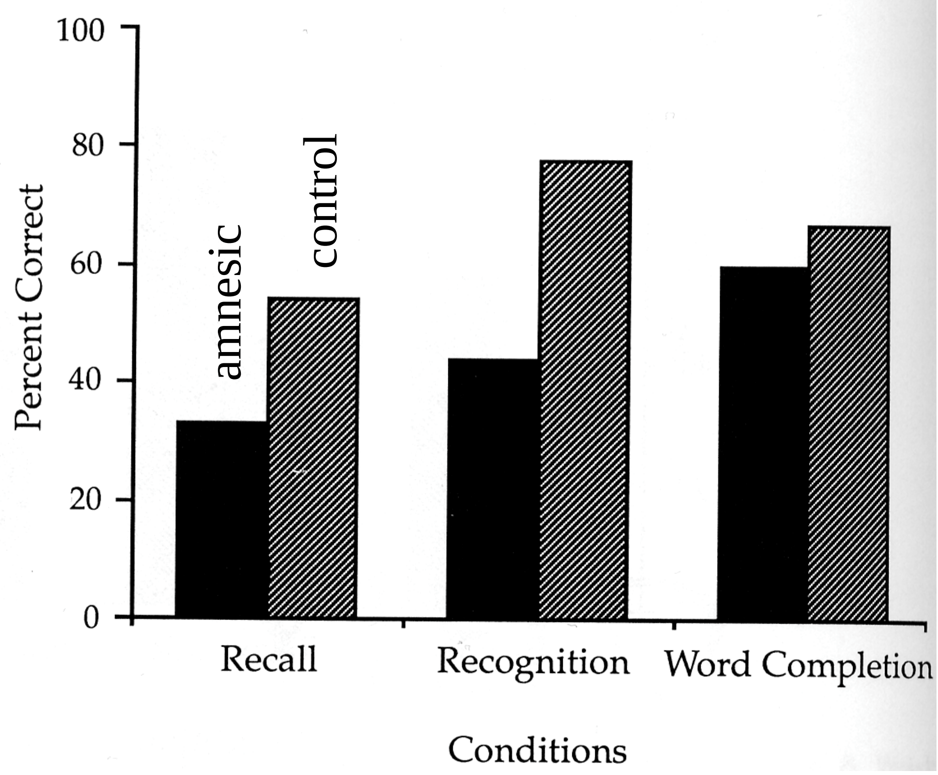
McCarthy & Warrington (1990)

Priming is intact in amnesiacs

ABSENT	ABS__________
INCOME	INC__________
FILLY	FIL__________
DISCUSS	DIS__________
CHEESE	CHE__________
ELEMENT	ELE__________



Graf et al. (1984)



Warrington & Weiskrantz (1970)

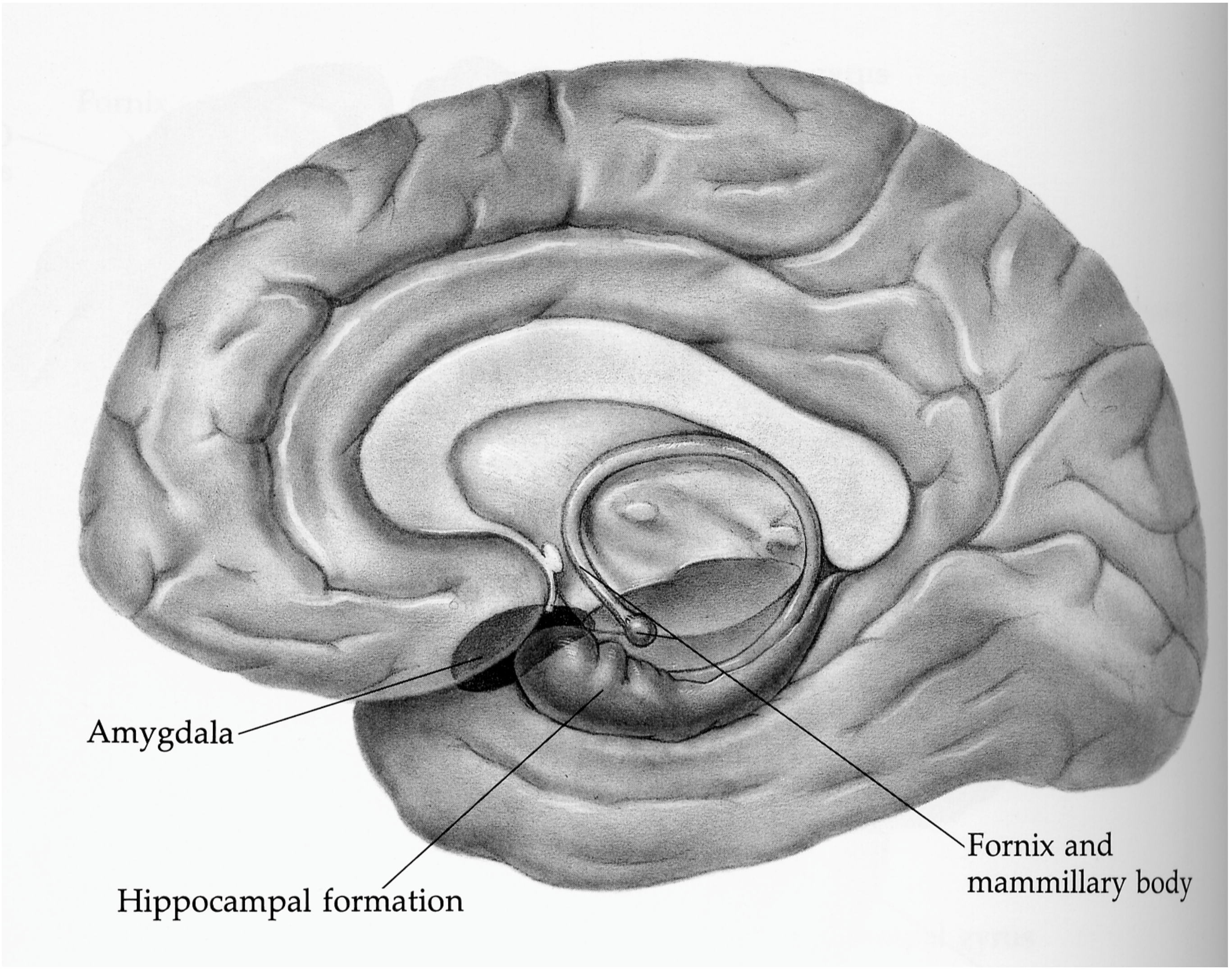
Learning skills (procedural memory)

H.M. improved with practice
on mirror-drawing and mirror-reading
tasks, from session to session.

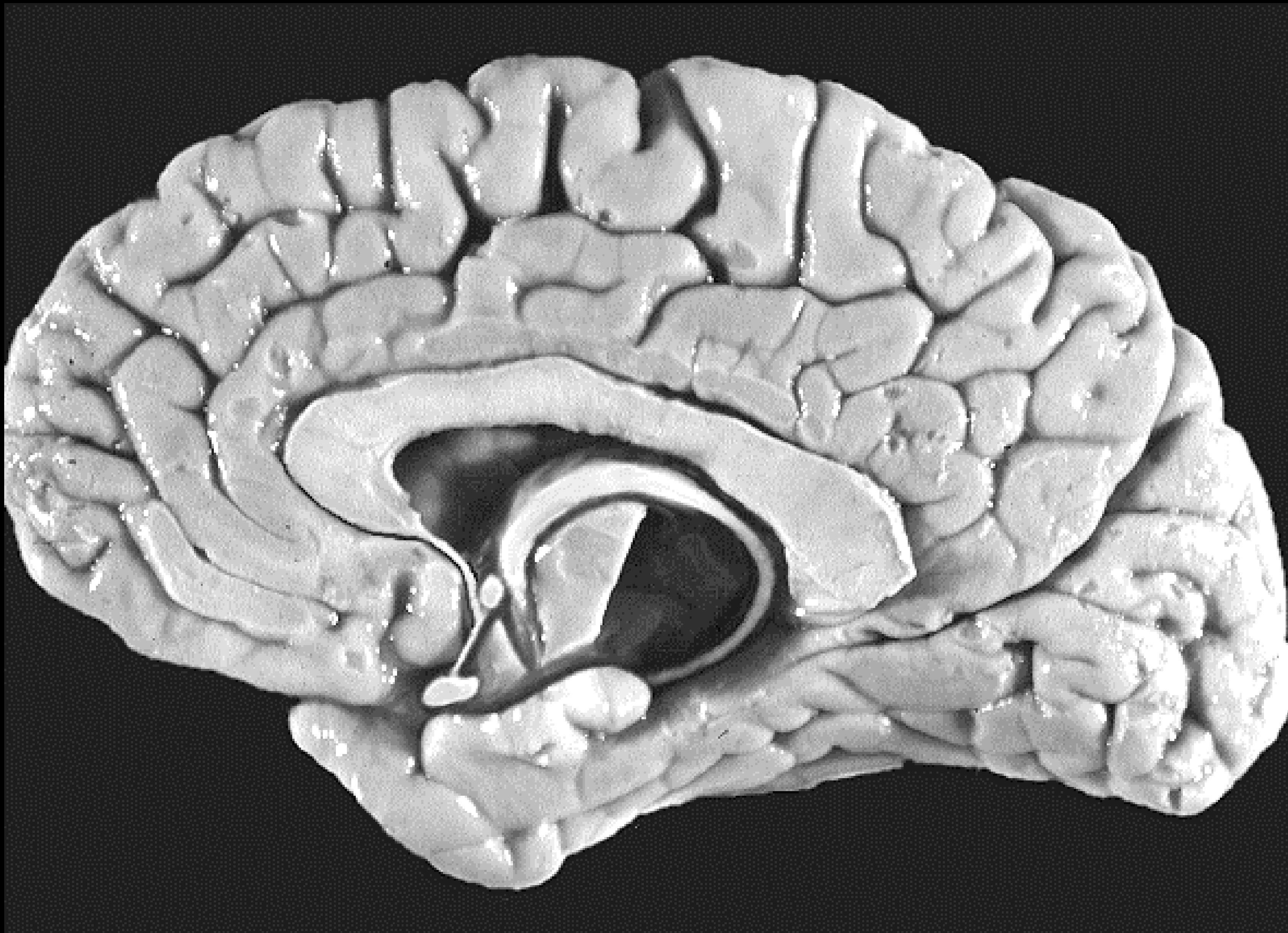
Yet he could not remember
practising.

Milner (1962), Corkin (1968), etc.

The medial temporal lobe: hippocampus, amygdala, fornix



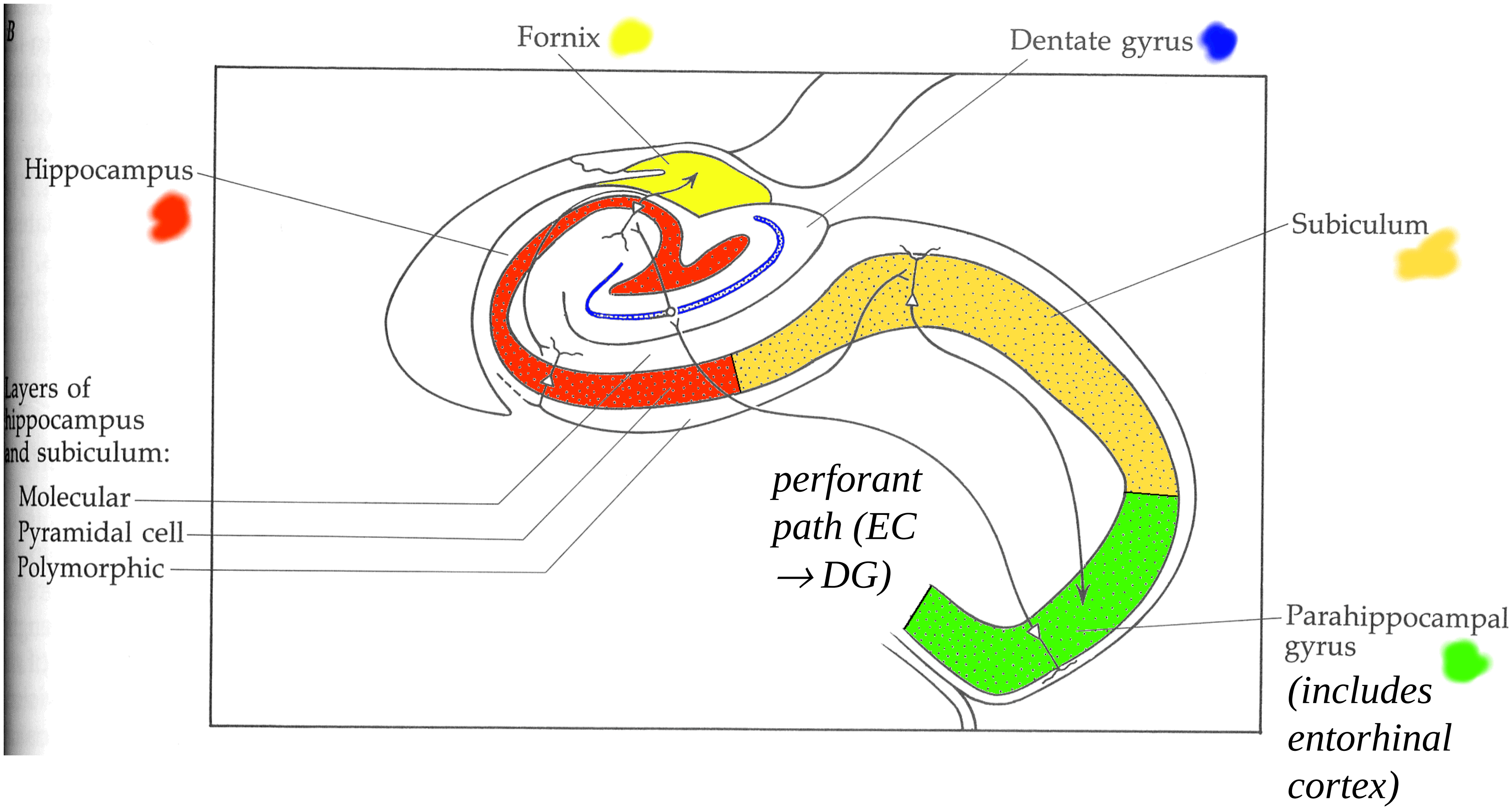
Medial temporal lobe and fornix



The hippocampal formation in cross-section

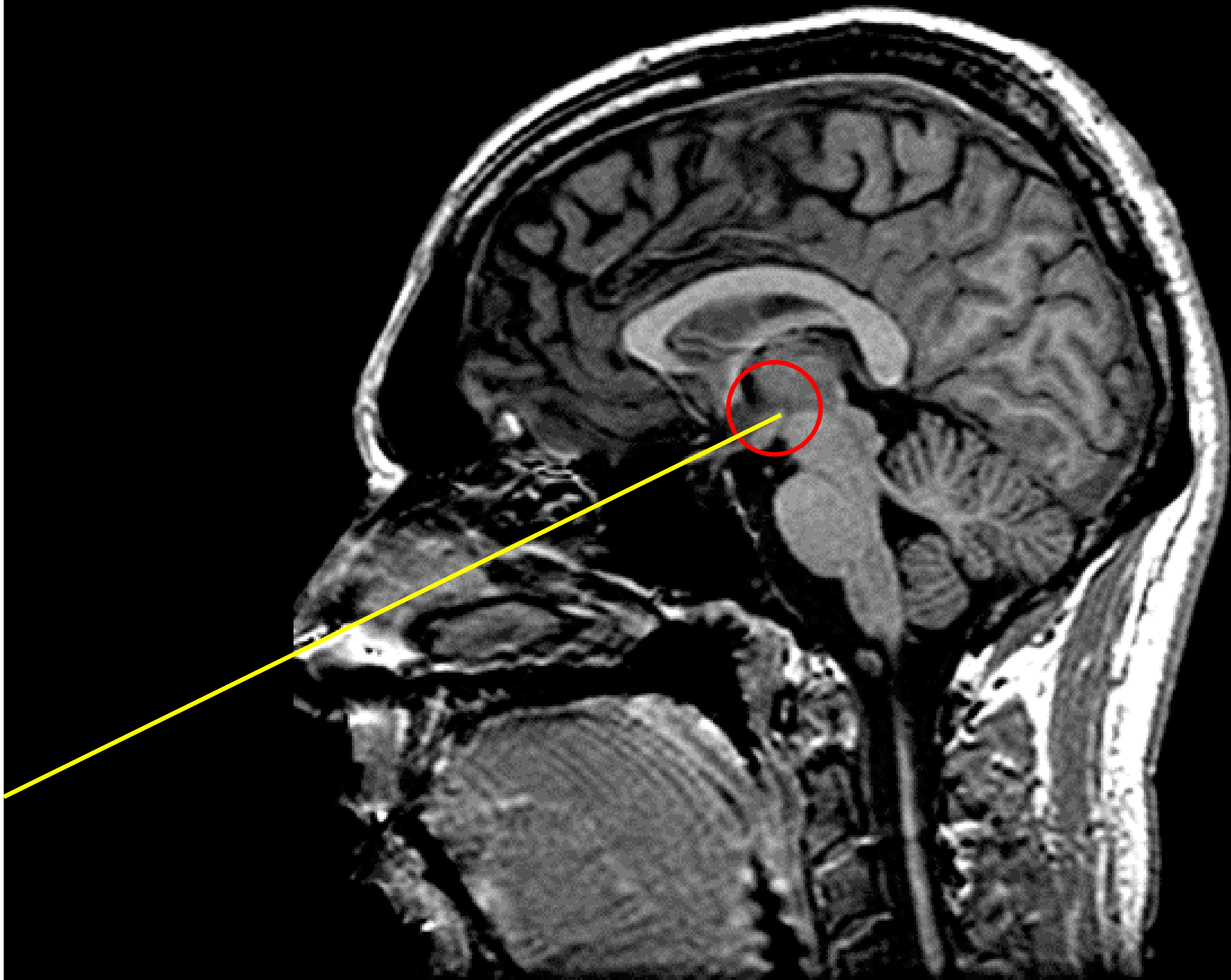
Martin (1989, p391)

The hippocampal formation in cross-section (approx.!)



Martin (1989, p391, modified)

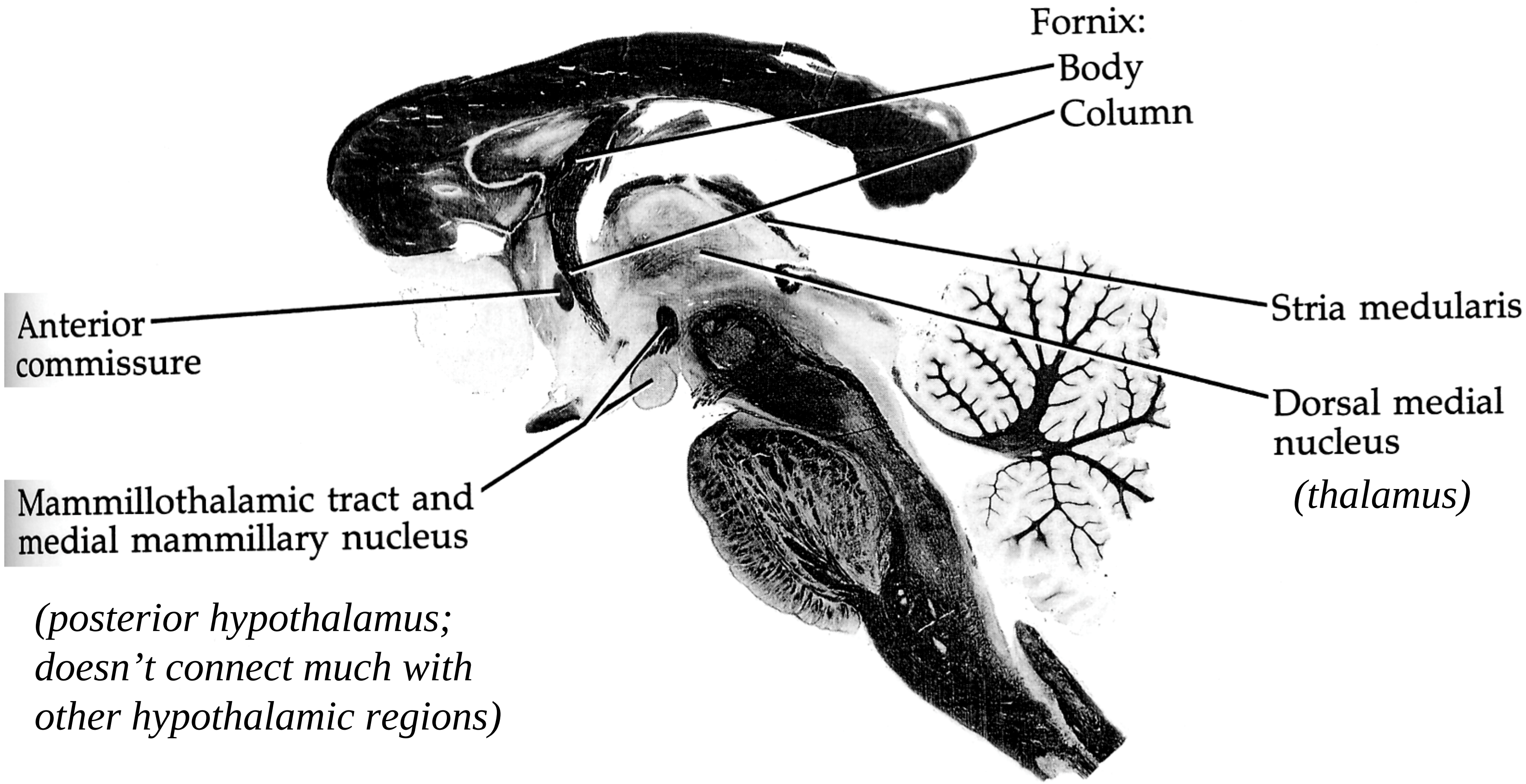
Patient N.A.: fencing foil (up nostril) to diencephalon



(Normal brain! Approximate area of damage in N.A. circled.)

Diencephalon: thalamus, hypothalamus, epithalamus

The Delay–Brion circuit: hippocampus → fornix → mammillary bodies → mammillothalamic tract → thalamus



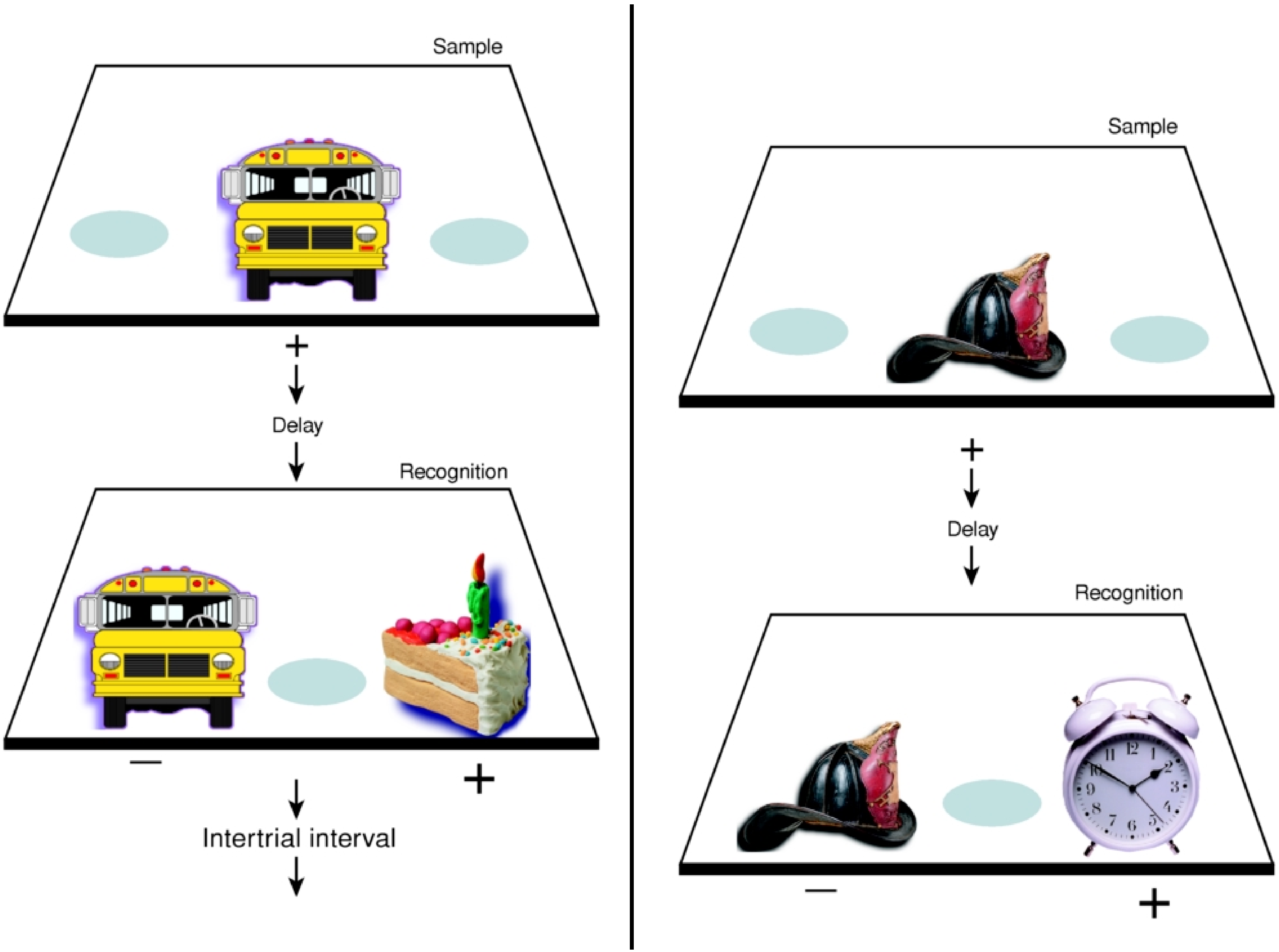
(thalamus)

(posterior hypothalamus; doesn't connect much with other hypothalamic regions)

(myelin stain; from Martin, 1991)

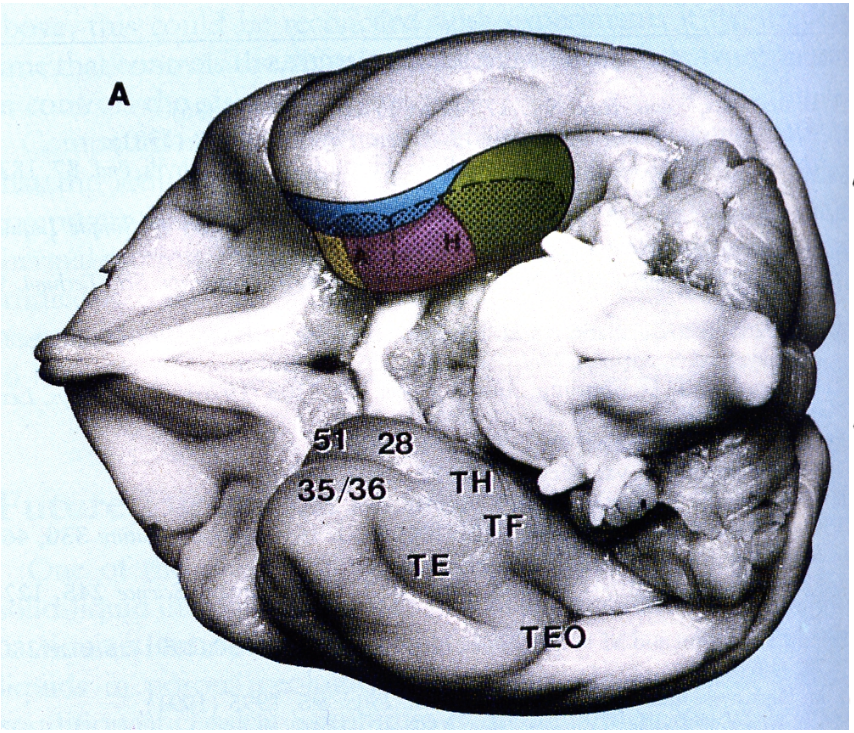
Defining the contribution of medial temporal lobe structures

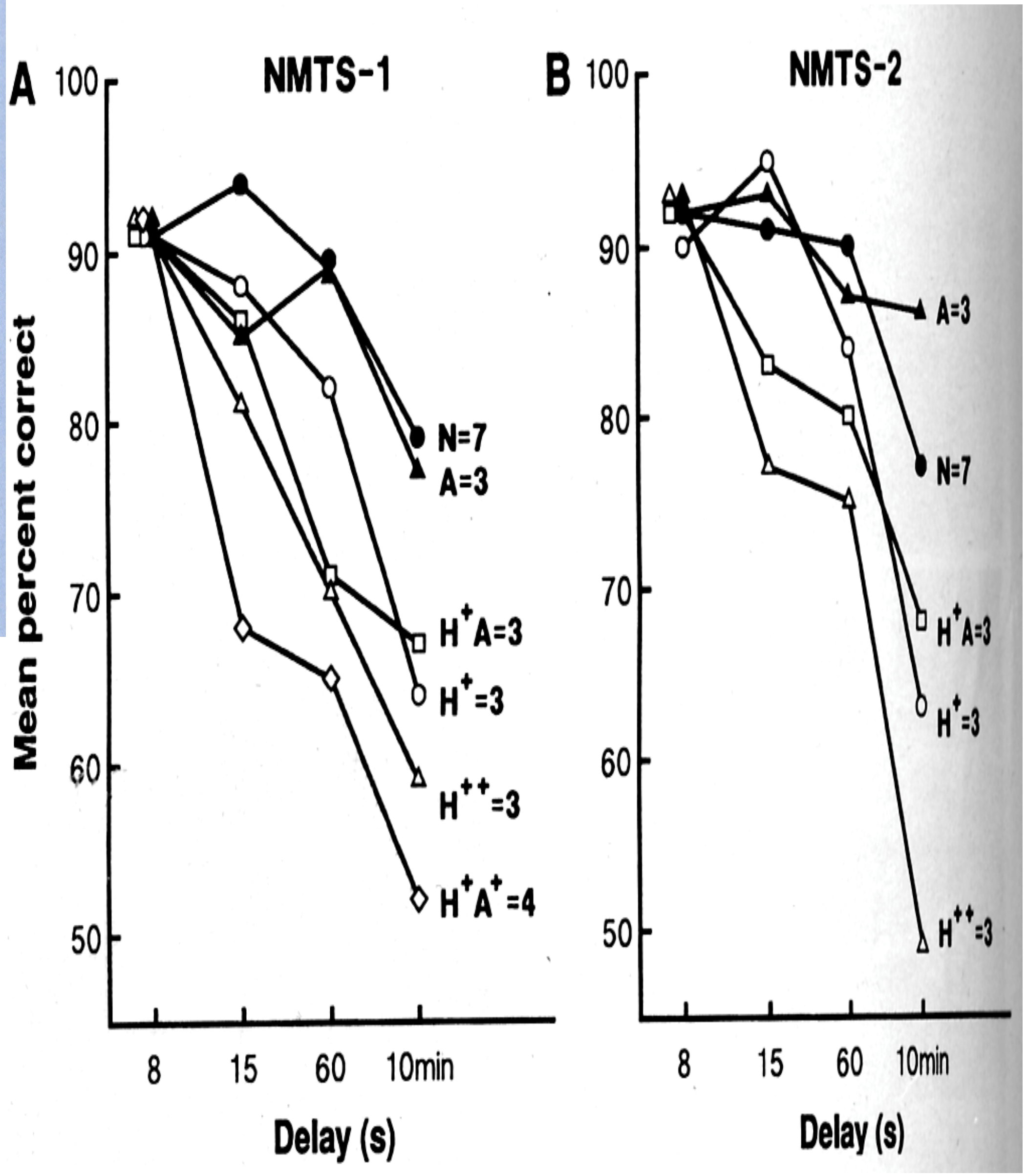
Delayed non-matching to sample



(from Zigmond et al., 1999)

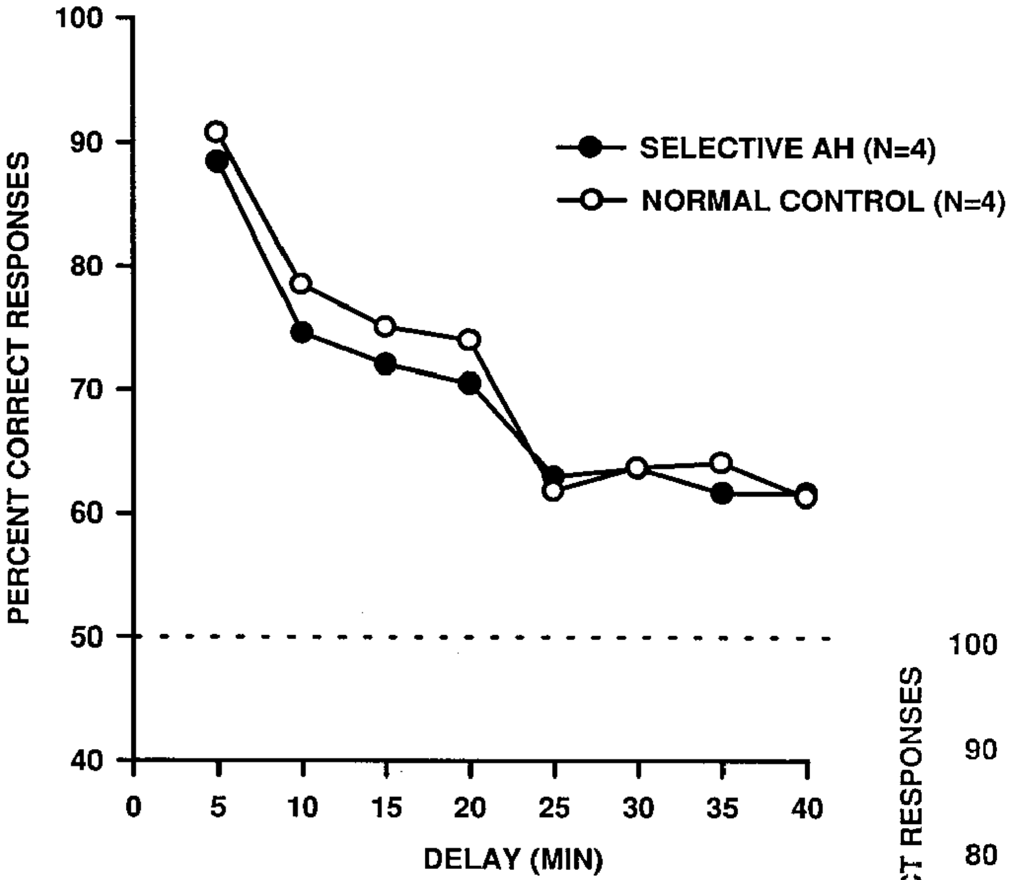
Medial temporal lobe lesions and DNMTS (1): aspirative

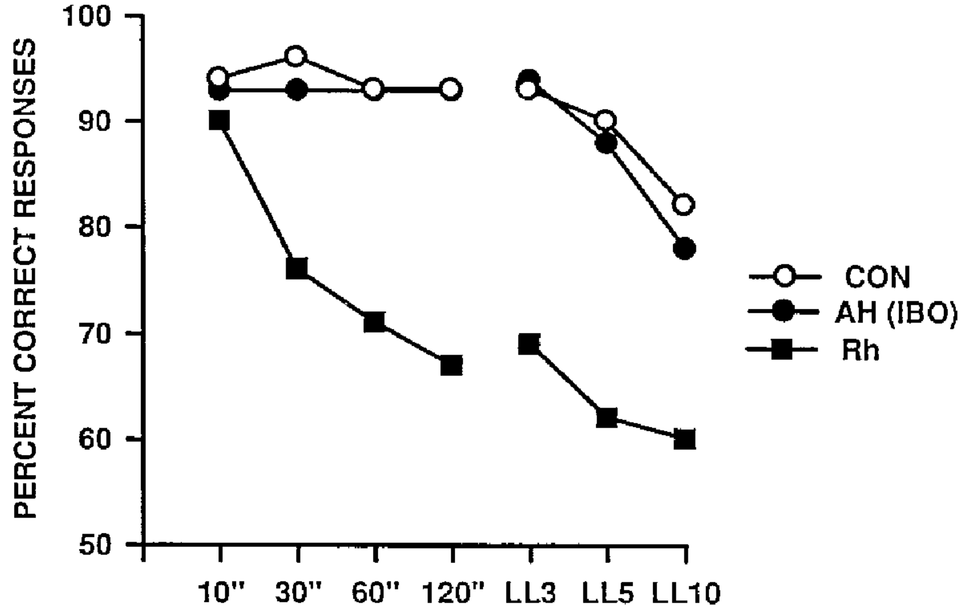




from Squire & Zola-Morgan (1991)

Medial temporal lobe lesions and DNMTS (2): excitotoxic

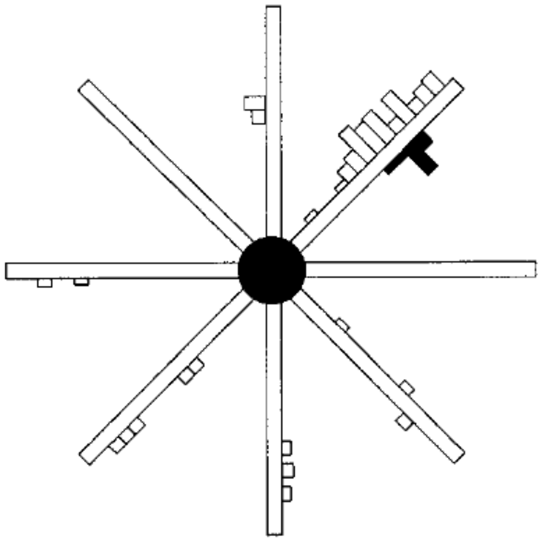




Murray & Mishkin (1998)

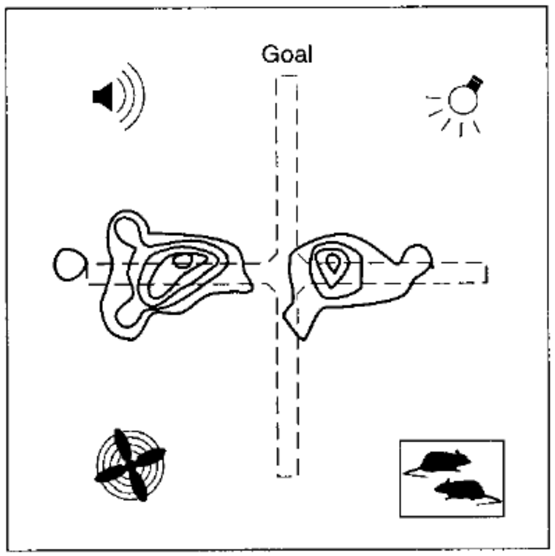
‘Place cells’ in the rat hippocampus

A

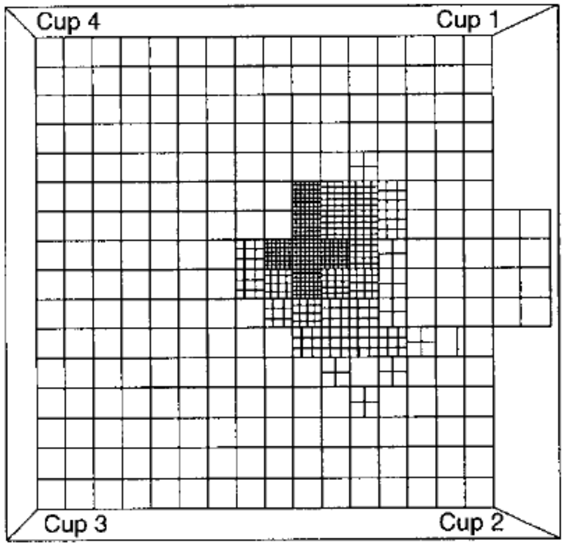


e.g. O’Keefe & Dostrovsky (1971)

C



D



The hippocampus as a cognitive map?

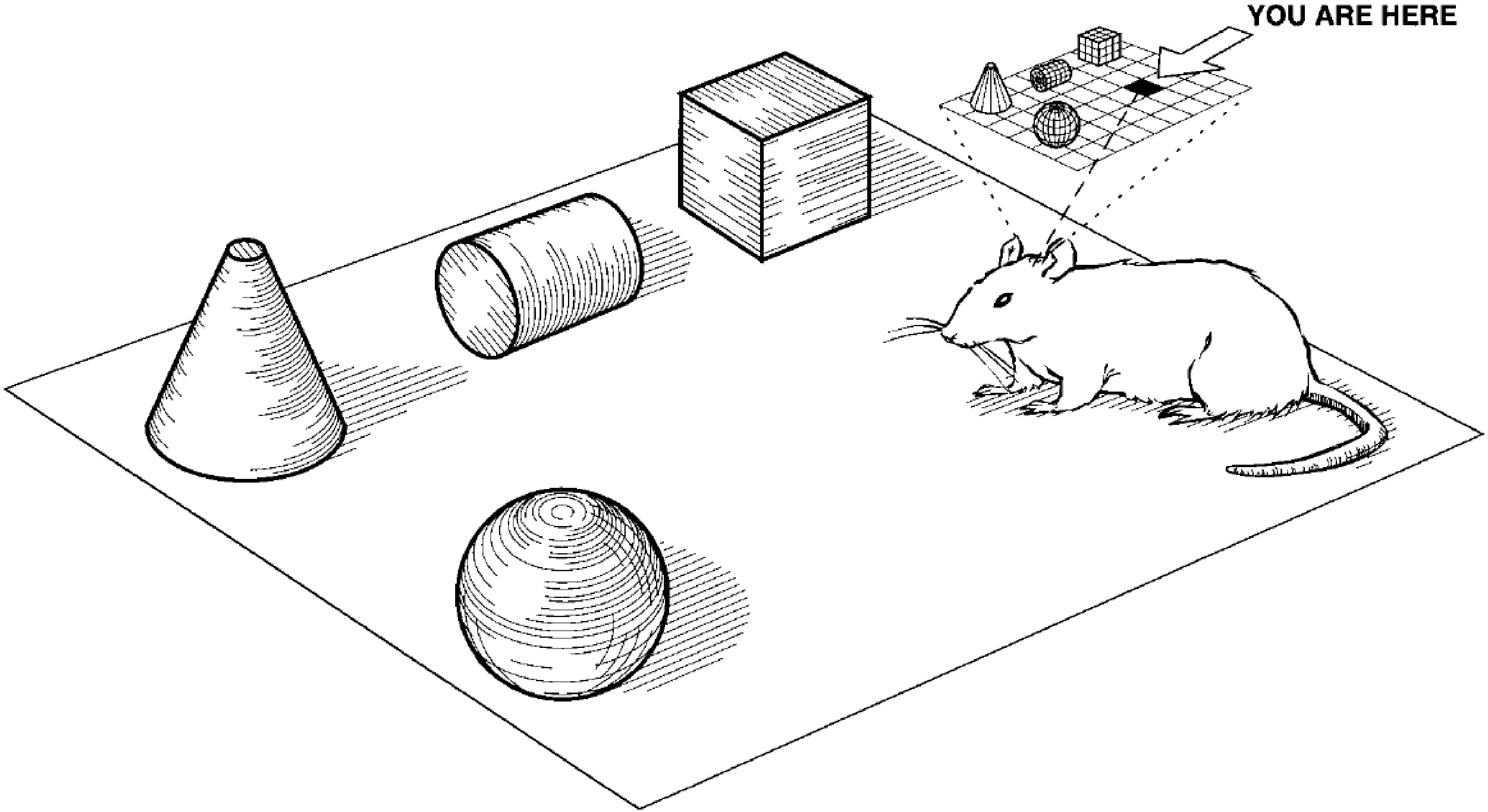
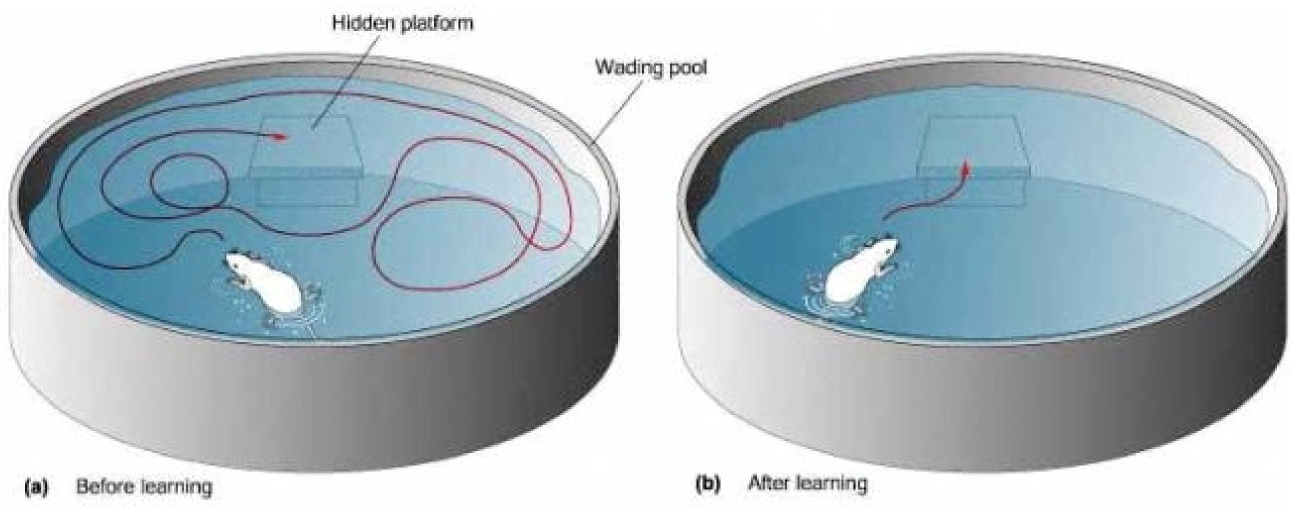


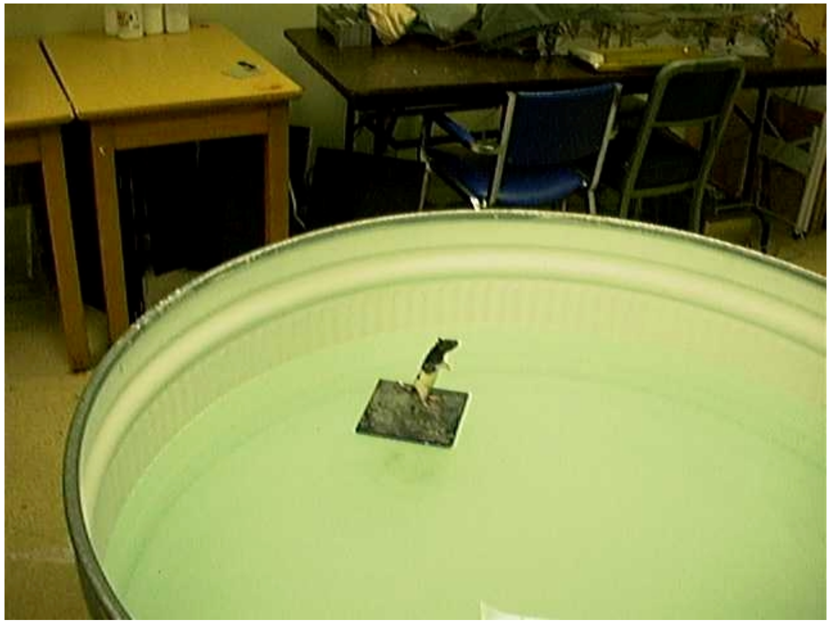
Figure 2. Cognitive Mapping

Conceptual model of hippocampal representation of a spatial environment according to the cognitive mapping hypothesis.

O'Keefe & Nadel (1978), after an idea by Tolman (1948)

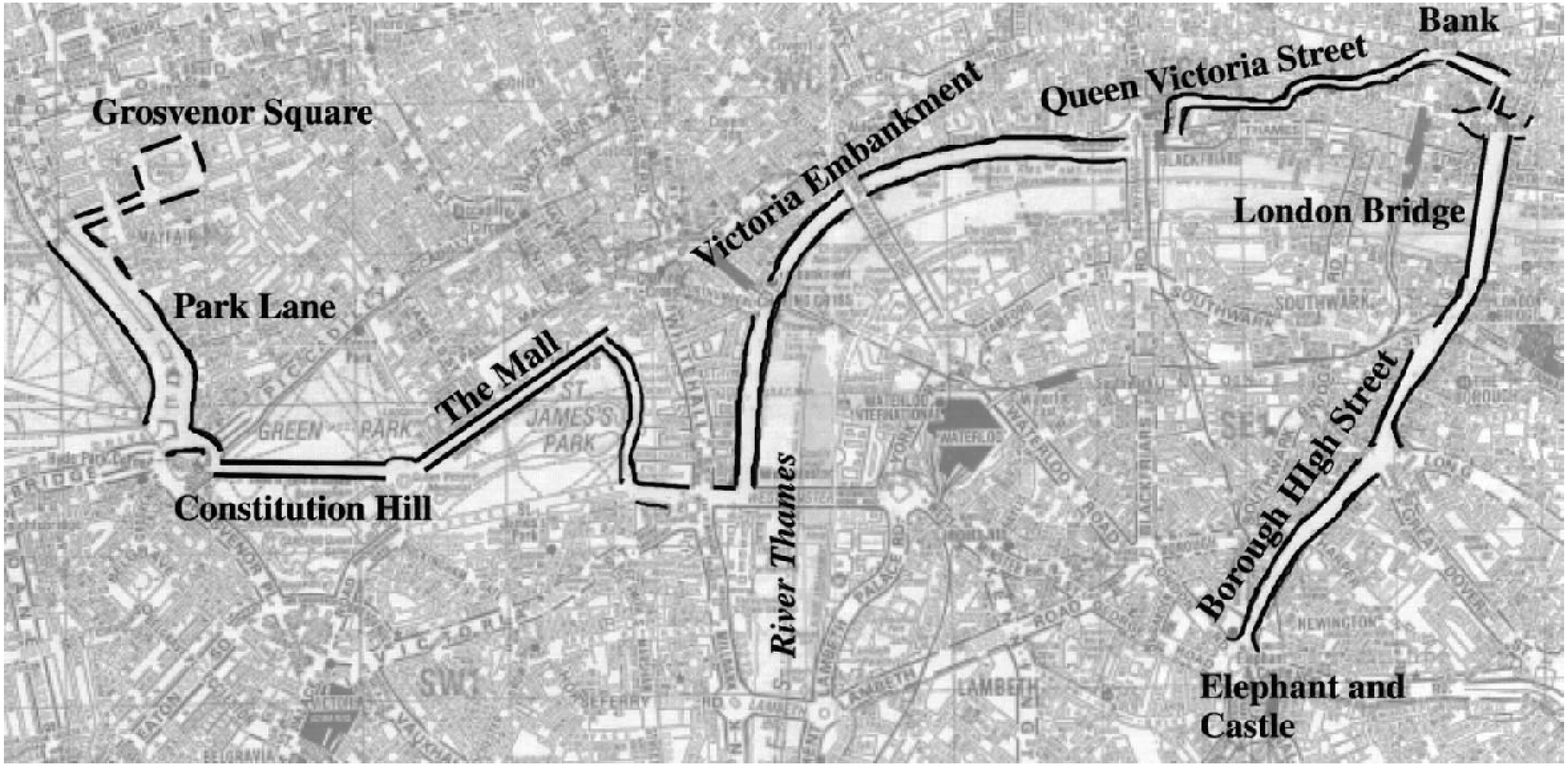
Hippocampus and spatial navigation: Morris water maze





Morris et al. (1982)

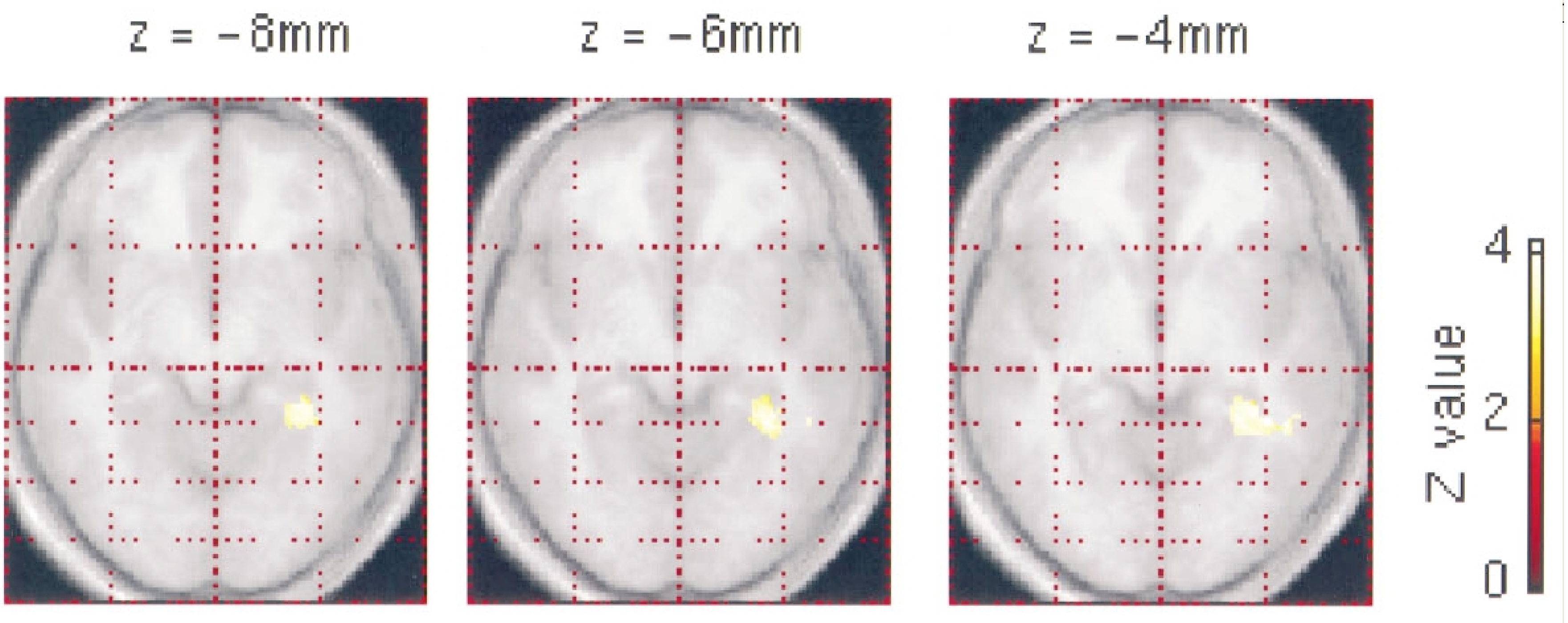
Hippocampus and spatial navigation: taxi drivers (1)



'igure 2. Map illustrating the complex route recalled by a taxi driver during a route scan. Subjects did not see any maps; they were blindfolded hroughout. His speech output for this task follows: Pick up on Grosvenor Square in Mayfair, drop off at Bank Underground Station, then at the Oval Cricket Ground. . . "Grosvenor square, I'd leave that by Upper Grosvenor Street and turn left into Park Lane. I would eh enter Hyde Park Corner, a ne-way system and turn second left into Constitution Hill. I'd enter Queen Victoria Memorial one-way system and eh leave by the Mall. Turn right Birdcage Walk, sorry right Horse Guards Parade, left Birdcage Walk, left forward Great George Street, forward into Parliament Square, forward Bridge treet. I would then go left into the eh the Victoria Embankment, forward the Victoria Embankment under the Blackfriars underpass and turn immediate eft into Puddledock, right into Queen Victoria Street, left into Friday Street, right into Queen Victoria Street eh and drop the passenger at the Bank where I would then leave the Bank by Lombard Street, forward King William Street eh and forward London Bridge. I would cross the River Thames nd London Bridge and go forward into Borough High Street. I would go down Borough High Street into Newington Causeway and then I would reach he Elephant and Castle where I would go around the one-way system. . . . " (end of scan).

Maguire et al. (1997)

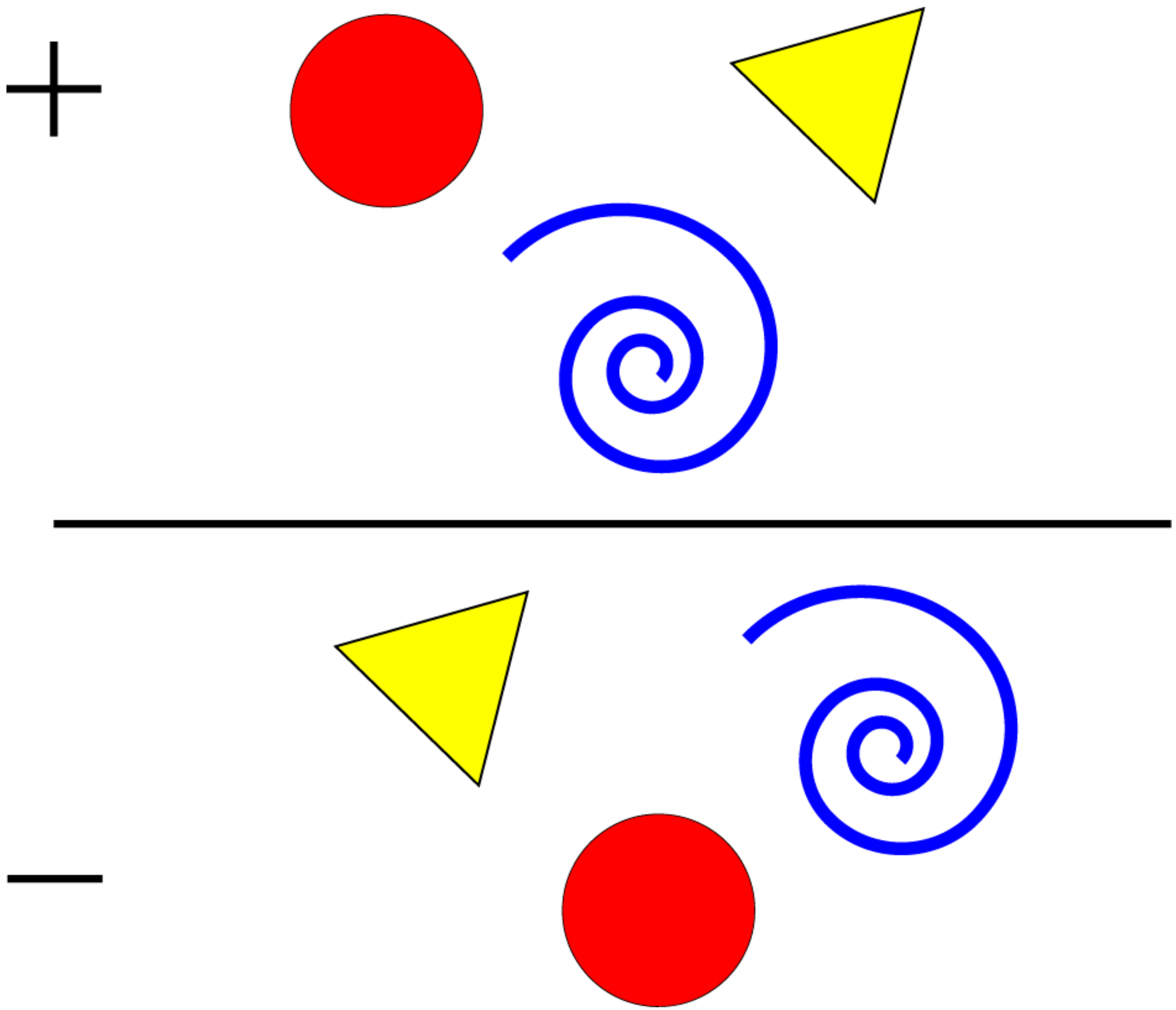
Hippocampus and spatial navigation: taxi drivers (2)



Route recall (versus recall of famous landmarks in unfamiliar cities, e.g. Statue of Liberty)

Maguire et al. (1997)

Hippocampus and scenes (1)



Gaffan & Harrison (1989)

Hippocampus and scenes (2)

Speilberg (1981)
'Raiders of the Lost Ark'

Gaffan (1992)

‘Relational coding’ in the hippocampus (1): spatial

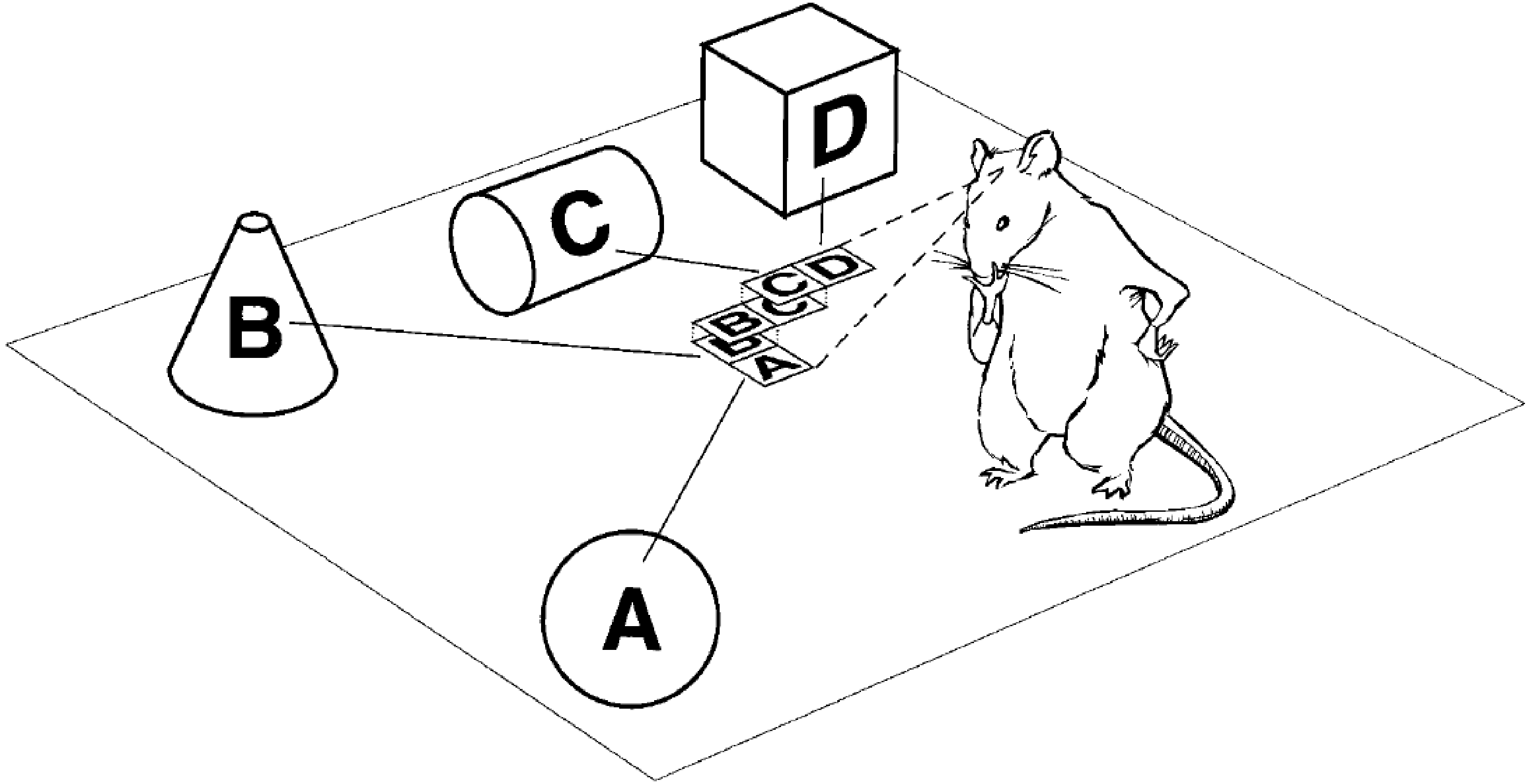


Figure 6. Relational Coding of Space

Representation of a spatial environment by cells that encode the spatial relations between a pair of the cues (AB, BD, or CD), plus nodal representations (dotted lines) for the cues that are common between some pairwise codings.

Eichenbaum et al. (1999)

‘Relational coding’ in the hippocampus (2): non-spatial

Train A>B, B>C, C>D, D>E.
Test A>E — easy (A always rewarded, E never).
Test B>D — hard (requires transitive inference).

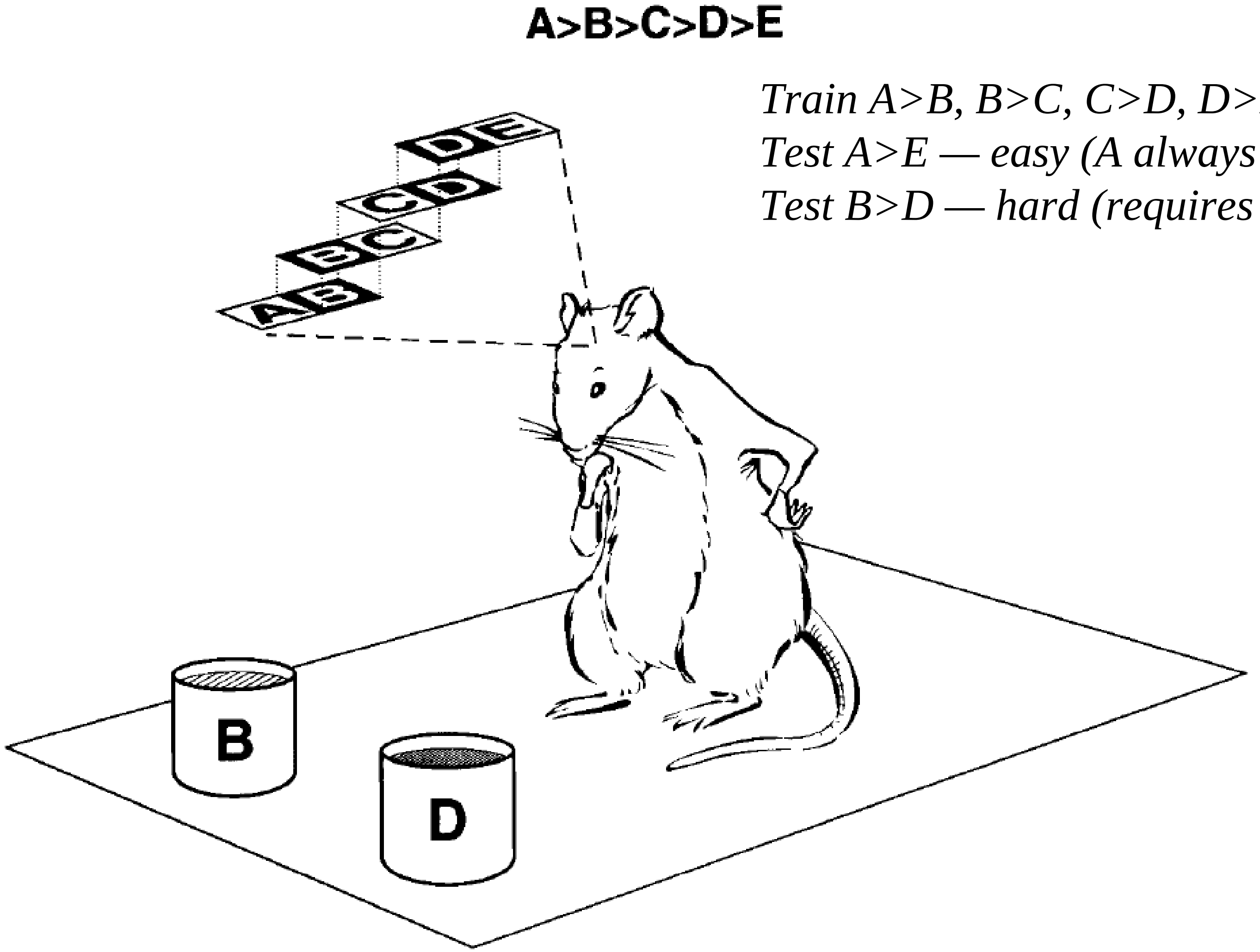


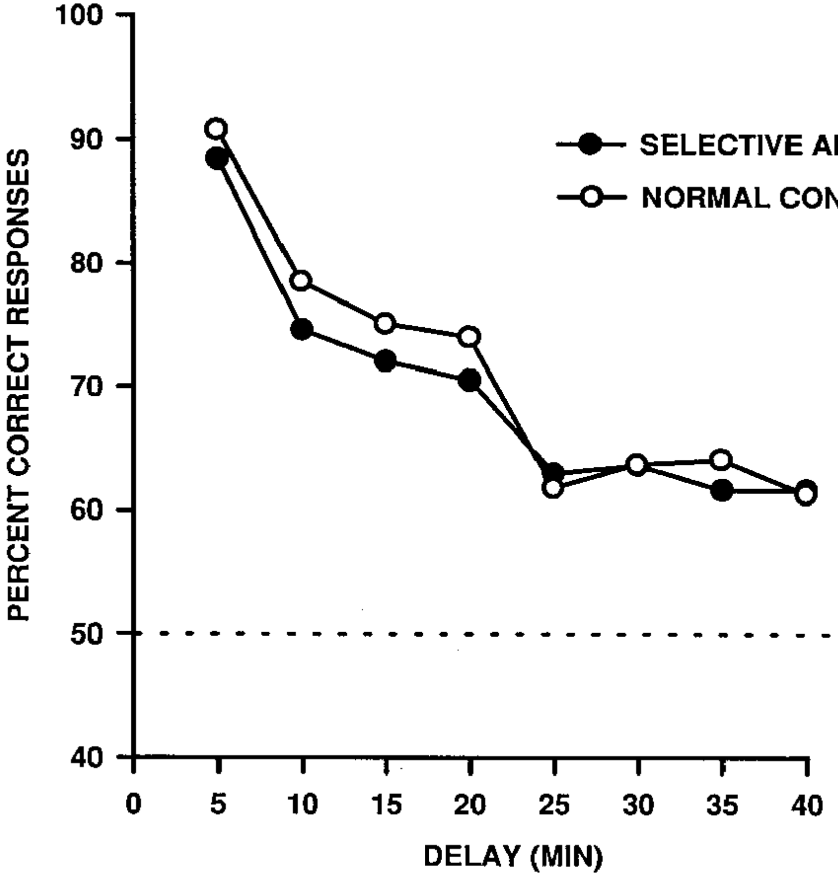
Figure 7. Transitive Inference in Serial Ordering

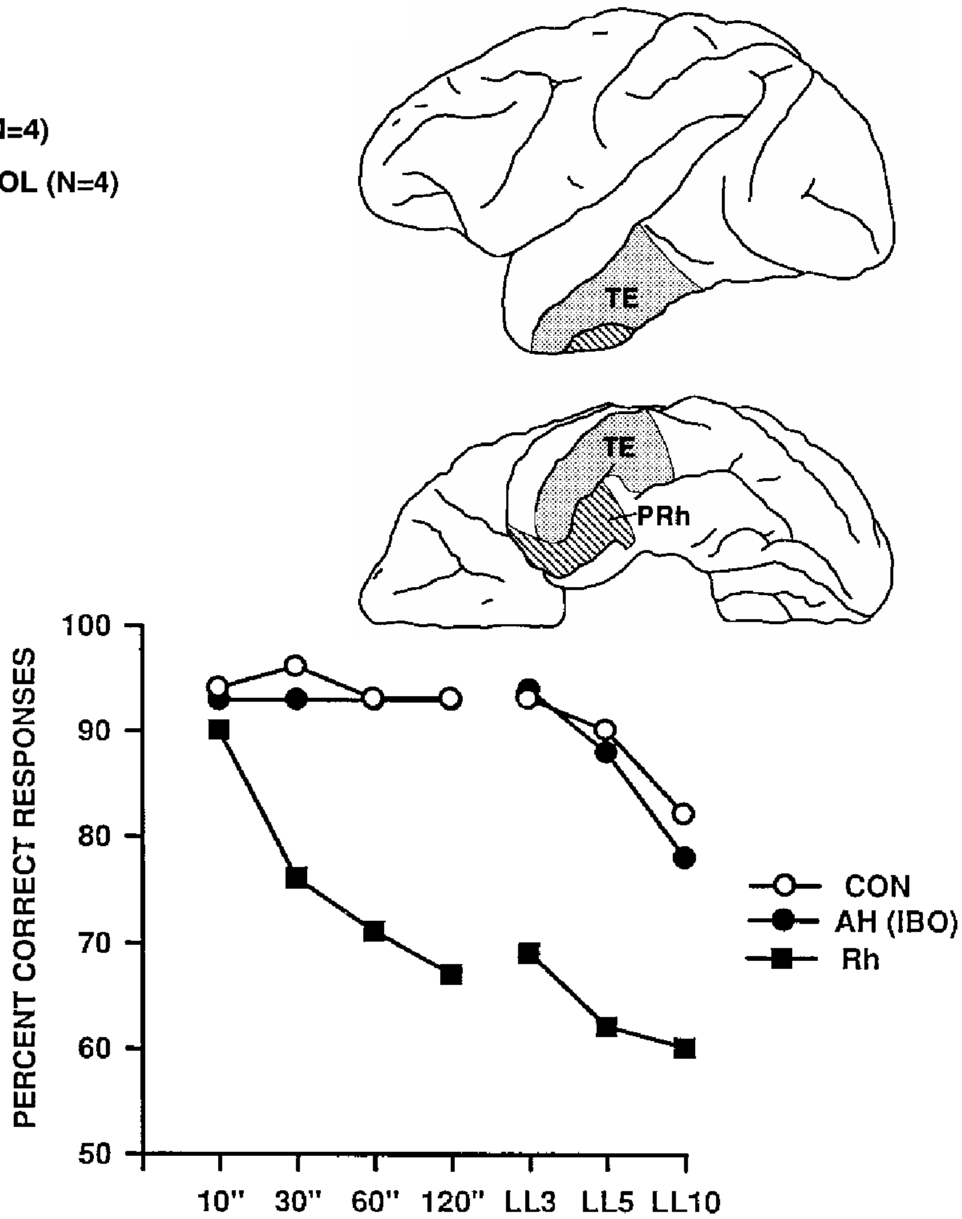
Representation of an odor series by cells that represent each trained odor pairing, plus nodal representations (dotted lines) of odors that are common between some of the trained pairings.

Eichenbaum et al. (1999)

Rhinal cortex

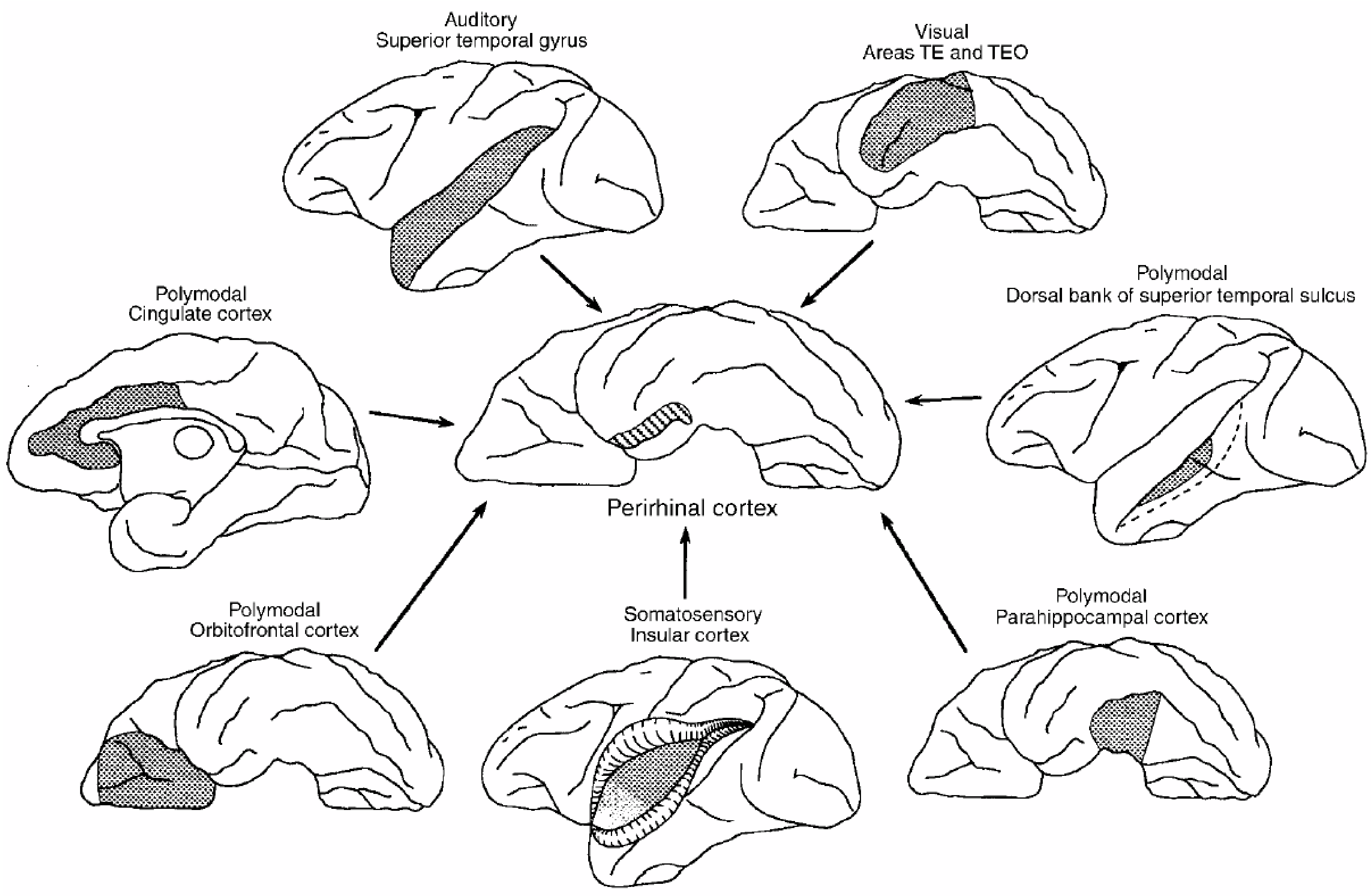
Rhinal cortex, not hippocampus, required for DNMTS





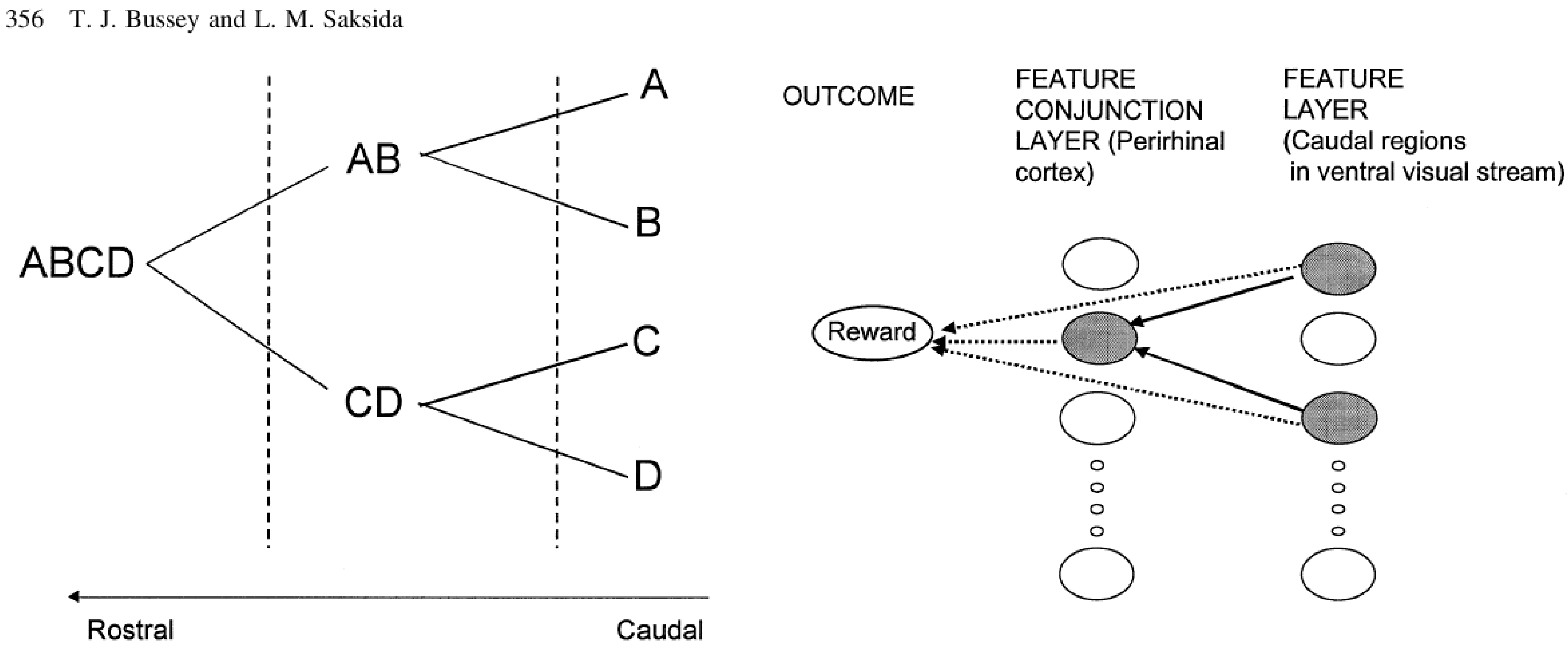
Murray & Mishkin (1998)

Perirhinal cortex is the first polymodal ventral stream area



Murray & Bussey (1999)

Perirhinal cortex: feature conjunctions (resolving ambiguity)



Bussey & Saksida (2002)

Semantic memory

Perinatal hypoxia: impaired episodic, preserved semantic

Table 1 *Results of neuropsychological tests*

	Case 1	Case 2	Case 3	Case 4	Case 5	Mean ± SD	Normal subjects (n = 35)
Age at testing (years)	12.8	11.7	11.6	16.3	12.3	12.9 ± 1.9	13.6 ± 1.3
Digit span							
Forward	6	7	6	8	7	6.8 ± 0.8	6.4 ± 1.2
Backward	5	5	6	6	3	4.7 ± 1.3	4.2 ± 1.5
Literacy (WORD) subtests							
Basic reading (standard score)							
Actual score	85	97	99	102	105	97.6 ± 7.7	100 ± 15†
IQ predicted score	83	86	89	106	92	91.2 ± 8.9	
Spelling (standard score)							
Actual score	77	96	88	84	118	92.6 ± 15.8	100 ± 15†
IQ predicted score	85	88	90	105	93	92.2 ± 7.7	
Reading comprehension (standard score)							
Actual score	84	87	74	97	87	85.8 ± 8.2	100 ± 15†
IQ predicted score	81	85	87	107	91	90.2 ± 10.1	
VIQ subtests							
Information	9	7	8	10	9	8.6 ± 1.1	10 ± 3†
Vocabulary	7	7	8	11	9	8.4 ± 1.7	10 ± 3†
Comprehension	7	8	9	14	8	9.2 ± 2.8	10 ± 3†

normal digit span, vocabulary, verbal information, and verbal comprehension

Table 2 *Results of tests of memory function*

	Case 1	Case 2	Case 3	Case 4	Case 5	Mean ± SD (n = 33)	Normal subjects
Story recall* (%)							
Immediate	25.0	38.9	20.8	27.2	11.3	24.6 ± 10.0	41.4 ± 14.9
Delayed	2.2	2.8	0	3.5	3.4	2.4 ± 1.4	32.3 ± 15.4
Geometric design† (± %)							
Immediate	53.6	32.1	57.1	64.2	35.7	48.5 ± 14.0	82.2 ± 13.5
Delayed	14.3	14.3	0	3.6	10.7	10.7 ± 5.0	77.8 ± 16.9
Children's Auditory Verbal Learning Test‡ (%)							
Immediate memory span	105	82	89	109	74	91.8 ± 14.9	100 ± 15.0§
Delayed	60	60	61	63	60	60.8 ± 1.3	100 ± 15.0§

severe delay-dependent impairment

Gadian et al. (2000)

Semantic dementia: impaired semantic, preserved episodic? 1

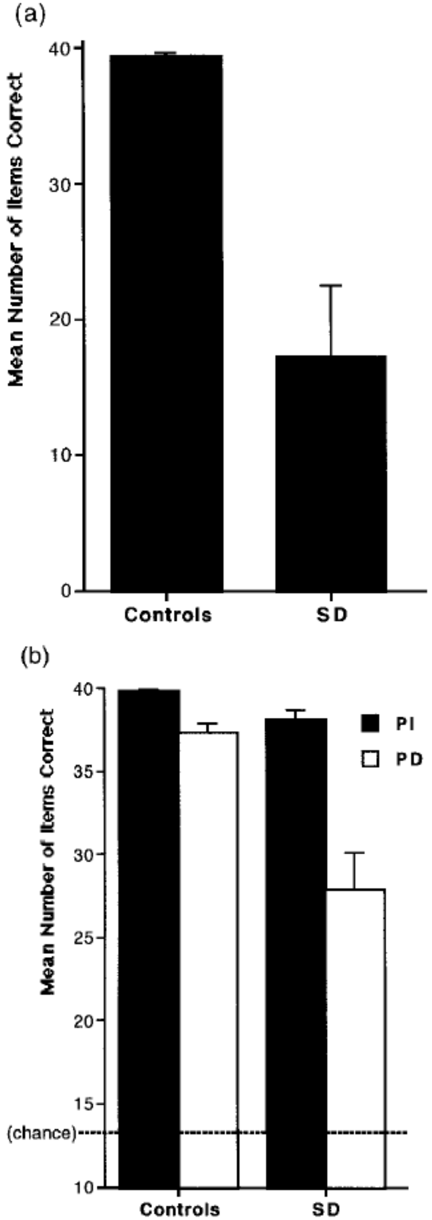
***semantic task** — name a familiar object*

***episodic task** — recognize an object (‘perceptually identical’)*

***mixed task** — recognize a different example of an object (‘perceptually different’)*

Graham et al. (2000)

Semantic dementia: impaired semantic, preserved episodic? 2

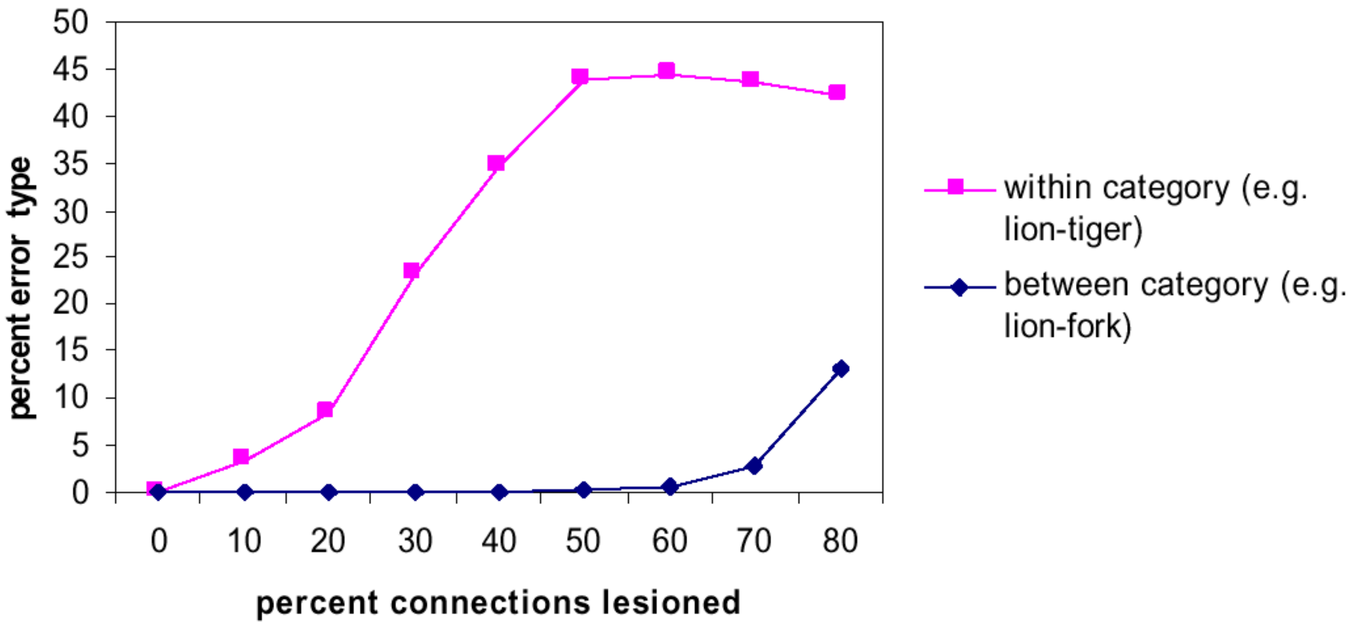


impaired semantic performance

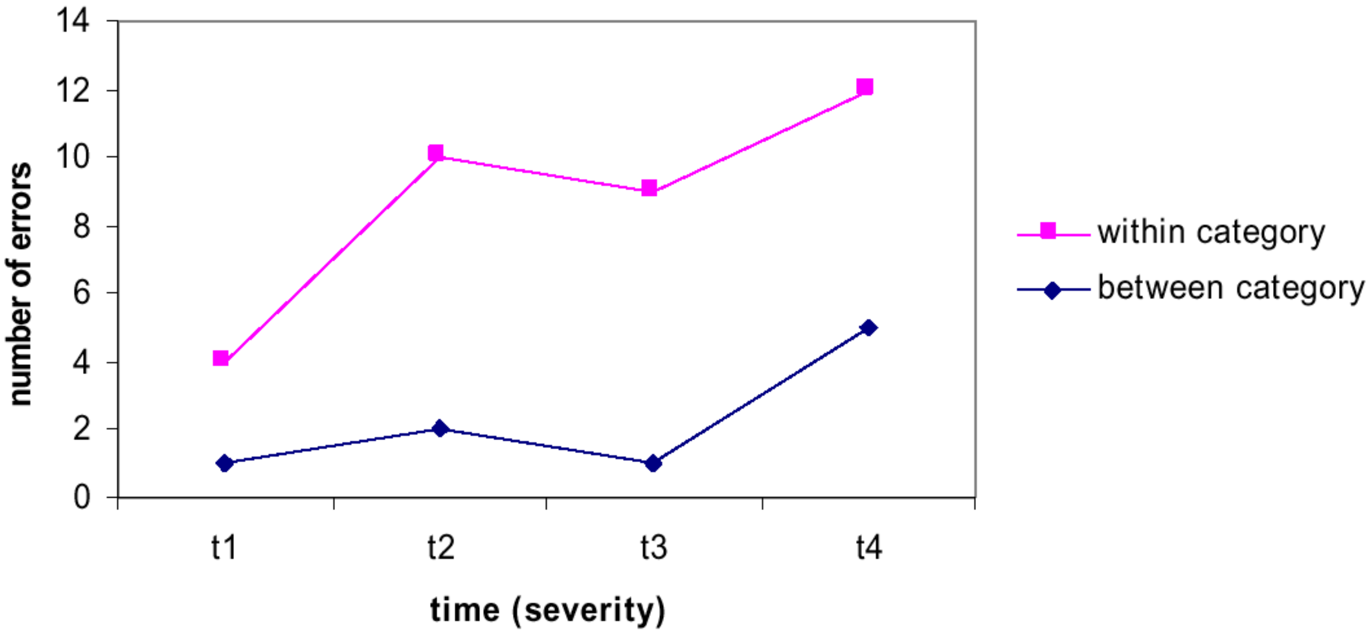
normal object recognition;
failure to recognize a different example of the same kind of object

Graham et al. (2000)

Semantic dementia: damage to a simple associative net?



computational model



patient with progressive semantic dementia

Moss et al. (2002)

Consolidation: hippocampal–cortical interactions?

Retrograde amnesia: hippocampus / medial temporal lobe

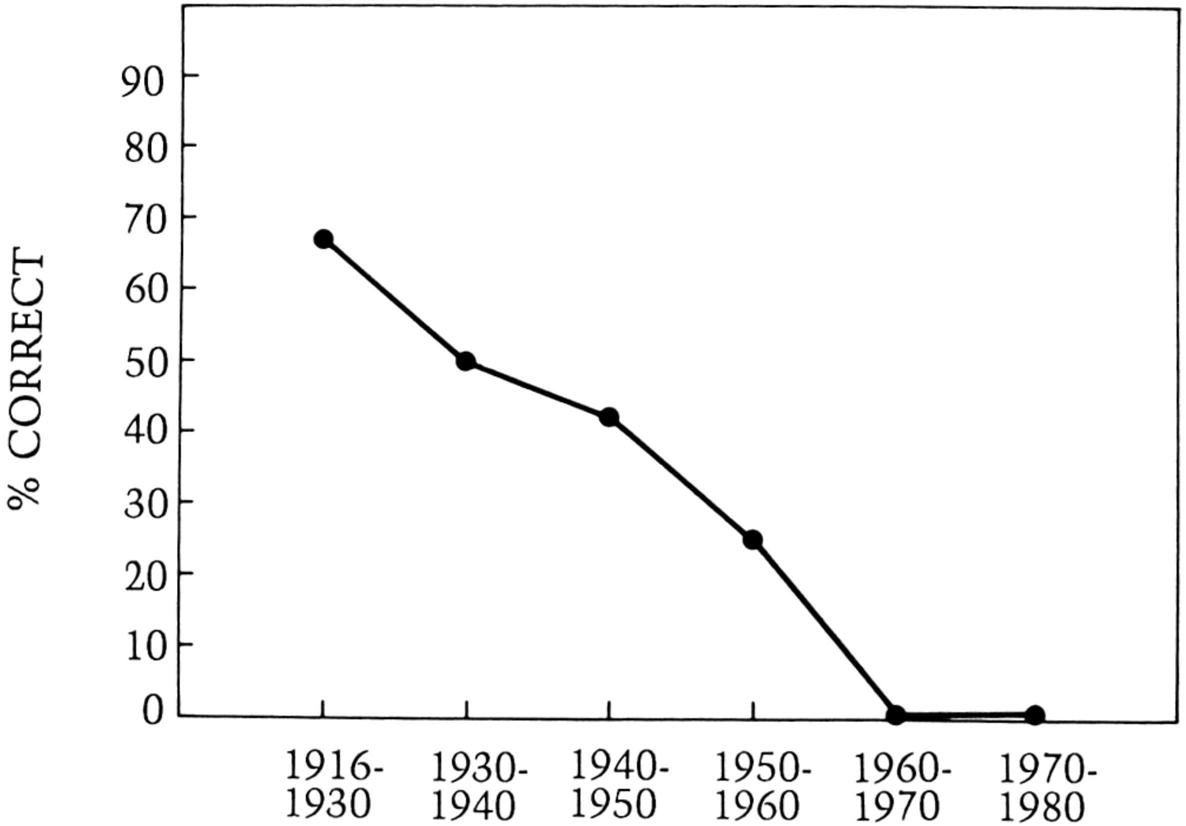
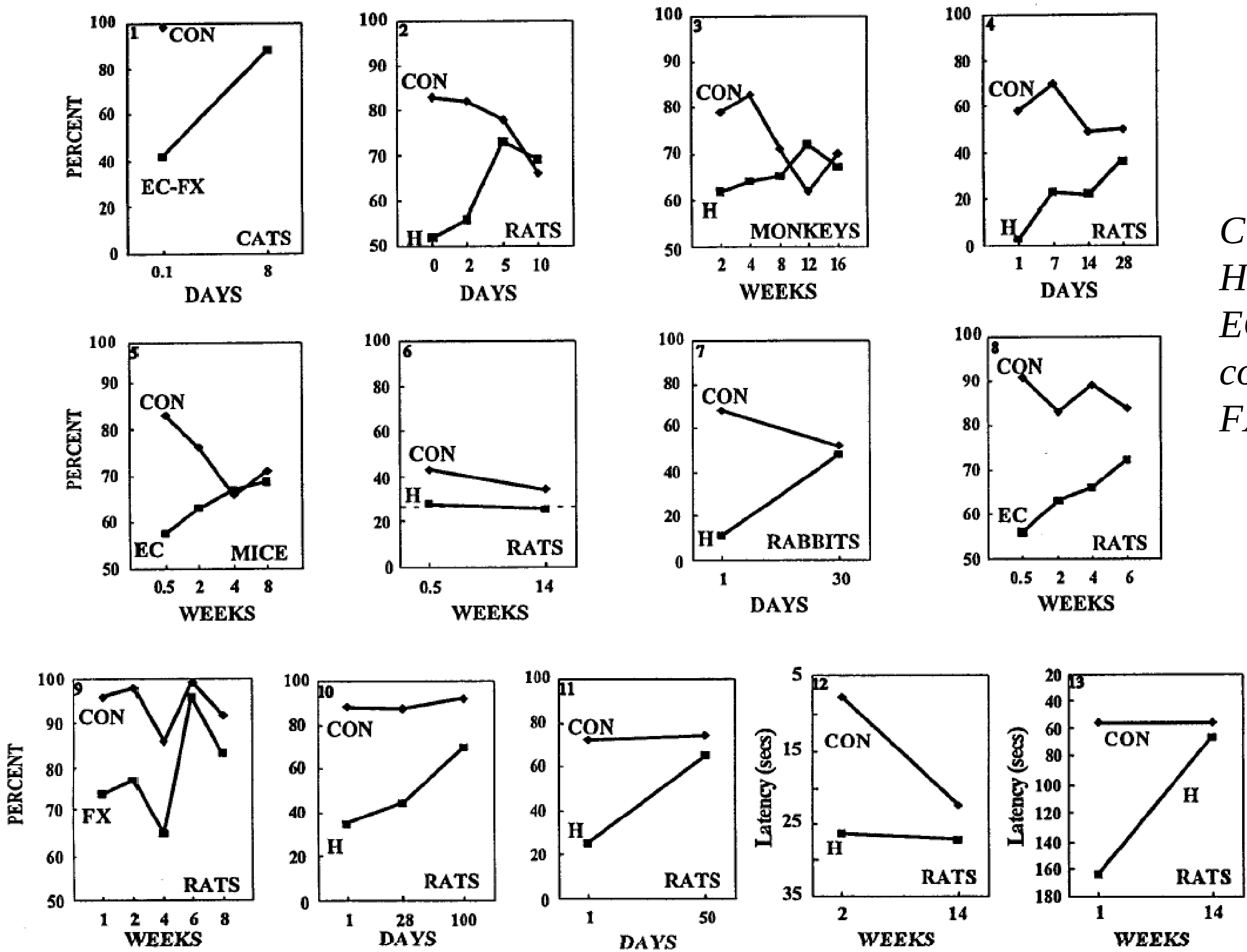


Figure 14.9. Recall of information from the patient's (P.Z.) published autobiography (Butters and Cermak, 1986).

Gradual transfer of memories from hippocampus (or MTL) to cortex elsewhere?

Scoville & Milner (1957); Squire et al. (2001)

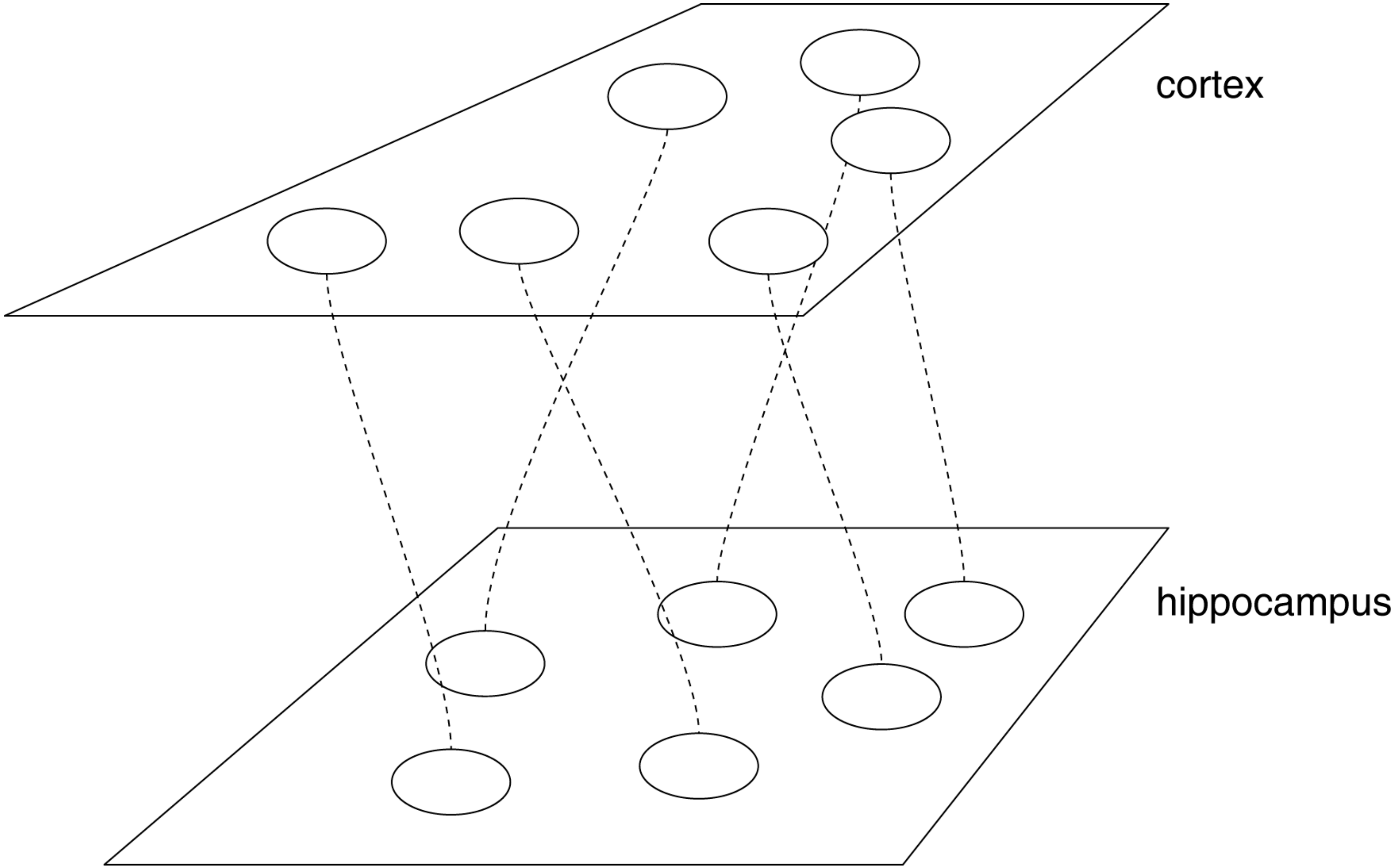
Prospective animal studies of retrograde amnesia



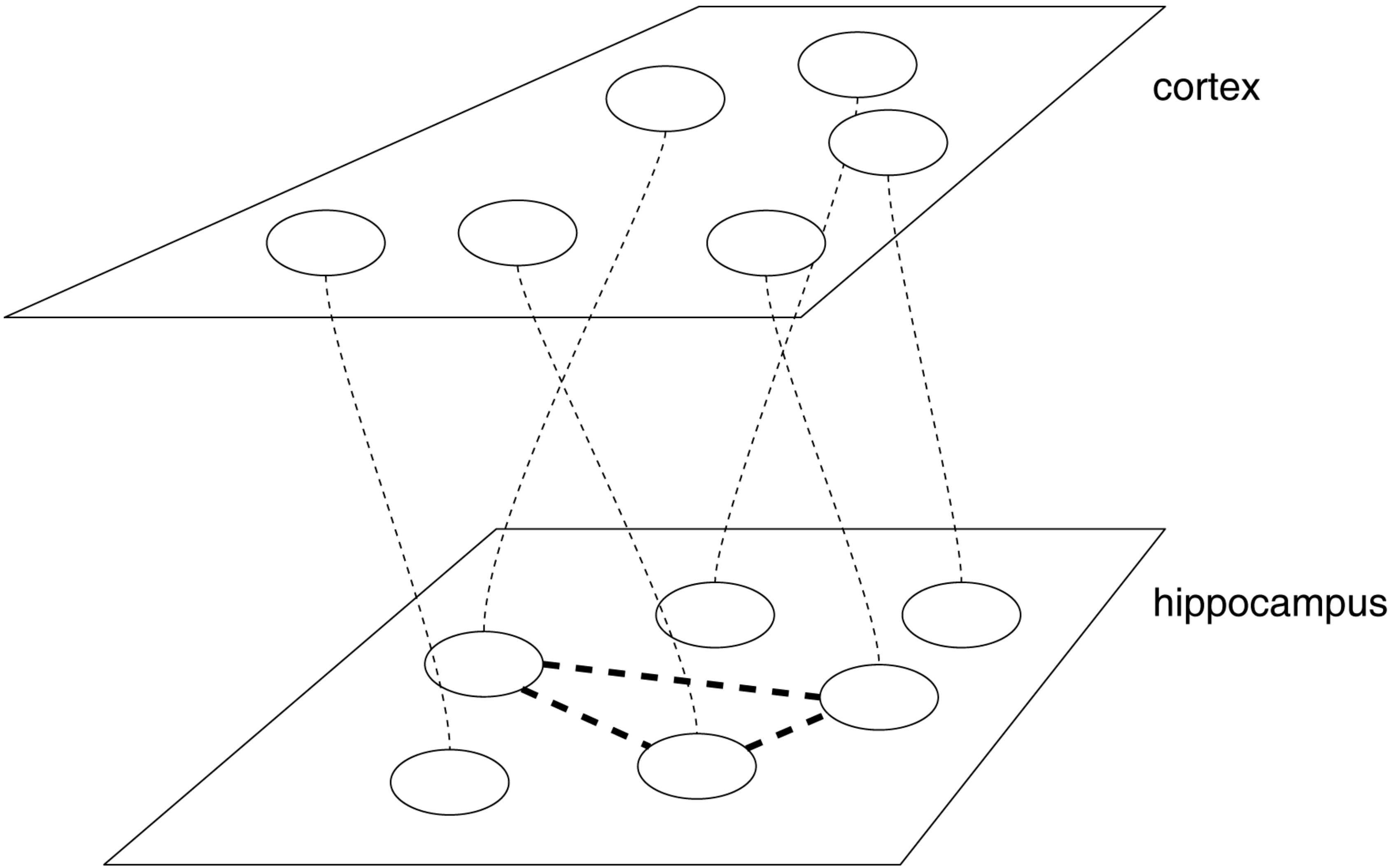
CON = control
H = hippocampus
EC = entorhinal cortex
FX = fornix

from Squire et al. (2001)

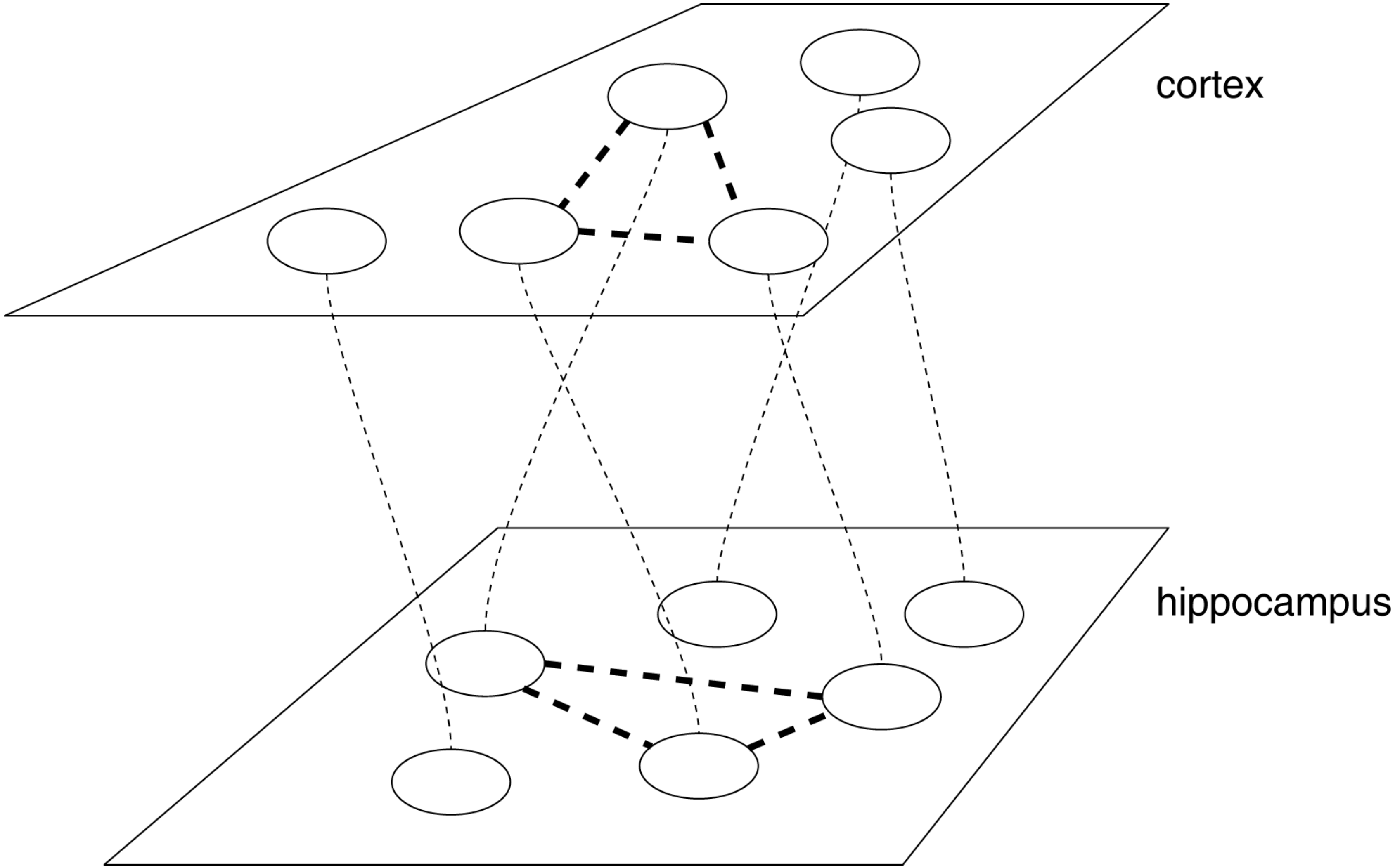
Hippocampal-cortical consolidation (1)



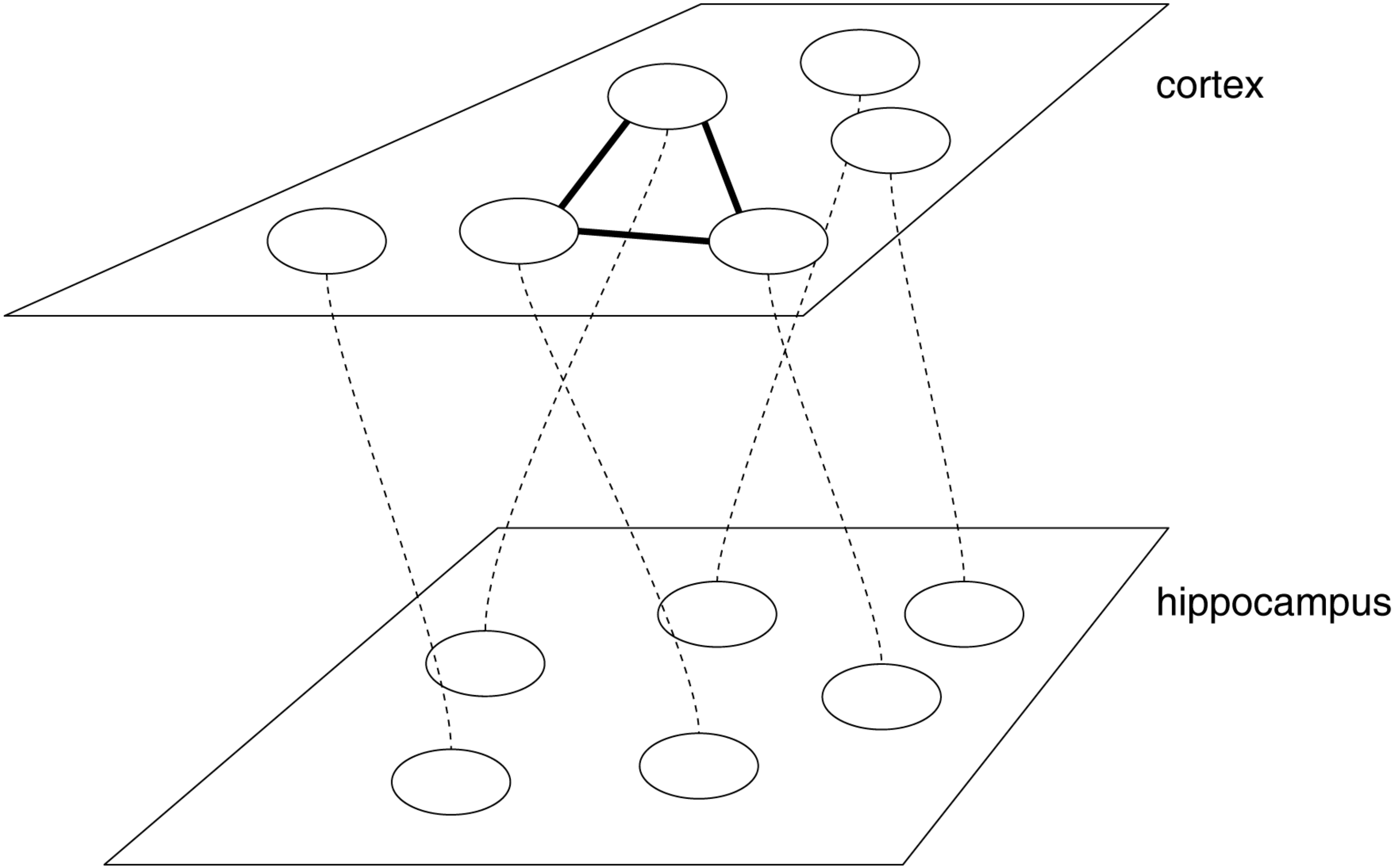
Hippocampal-cortical consolidation (2)



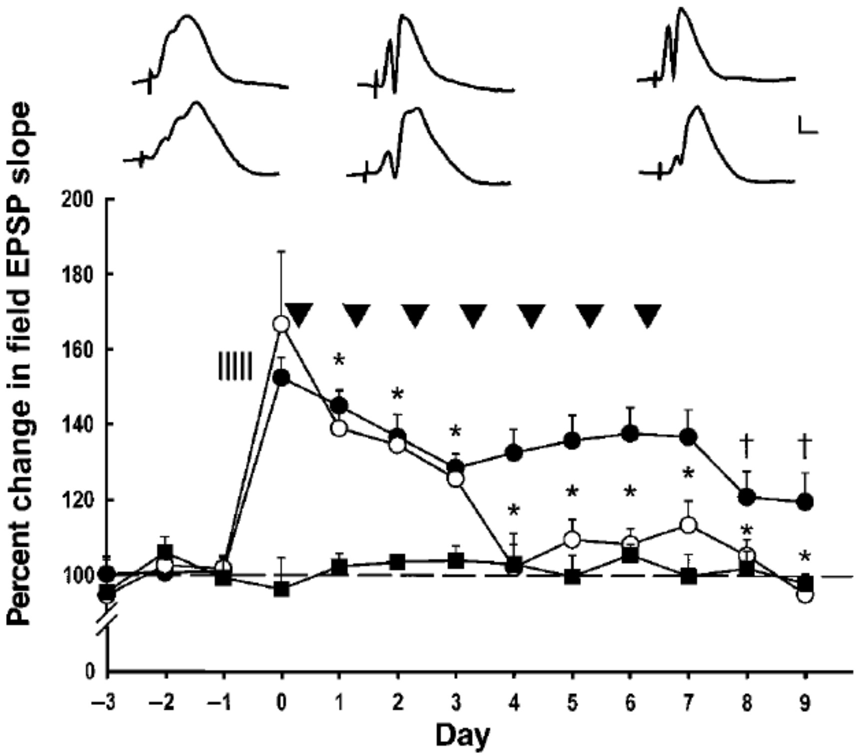
Hippocampal-cortical consolidation (3)

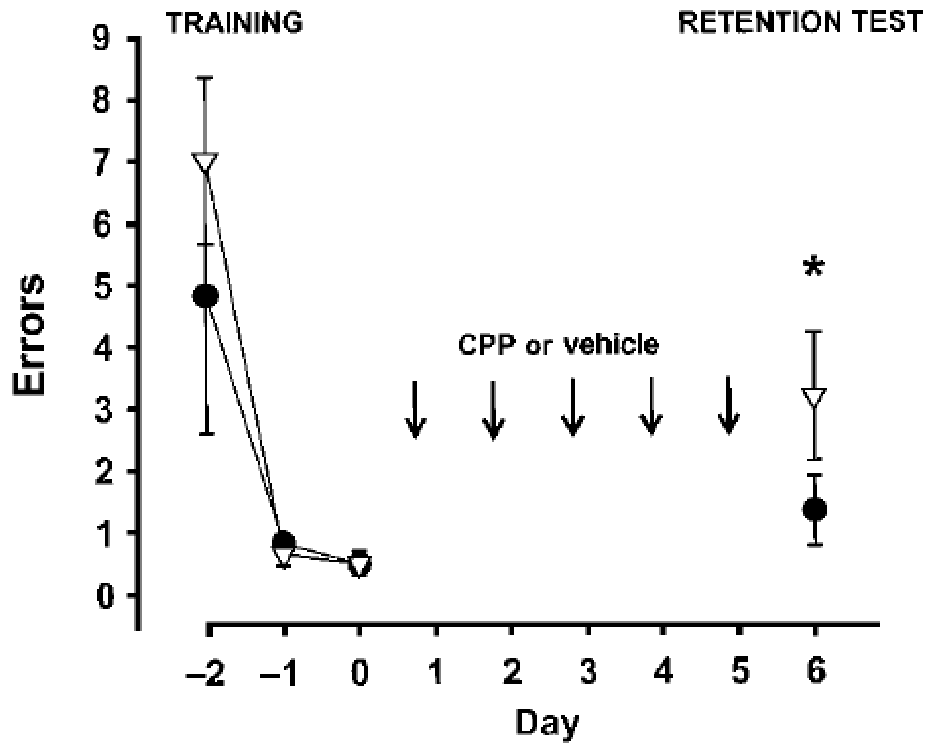


Hippocampal-cortical consolidation (4)



Does blockade of NMDA receptors prevent forgetting?



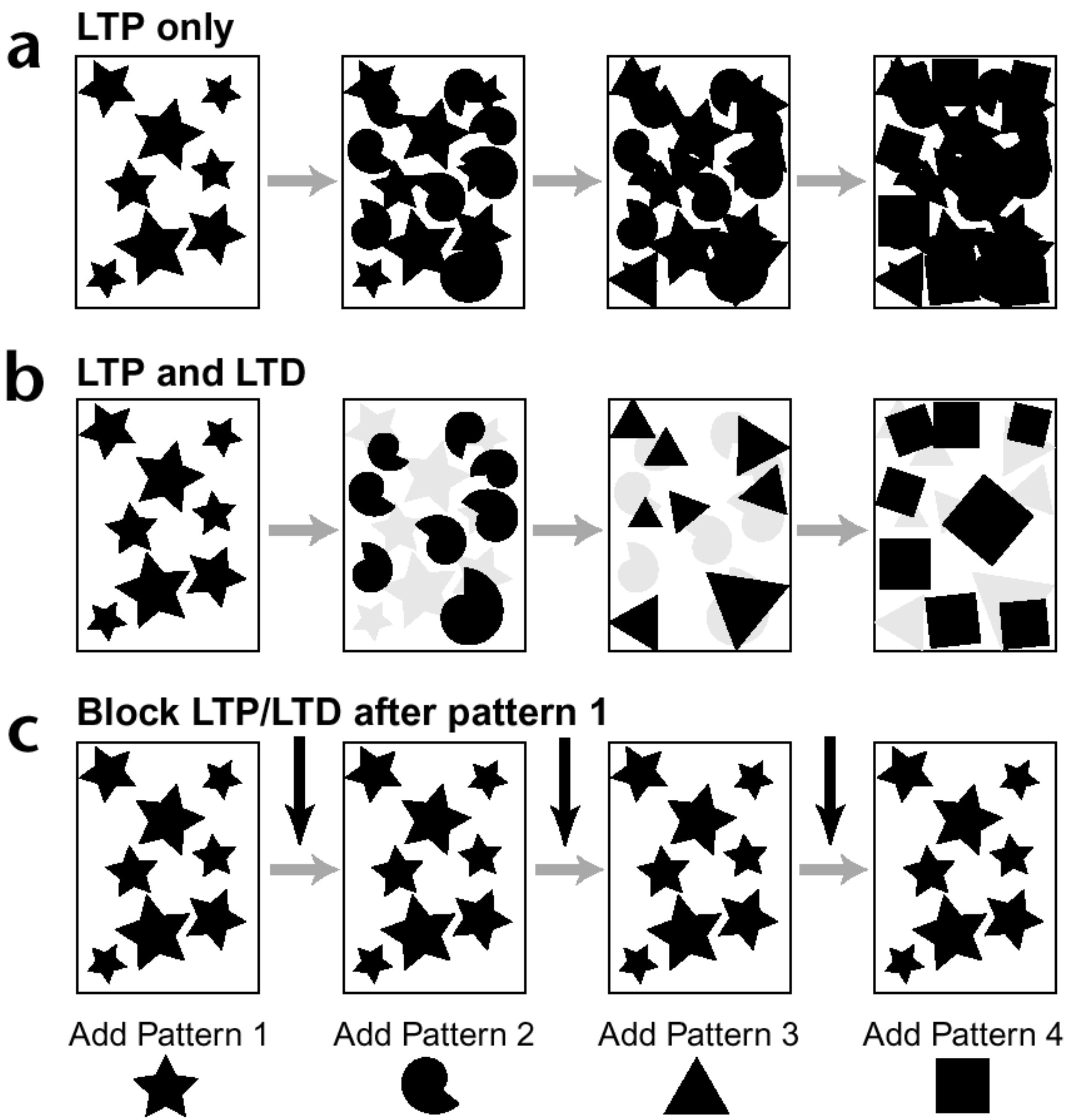


Systemic CPP (black circles) blocks decay of hippocampal LTP, compared to vehicle (white circles).

Systemic CPP (black circles) blocks decay of a memory for 8-arm radial maze performance, a task that is hippocampus-dependent, compared to vehicle (white triangles).

Villarreal et al. (2001)

The stability–plasticity dilemma: catastrophic interference



Rosenzweig et al. (2002), after an idea by Grossberg (1982)

Sleep and consolidation

‘Replay’ of hippocampal activity during sleep

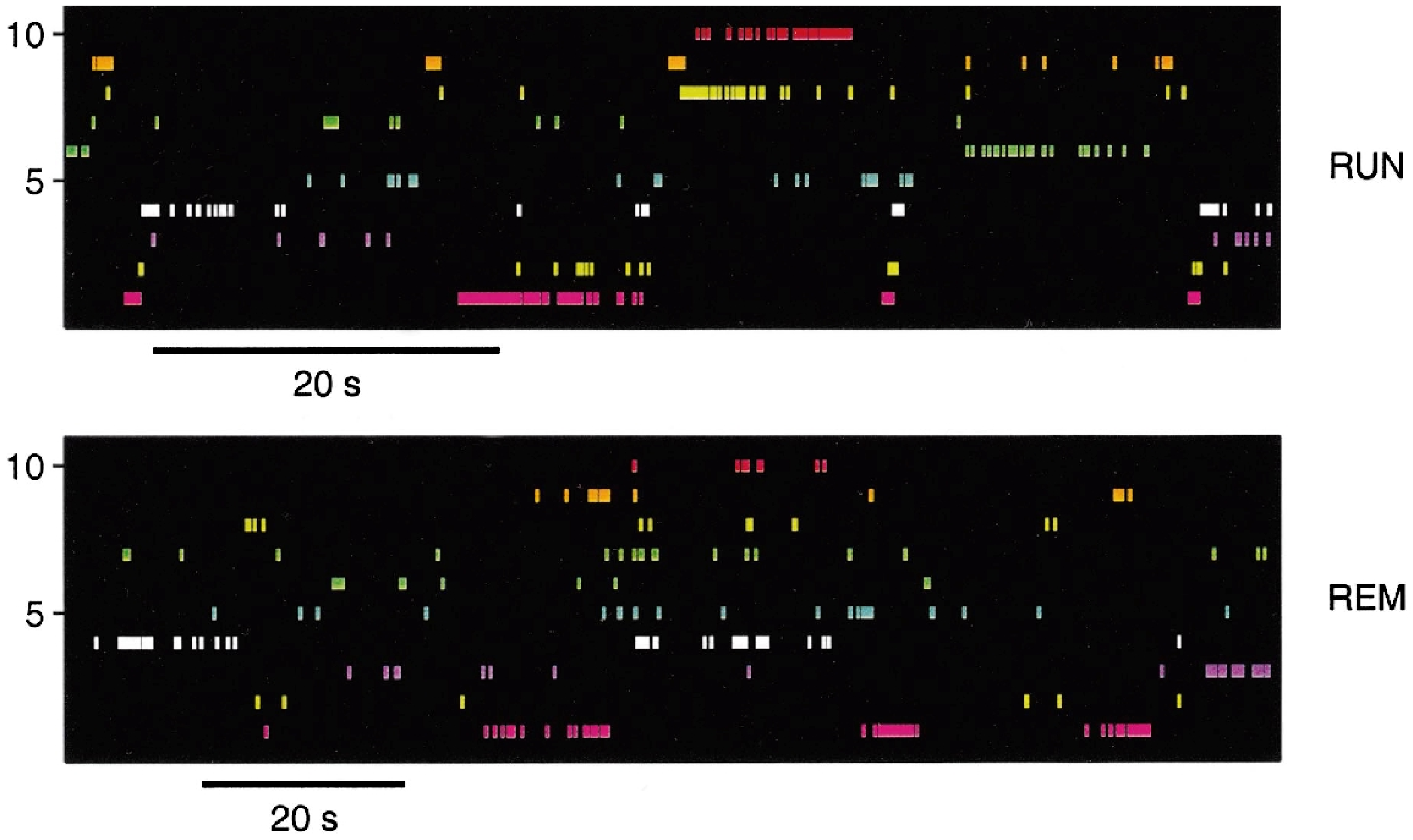
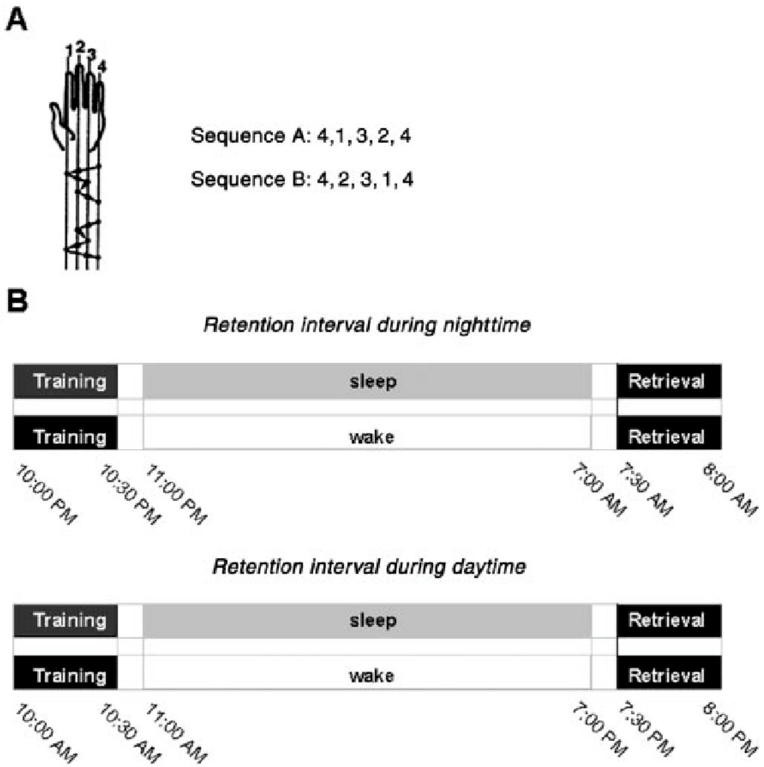


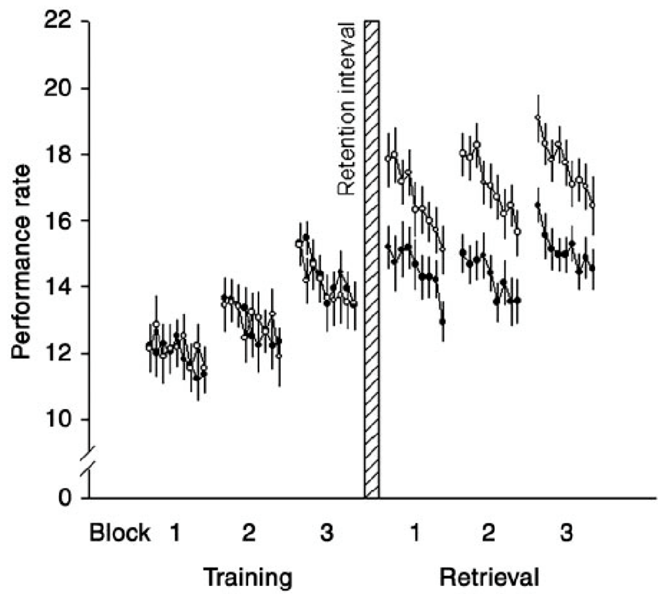
Figure 3. Example Correspondence between a REM Template and RUN Activity

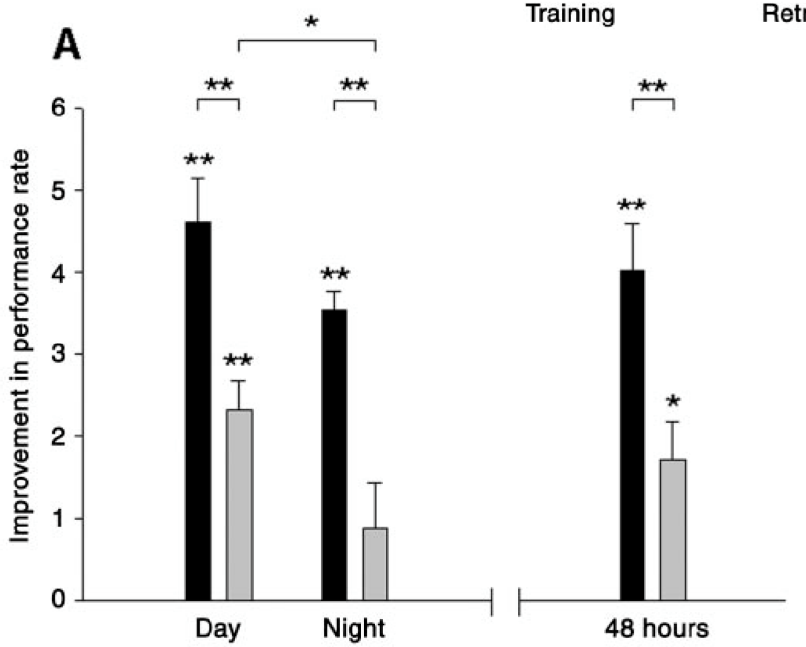
(Top) Rasters of 10 pyramidal cells during a 75 s window from RUN. The RUN time axis is scaled to maximize raster alignment with REM (SF = 1.6). (Bottom) Rasters of the same cells over the duration of a 120 s REM template.

Louie & Wilson (2001)

‘Procedural’ memory consolidation and sleep

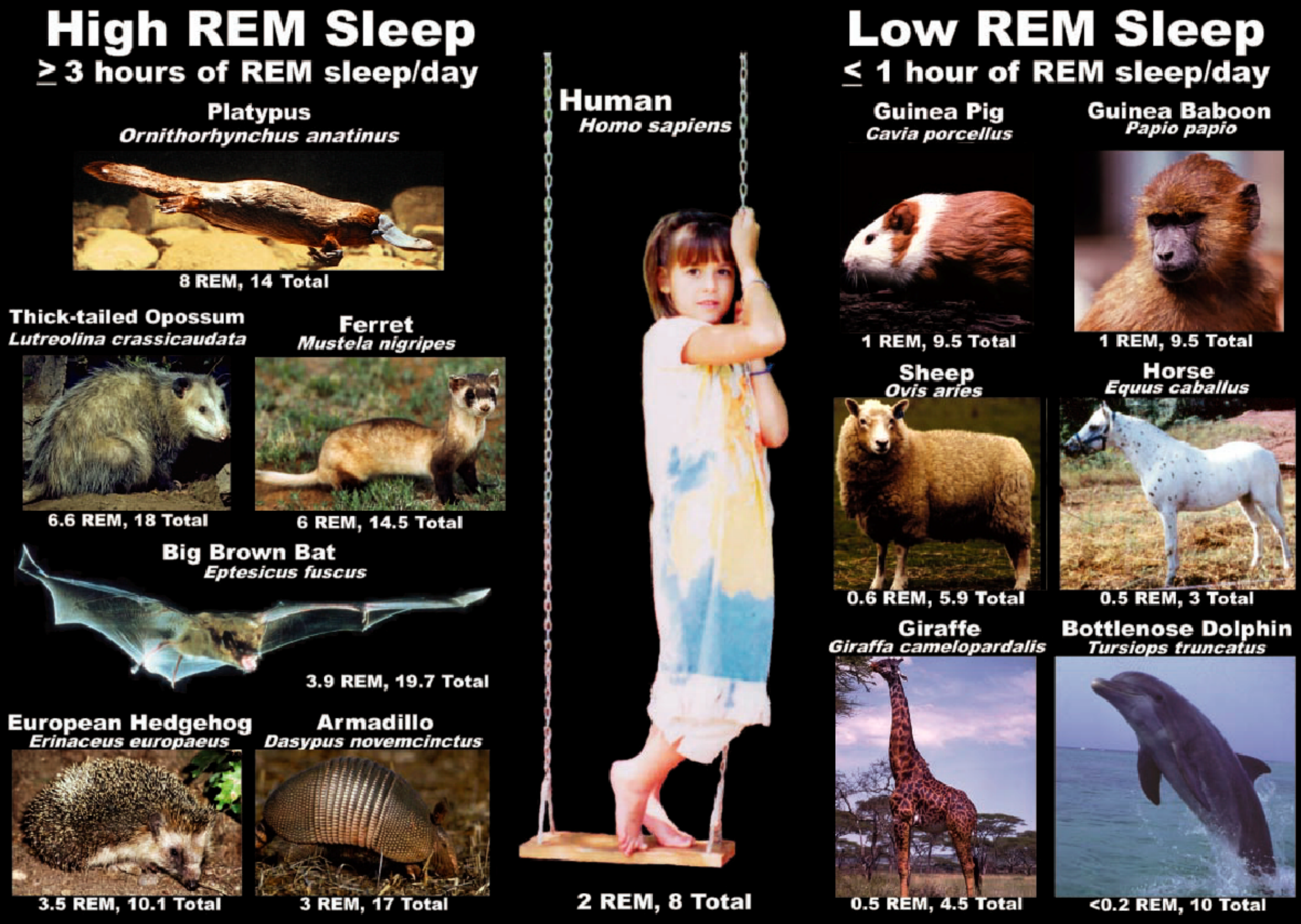






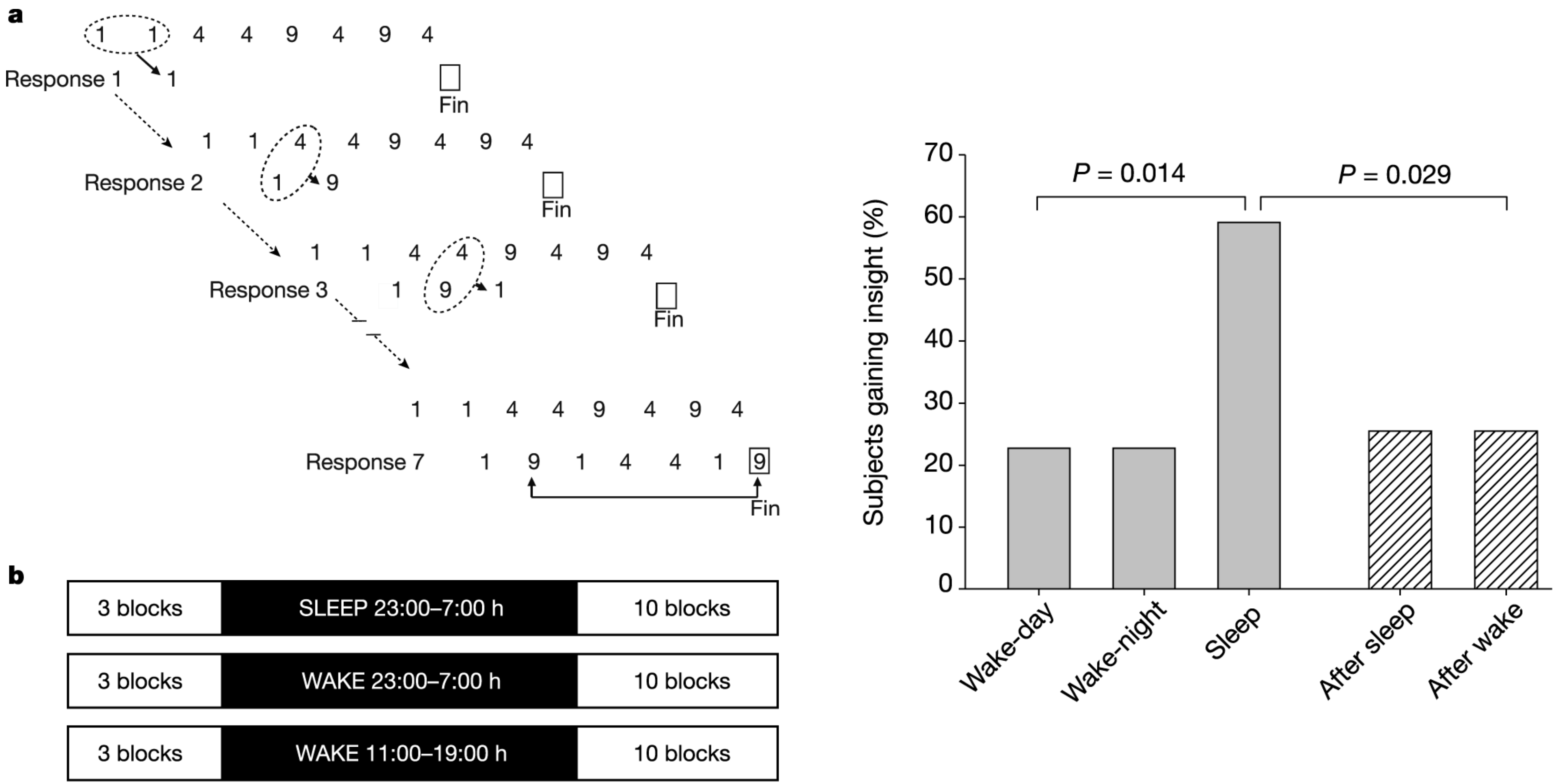
Fischer et al. (2002). “Sleep forms memory for finger skills.”

REM sleep across species



Siegel (2001)

‘Sleep inspires insight.’



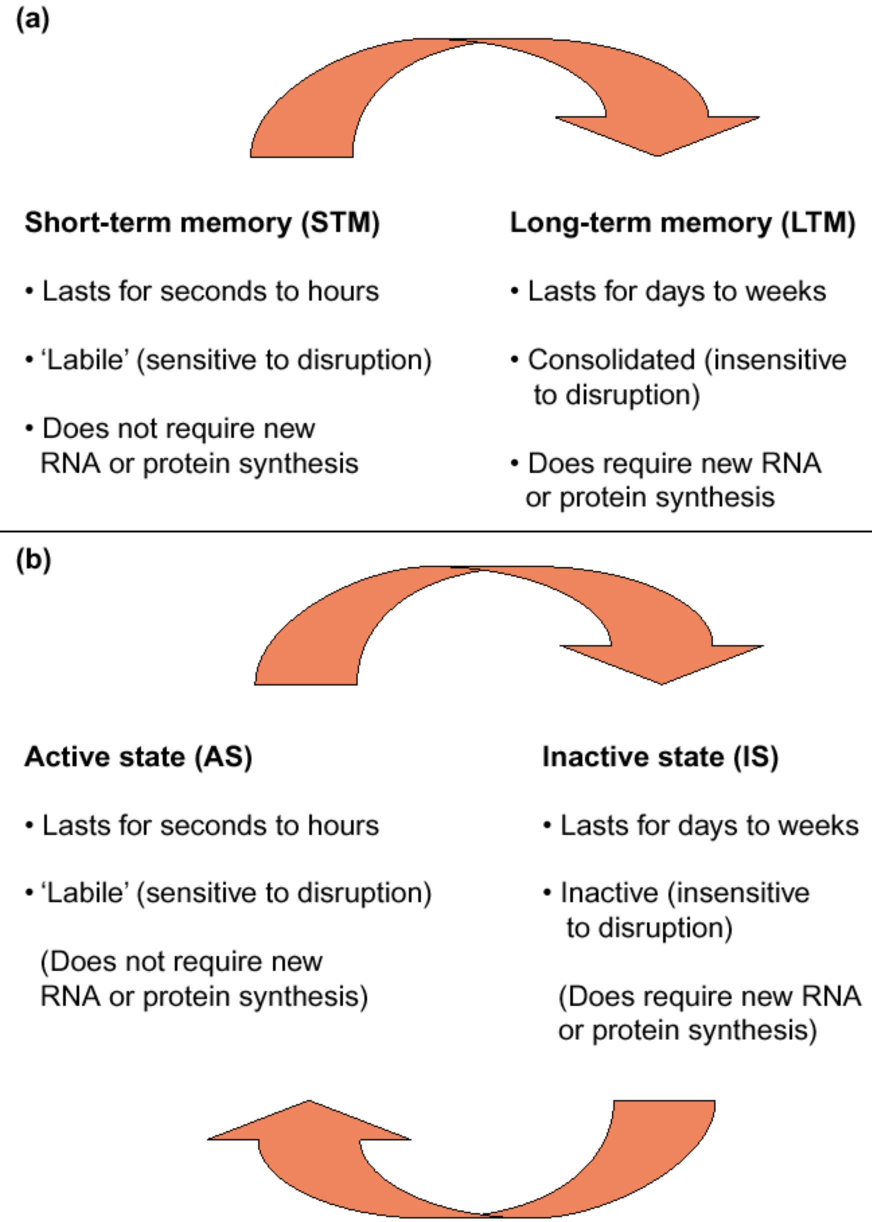
Wagner et al. (2004) Nature 427: 352

Reconsolidation

‘Reconsolidation’

consolidation

reconsolidation



Nader (2003)

Reconsolidation in the amygdala

Conditioned freezing requires the basolateral amygdala (BLA) — the BLA is a key site of association.

- *Train CS(tone)→US(shock)*
- *Present CS; infuse anisomycin (protein synthesis inhibitor) or vehicle into BLA*
- *Test conditioned freezing to the CS*

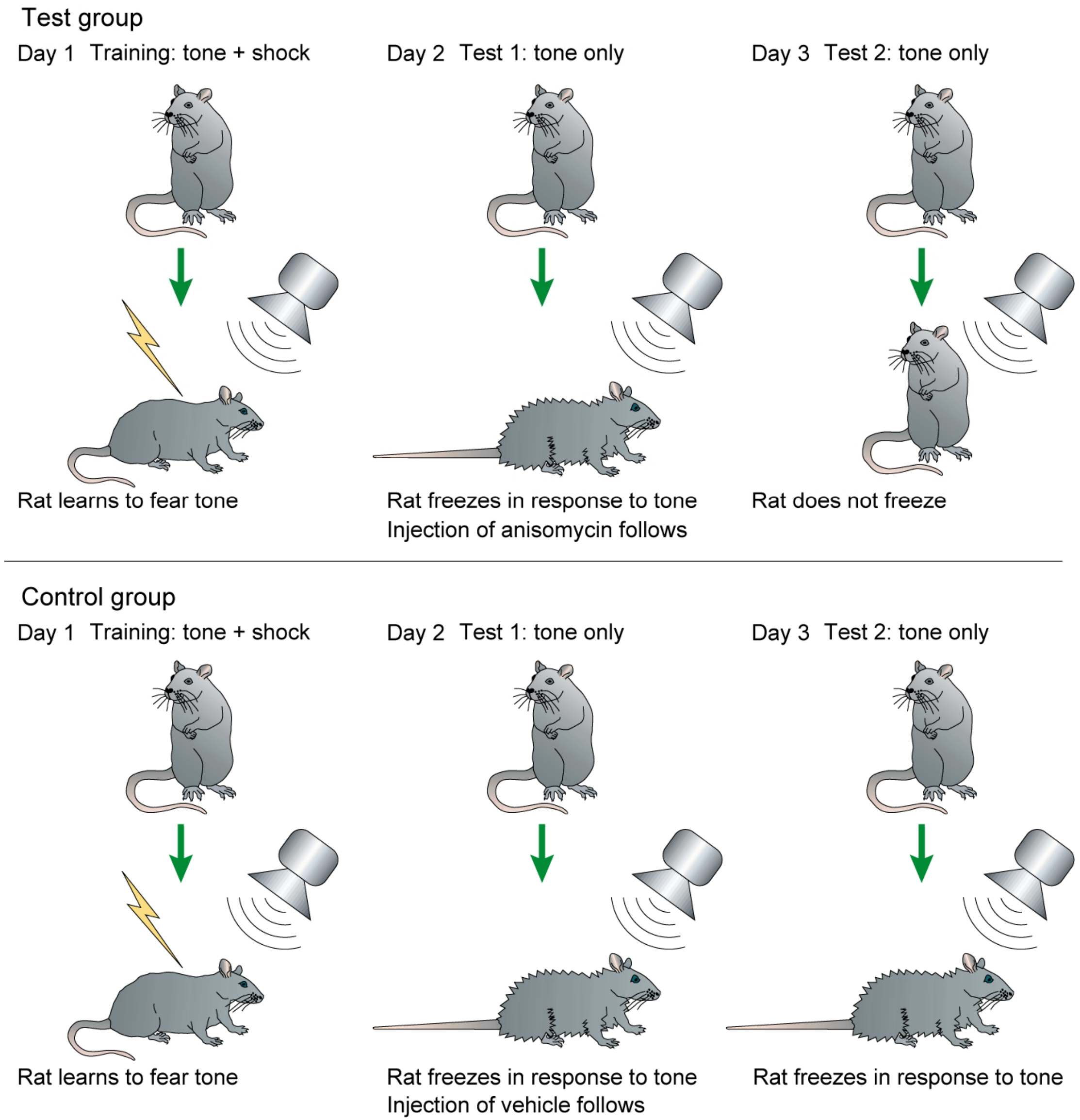


Figure 1 | Manipulations used to show reconsolidation. Memory for fear is disrupted in the test group if the tone is presented before the injection of anisomycin. In the control group, fear conditioning persists after the initial retrieval event (day 3).

Nader et al. (2000)

1969: ECT for obsessive–compulsive disorder

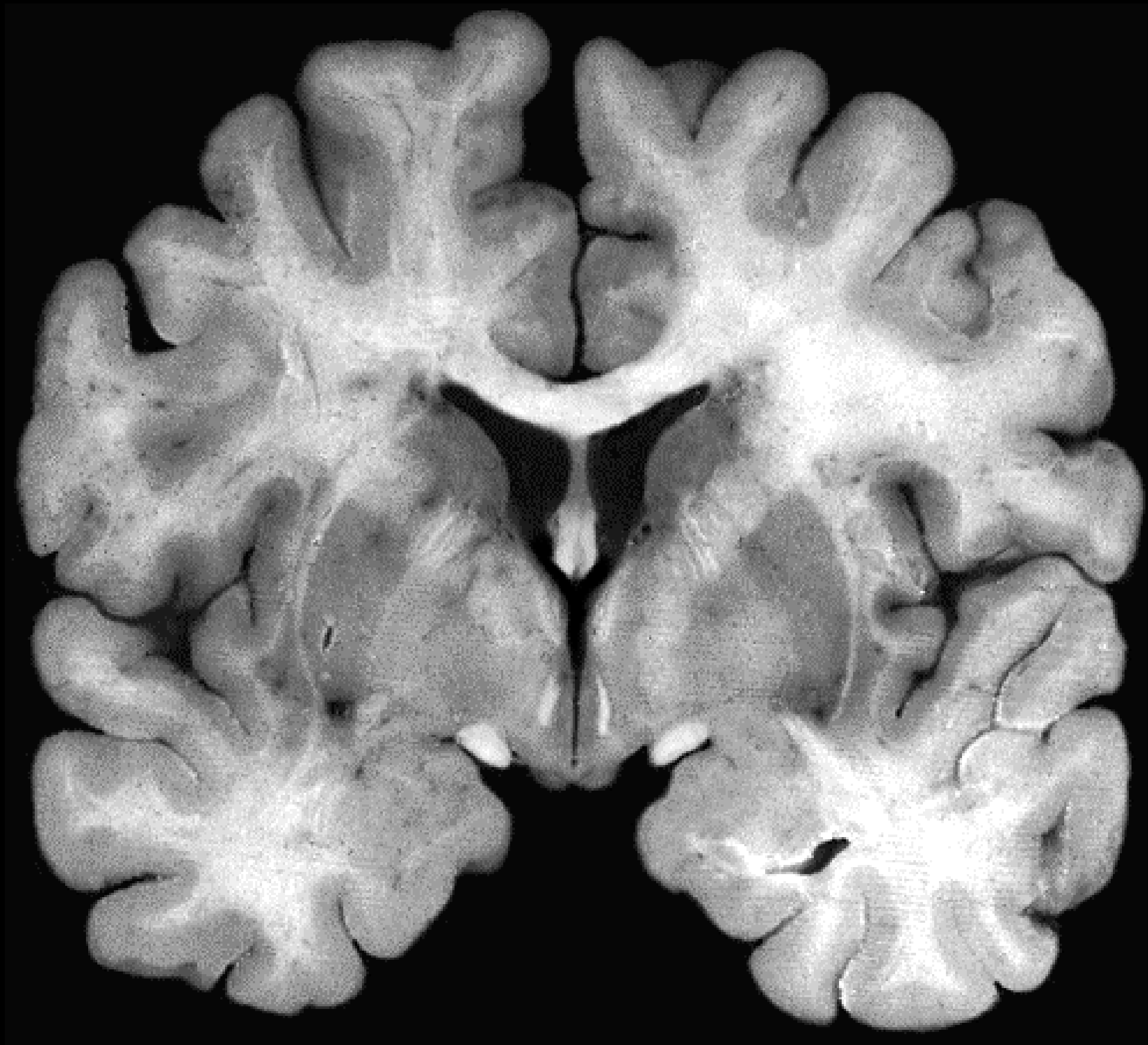
Patients with OCD or hallucinations were given ECT after being prompted to act out their desires or after their hallucination had begun. All 28 patients... improved dramatically for periods ranging from 3 months to the time of publication of the manuscript, 10 years later. One relapsed, but was treated once using the same approach and recovered.

> Many of the subjects had previously received between 5 and 28 ECT sessions, while anaesthetized, with little benefit.

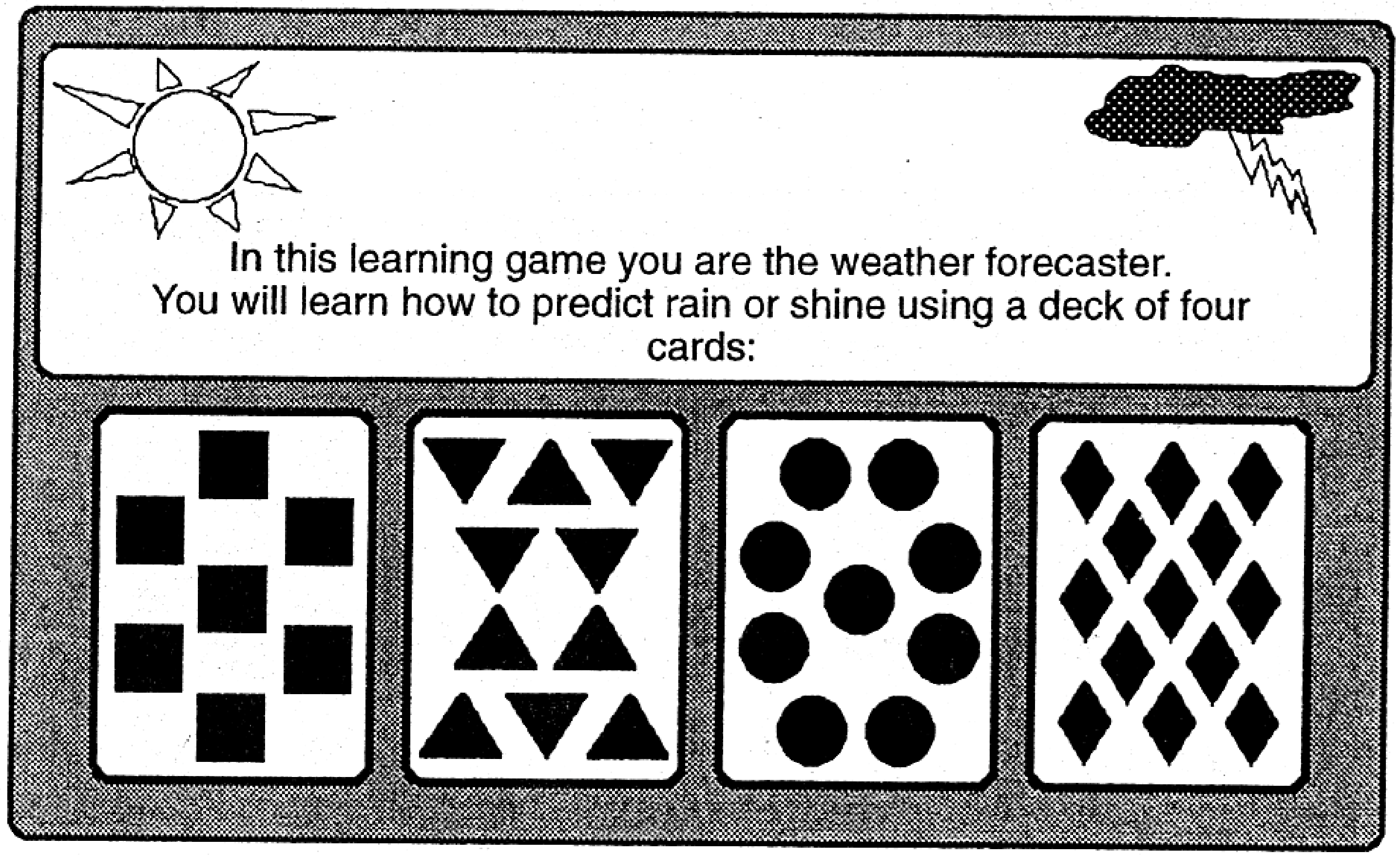
Case study. 30-year-old woman with OCD received 22 ECT treatments in 1 year while anaesthetized, but became worse. She was made to act out her compulsion of killing her mother with a butcher's knife and was then administered a single session of ECT while still awake. 'The next day, greatly improved, she went home and spoke kindly to her mother for the first time in years. She asked her mother "Do you love me?" and then kissed her. When the author asked if she still felt like stabbing her mother, she laughed and said, "Oh, she doesn't deserve anything like that"'. She returned home and to work, and remained free of symptoms for the 2 years up to the publication of the study.

Rubin et al. (1969); Rubin (1976); see Nader (2003)

Habit learning



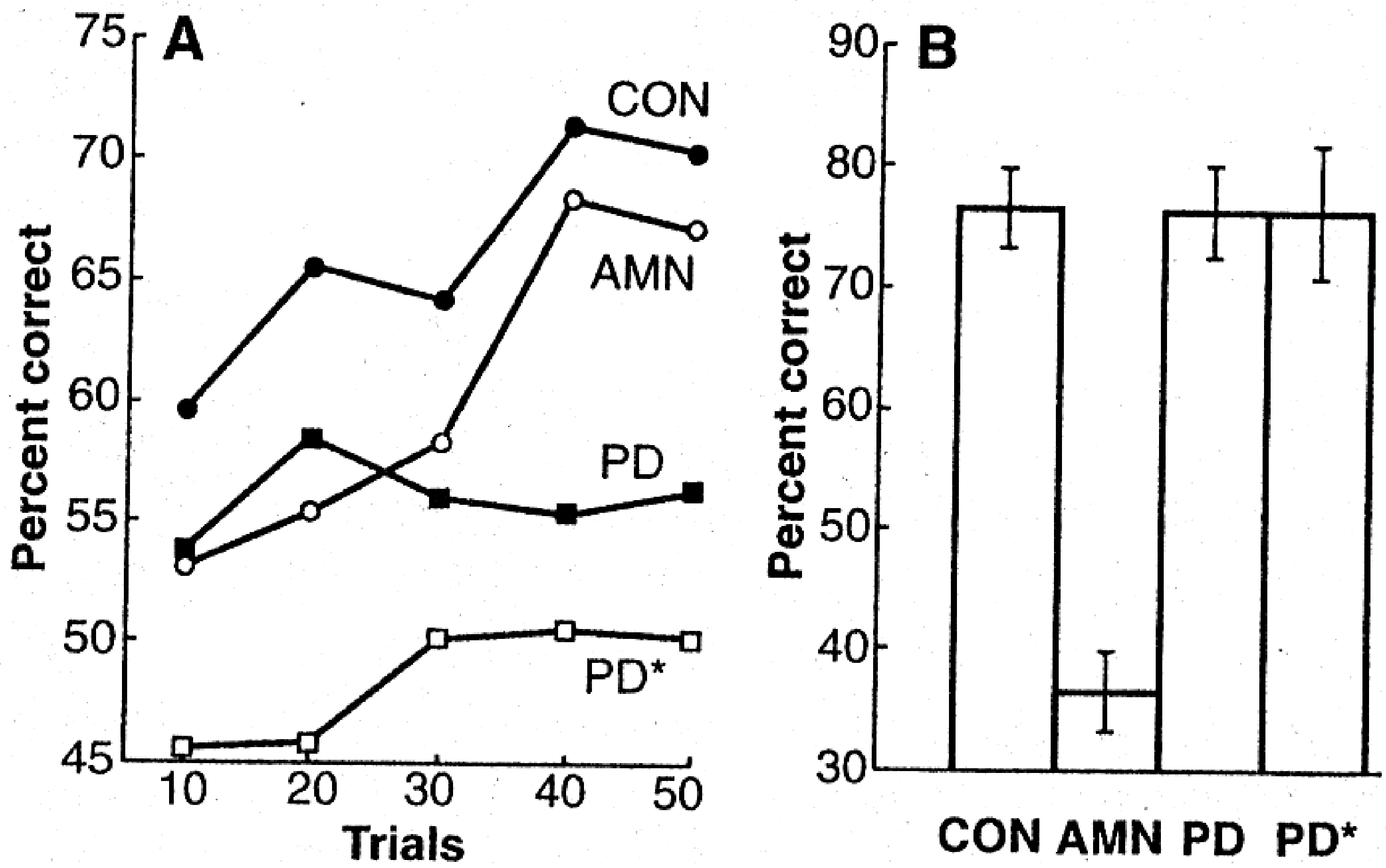
A double dissociation between PD and amnesiacs (1)



- ***Task 1 (probabilistic classification):*** *one to three cards are shown. The subject must predict sunshine or rain. Feedback is provided (correct/incorrect). One cue is associated with sunshine on 25% of occasions; one on 43% of occasions; one 57%; one 75%.*
- ***Task 2 (declarative):*** *memory for features of the game (screen layout, cues, etc.) is tested with four-way multiple-choice questions.*

Knowlton et al. (1996)

A double dissociation between PD and amnesiacs (2)

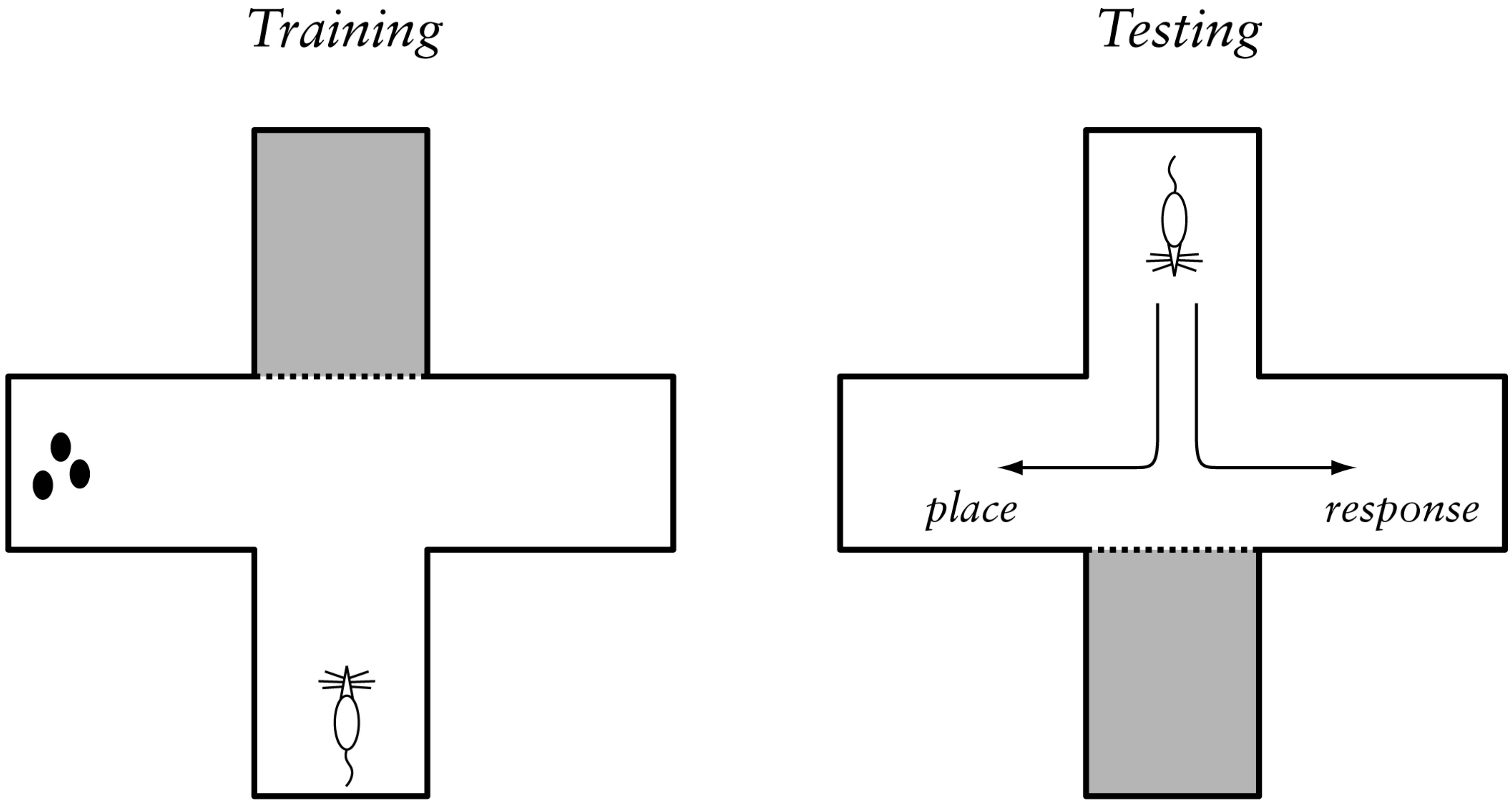


• ***PD patients:*** *impaired on probabilistic classification task, not declarative. (PD* = severe.)*

• ***Amnesic patients (with bilateral hippocampal damage or midline diencephalic damage):*** *impaired on declarative task, not probabilistic classification.*

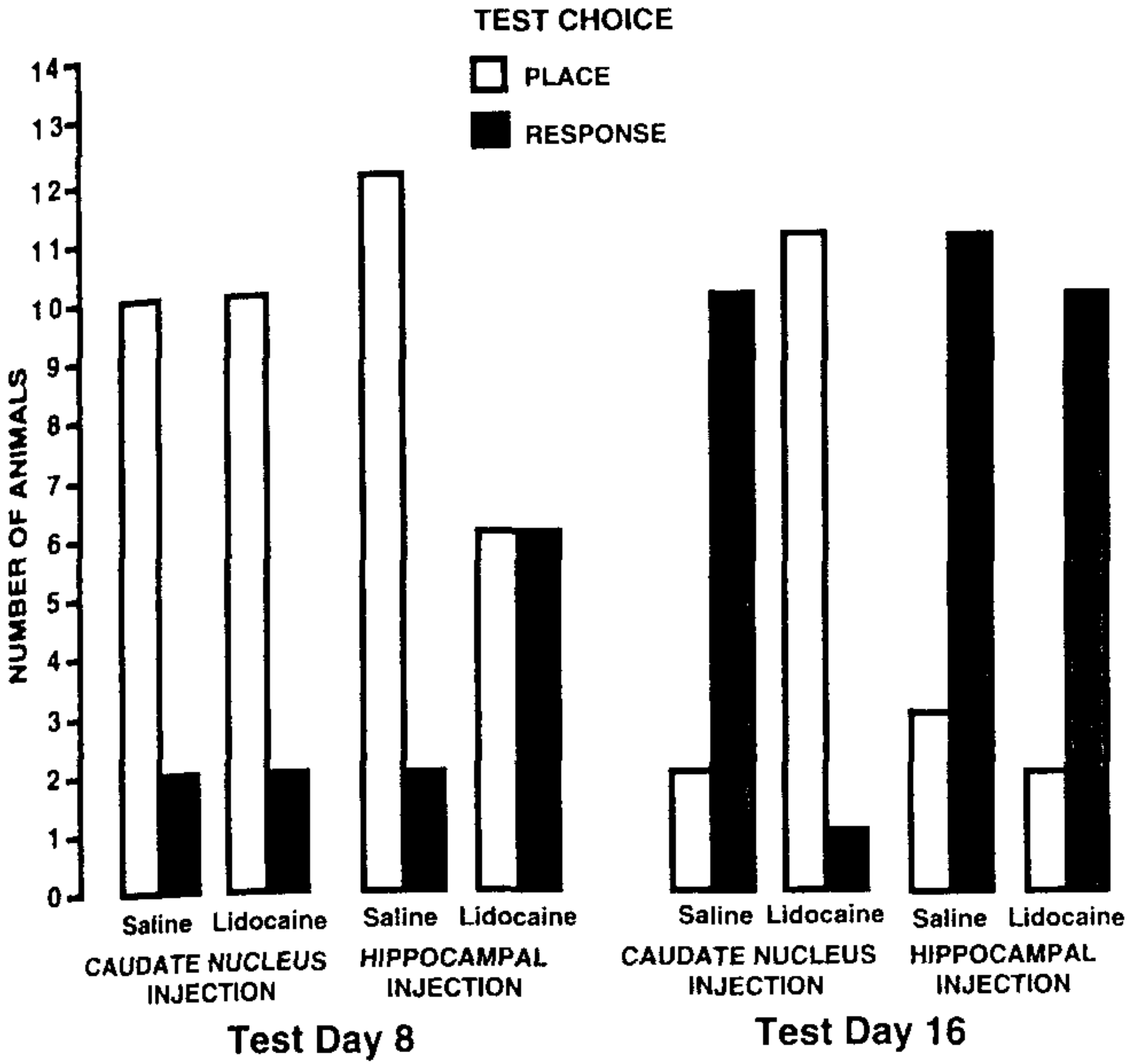
Knowlton et al. (1996)

Habits and the dorsal striatum (1)



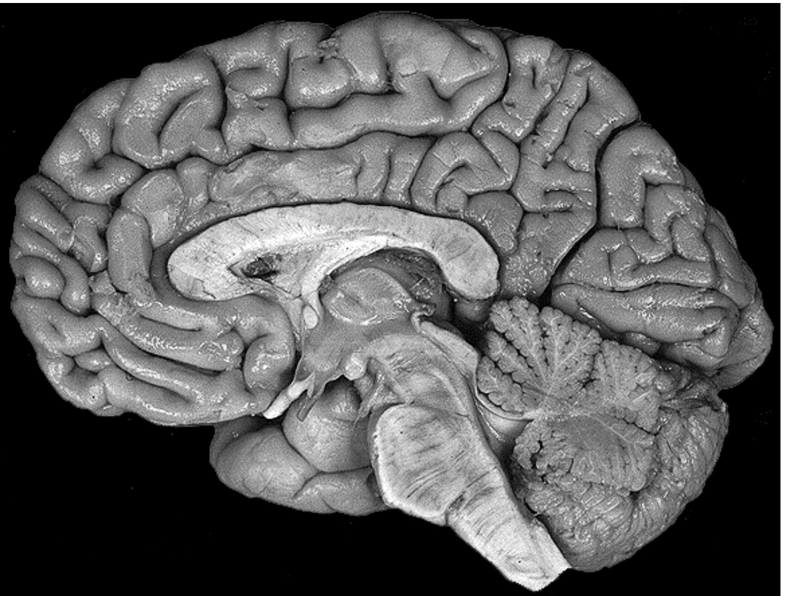
Packard & McGaugh (1996)

Habits and the dorsal striatum (2)



Packard & McGaugh (1996)

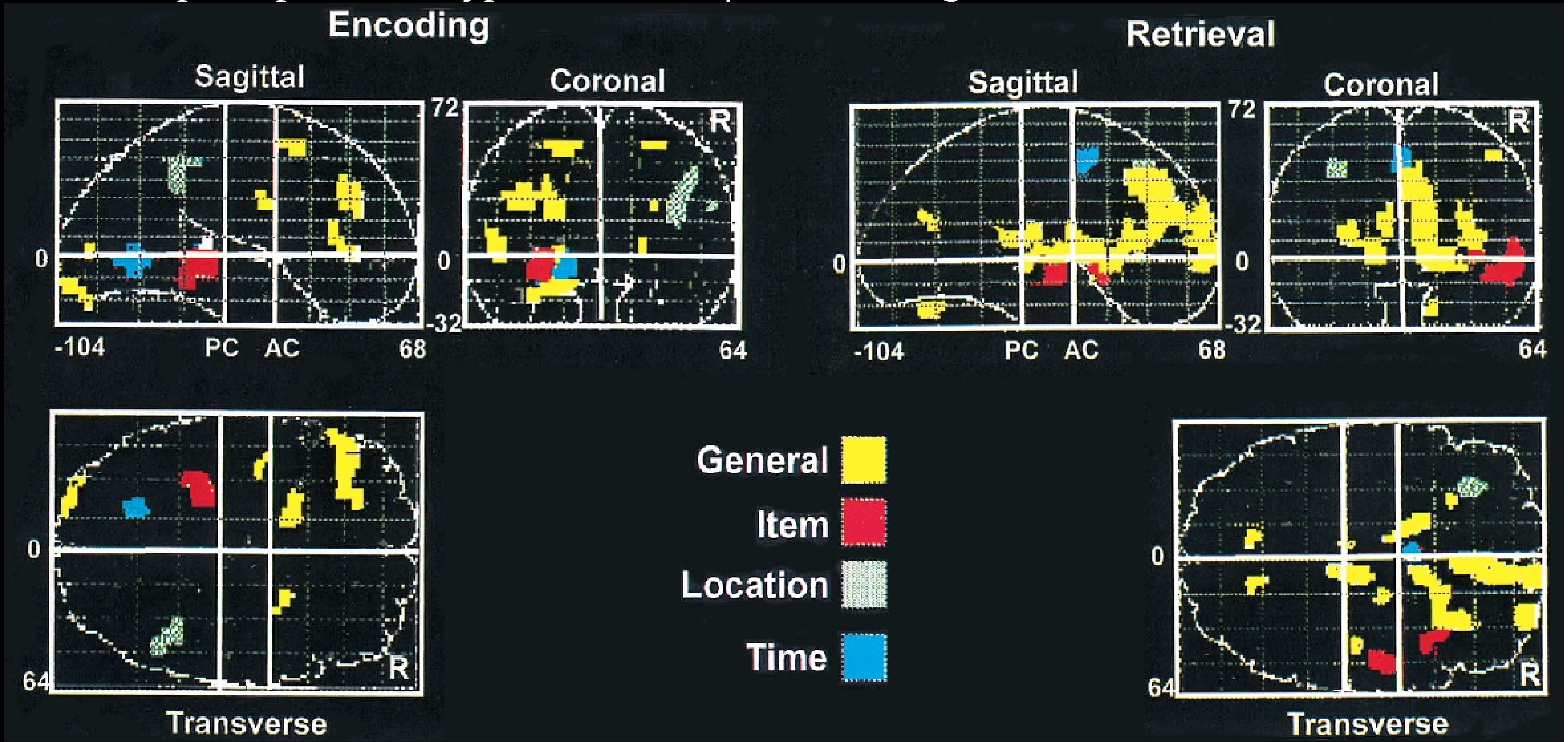
Memory and the prefrontal cortex



Memory encoding and retrieval (1)

'Hemispheric asymmetric in encoding and retrieval' (HERA) model.

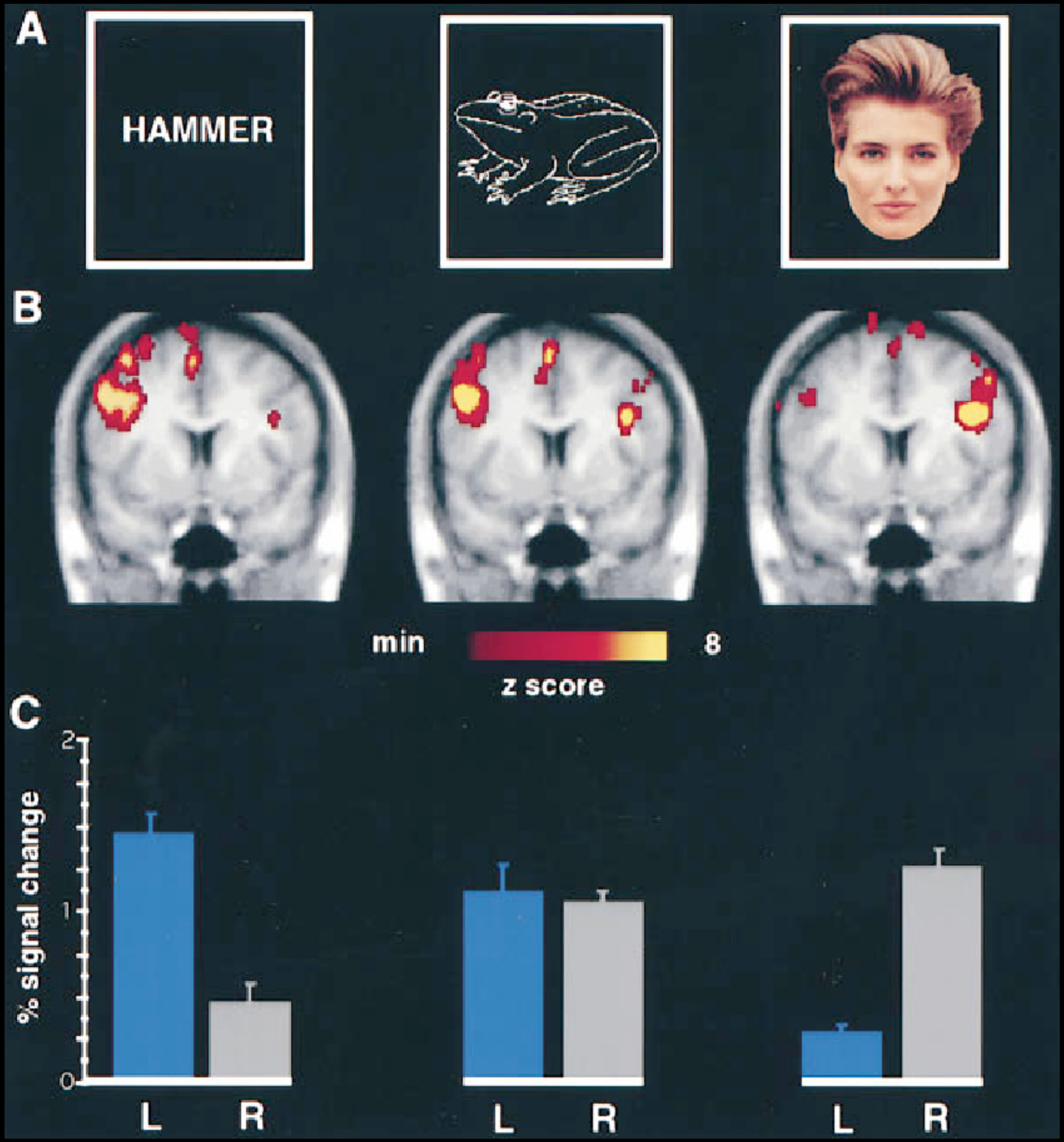
Passive perception is a typical control for 'encoding'.



Tulving et al. (1994); Nyberg et al. (1996; 1998)

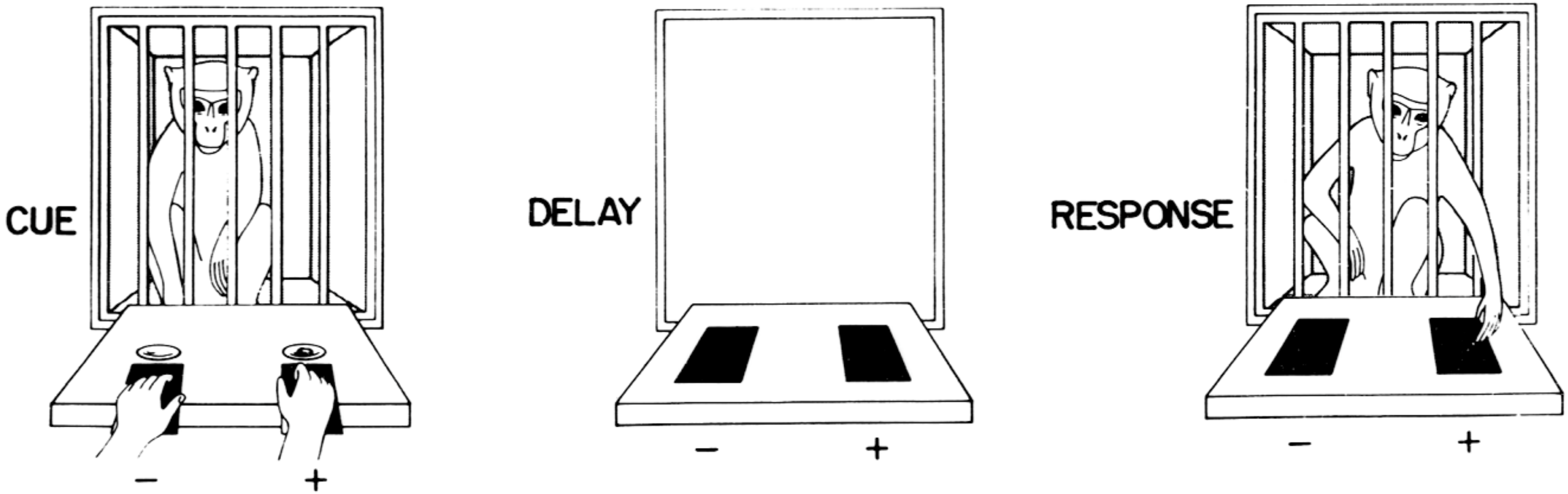
Memory encoding and retrieval (2)

Encoding material activates different regions of the PFC depending on the material encoded.



Kelley et al. (1998)

Delayed response task



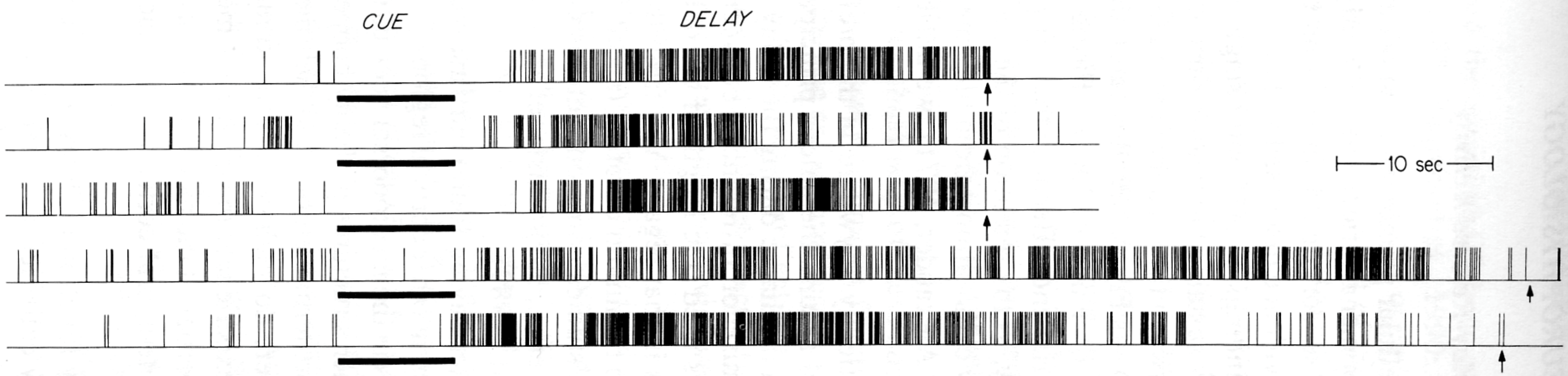


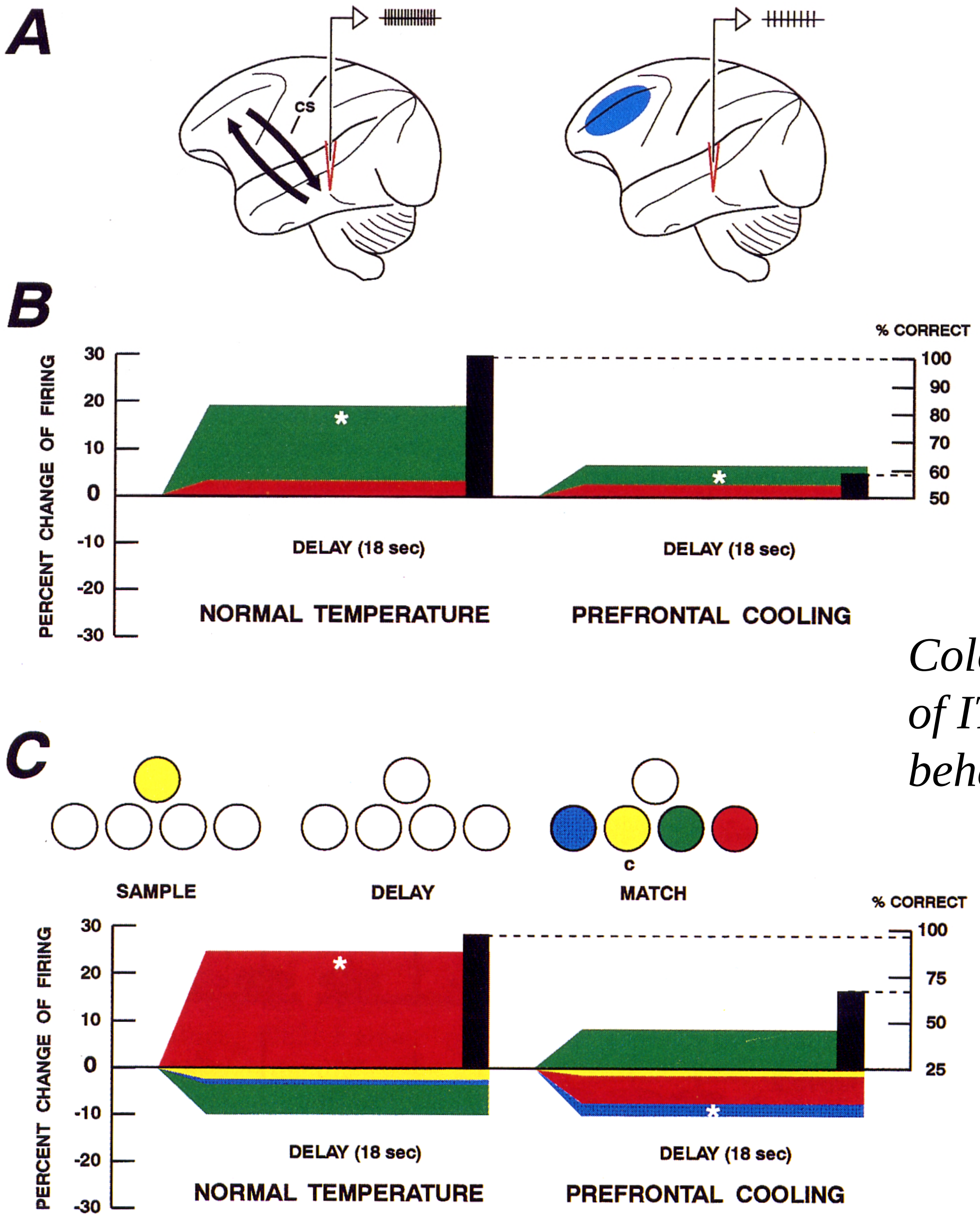
FIG. 5.9. Activity of a prefrontal unit during five delayed-response trials. In each trial, a horizontal bar marks the cue period and an arrow the end of the delay (i.e., the presentation of the choice stimuli). Note the activation of the cell during the delay: over 30 sec in the upper three trials, 60 sec in the lower two trials. (From Fuster and Alexander, 1971, with permission.)

Friedman & Goldman-Rakic (1988); task by Hunter (1913); Fuster & Alexander (1971)

Working memory: PFC maintains posterior cortex activity?

Two-colour DMTS

Four-colour DMTS



Coloured areas: activity of IT neurons. Black bars: behavioural performance.

Fuster & Alexander (1970); Fuster (1995)