

Visual Memory
'Any neural or behavioural phenomenon implying storage of a past visual experience'.

Encoding



no associations

no context

imagery

non-visual cue

imagery

recall time/place

RECOGNITION

Familiarity

Recollection

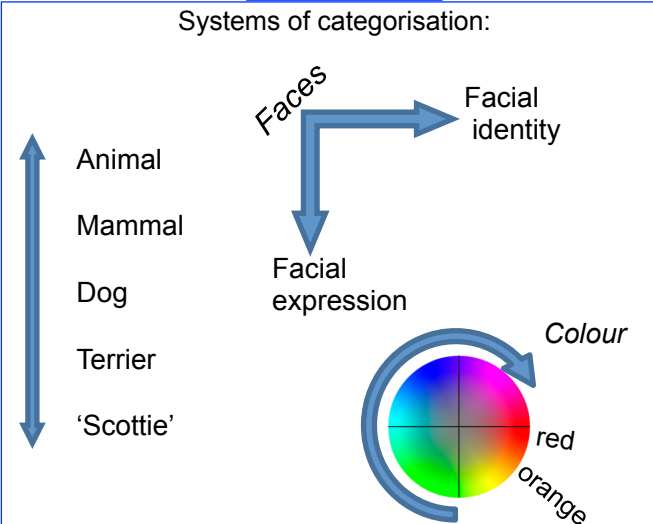
Retrieval

Categories

Individual exemplars:

Visual 'events'

Systems of categorisation:



- e.g. Jeremy Corbyn
- e.g. Miley Cyrus
- e.g. The Crimea
- e.g. World Trade Centre

- 'snapshots' of scenes;
- groupings of recognised items /people & place.

'photographic' memory

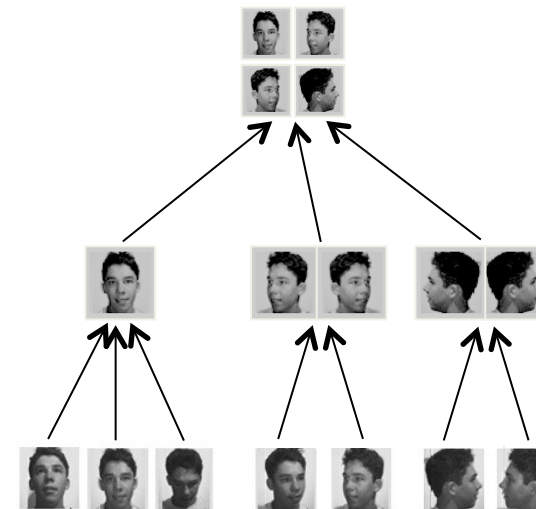
'deja vu'
= episodic false familiarity

SEMANTIC	EPISODIC	e.g. Semantic familiarity; learning individual faces
X		familiarity
		recollection

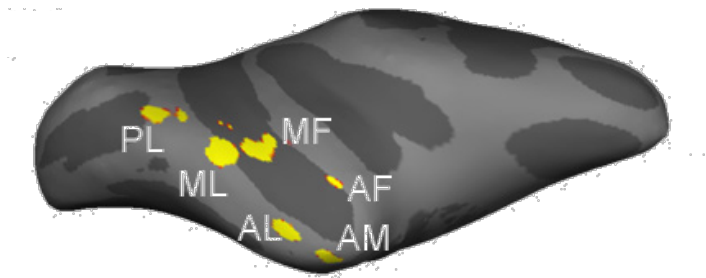
AM patch:
View invariant
Subject specific
latency = 124 msec

AL patch:
View symmetrical
latency = 104 msec

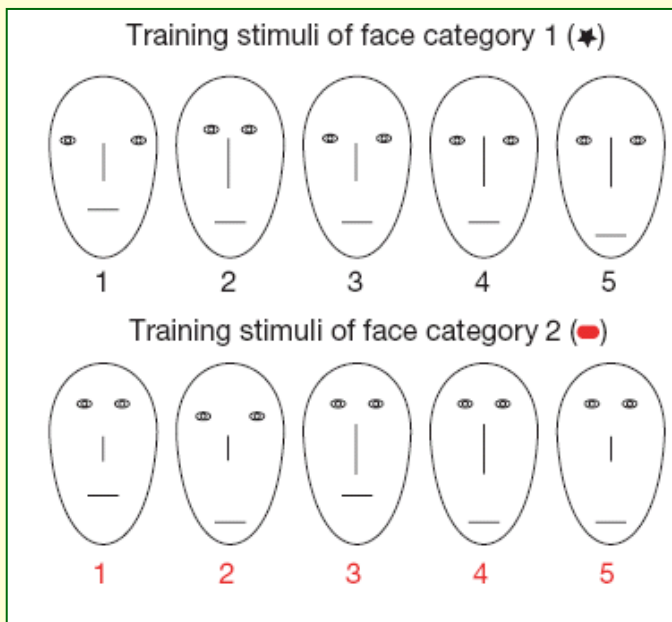
ML/MF patches:
View selective
Subject inspecific
latency = 88 msec



e.g. **Friewald & Tsao (2010) Hierarchical model** [Ref 3]

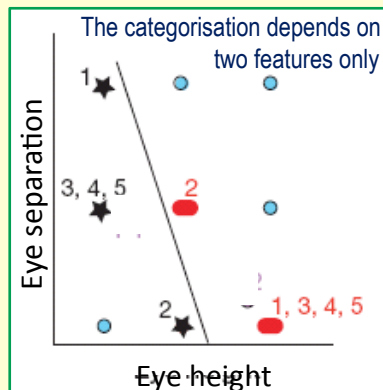


e.g. **Sigala & Logothetis (2002)** [Ref 2]
Area TE neurons learning 'facial' features

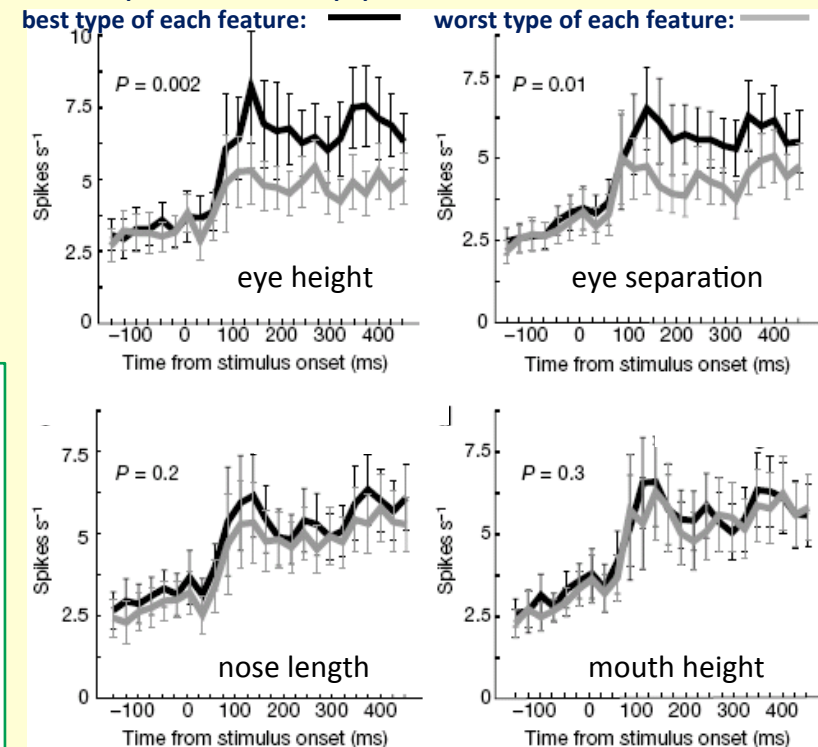


Parametric 'face-space':

- eye height
- eye separation
- nose length
- mouth height

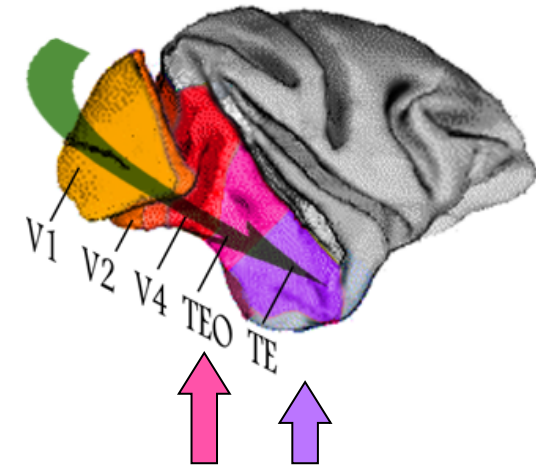


Mean response of recorded population:



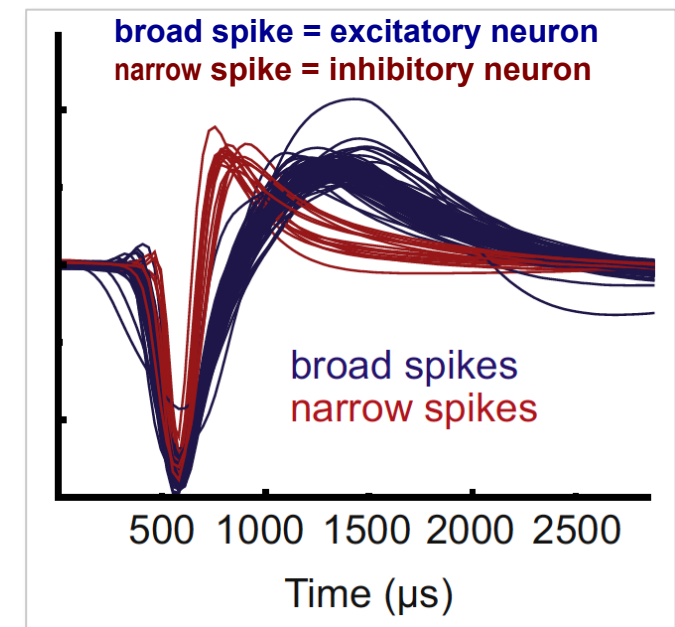
SEMANTIC	EPISODIC	Woloszyn & Sheinberg (2012) ^[Ref 4] Neural encoding of familiarity v novelty
X		familiarity
		recollection

NOVEL V. FAMILIAR STIMULUS SETS



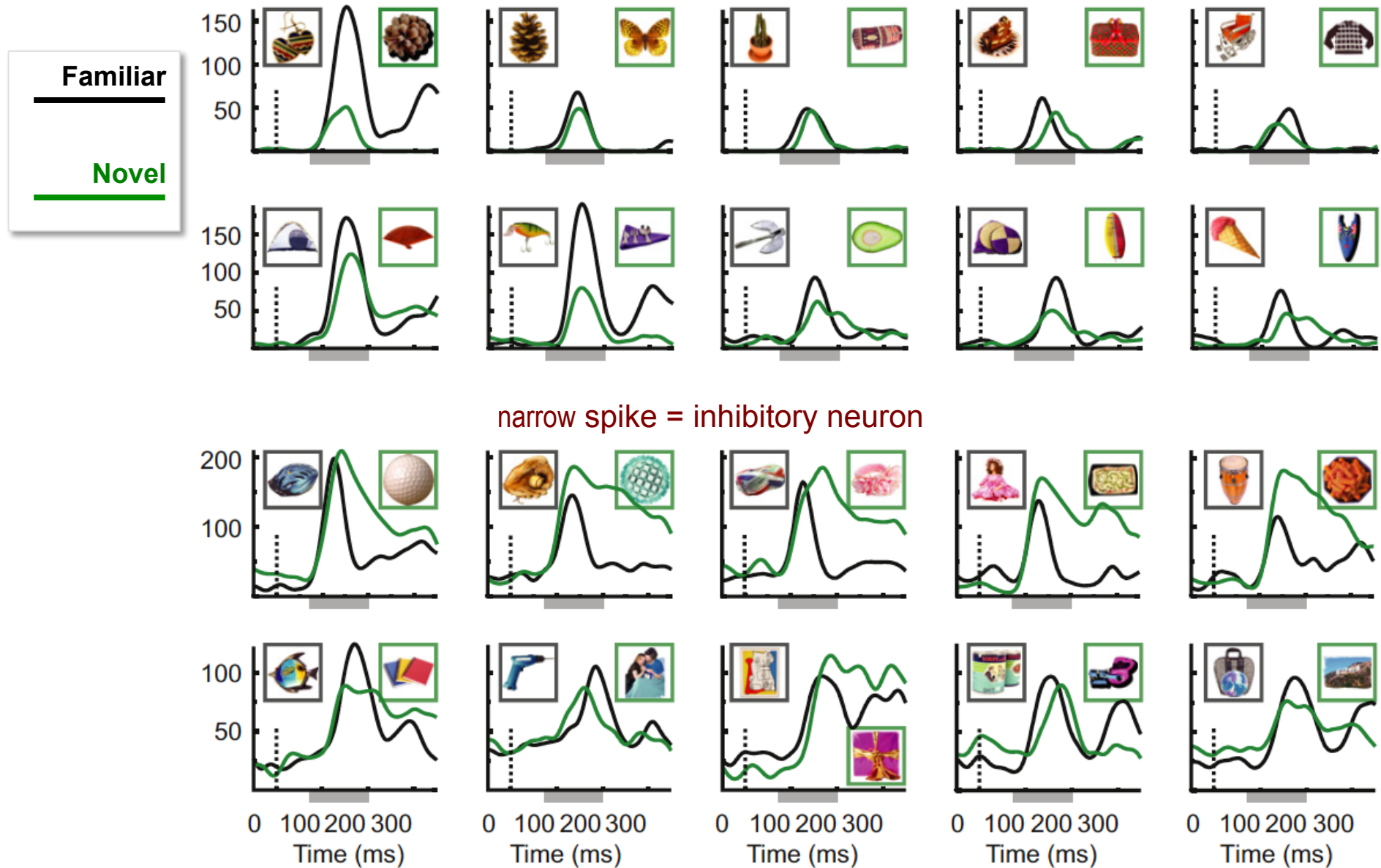
Areas TEO & TE

- known together as 'IT cortex' (inferior temporal)



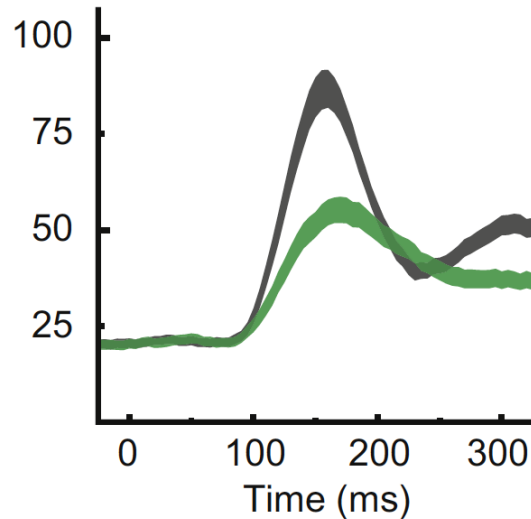
SEMANTIC	EPISODIC	Woloszyn & Sheinberg (2012) ^[Ref 4] Neural encoding of familiarity v novelty
X		<i>familiarity</i>
		<i>recollection</i>

broad spike = excitatory neuron



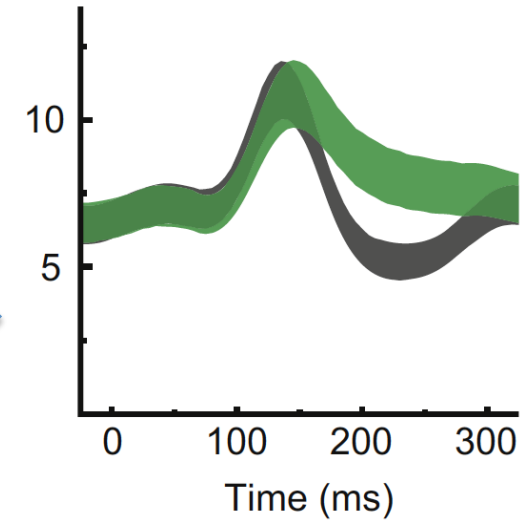
SEMANTIC	EPISODIC	Woloszyn & Sheinberg (2012) ^[Ref 4] Neural encoding of familiarity v novelty
X		<i>familiarity</i>
		<i>recollection</i>

broad spike = excitatory neurons

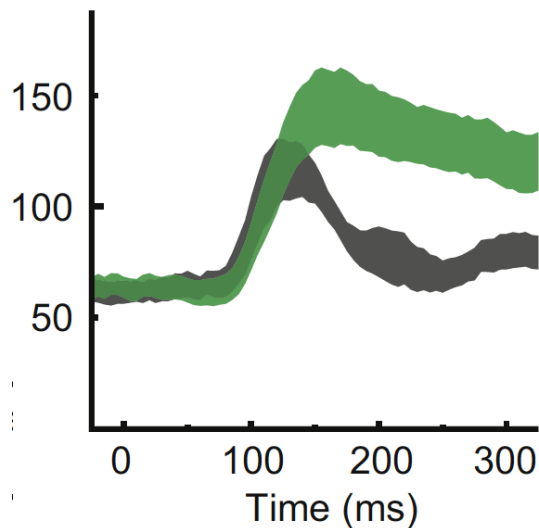


Neural population:
Average response
to best stimulus

Average response
to all stimuli

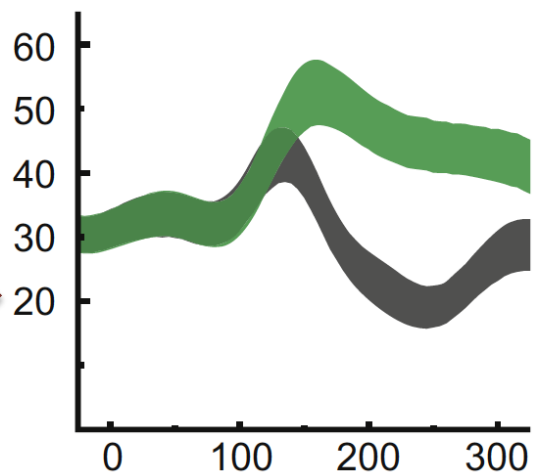


narrow spike = inhibitory neurons



Neural population:
Average response
to best stimulus

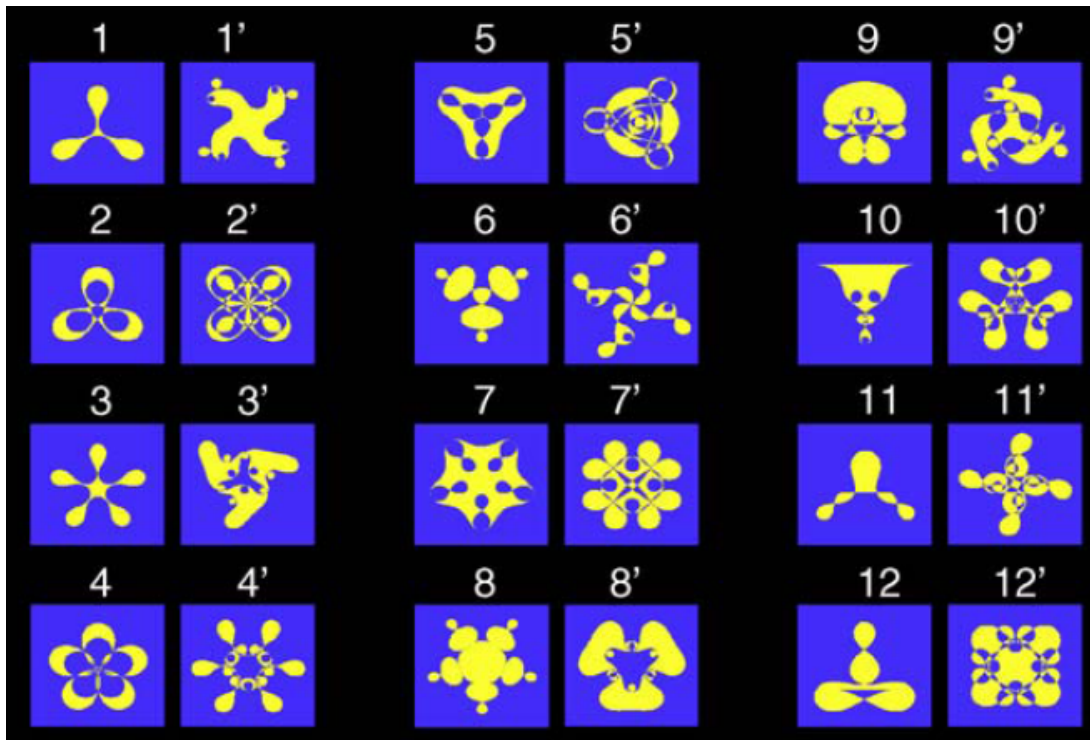
Average response
to all stimuli



Naya, Miyashita *et al.* (2003-2010) Paired-associate task –
formation of visual 'semantic' memory in medial temporal lobe [refs 5-7]

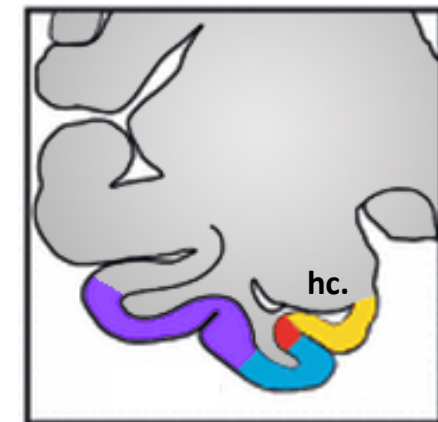
Paired-associate task:

1. Learn the specific pairings for 12 pairs of unfamiliar complex patterns;
2. Observe a single cue stimulus (any one of the 24 items) e.g. item 5';
3. Recall associated item (item 5);
4. Select correct item from a choice of two (e.g. 5 & 8').



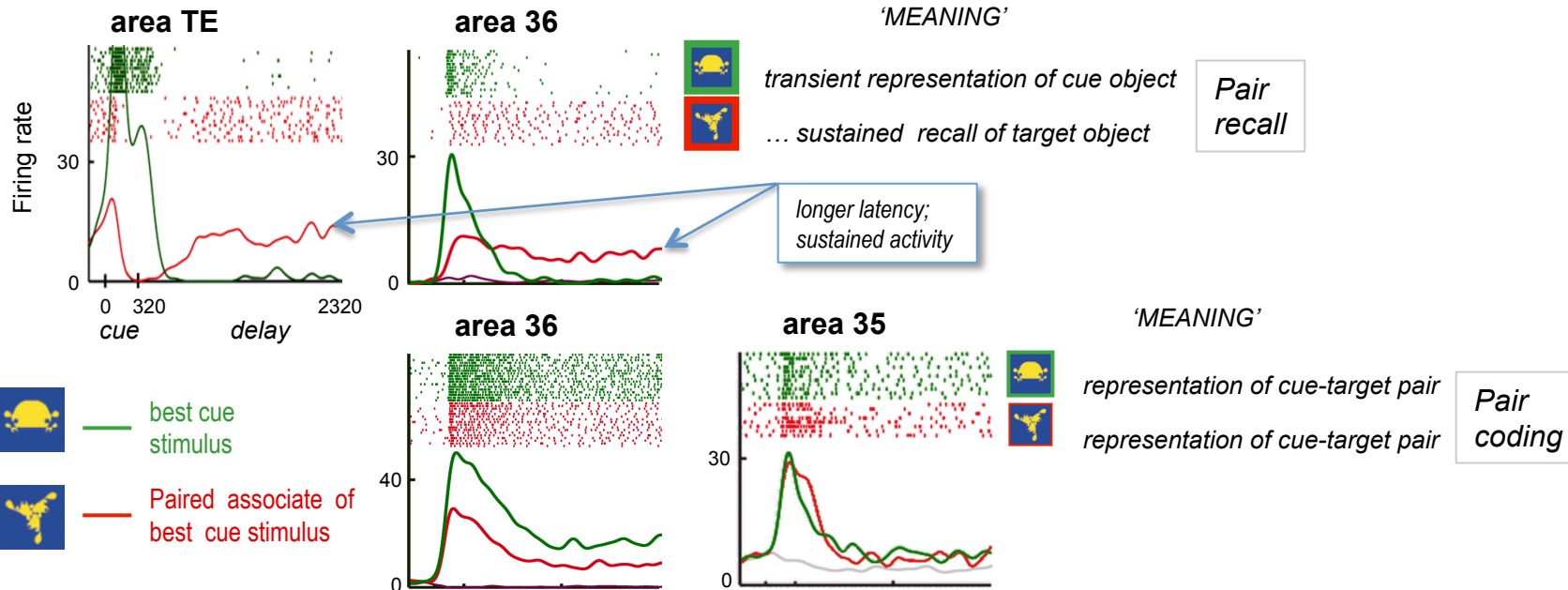
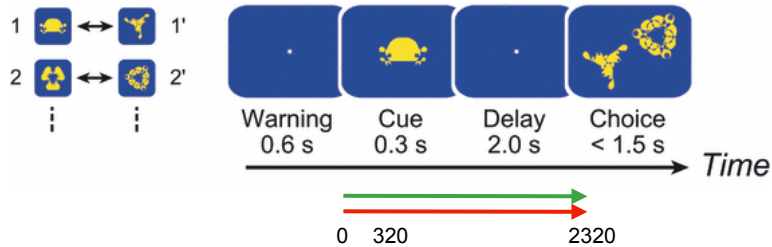
SEMANTIC	EPISODIC	Naya, Miyashita <i>et al.</i> (2003-10) ‘Paired-associate task’ – learning arbitrary associations [5-7]
		familiarity
X		recollection

Area TE Inferotemporal cortex
 Area 36 } Perirhinal cortex
 Area 35 }
 ECECEC Entorhinal cortex

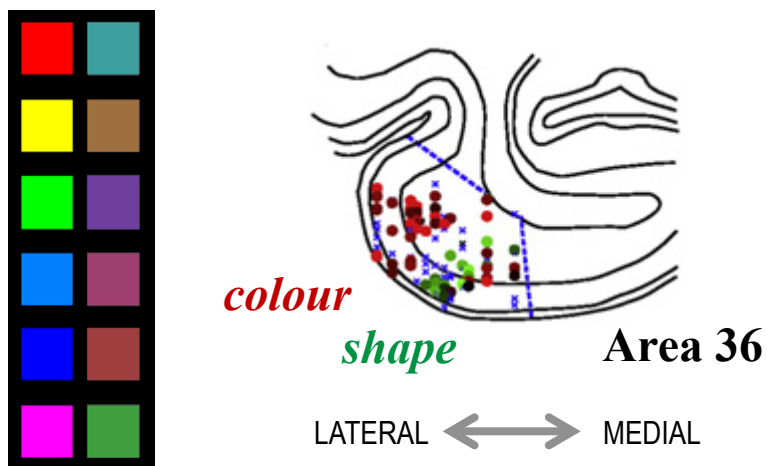


DORSAL

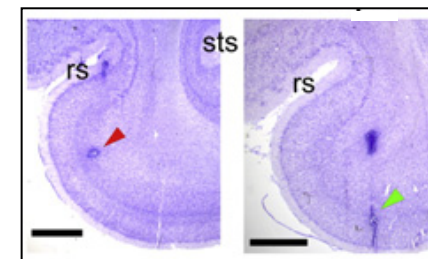
LATERAL



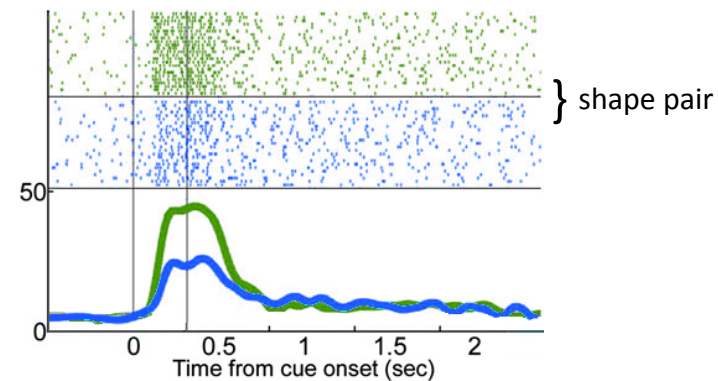
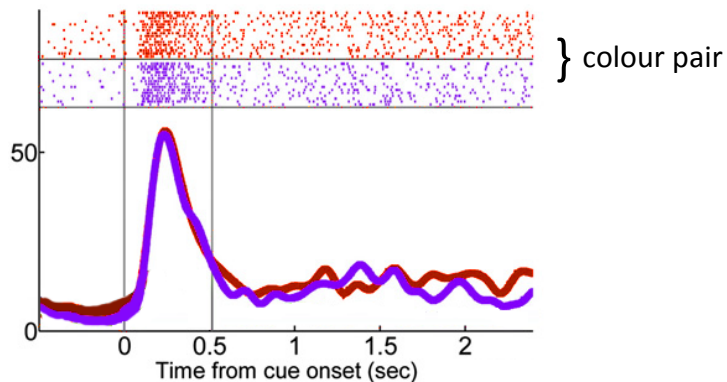
Kasahara *et al.* (2011)^[Ref 8] Colour or shape pair associates task



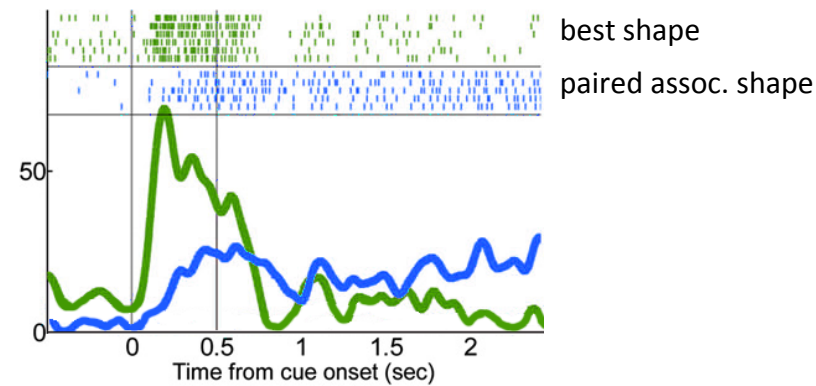
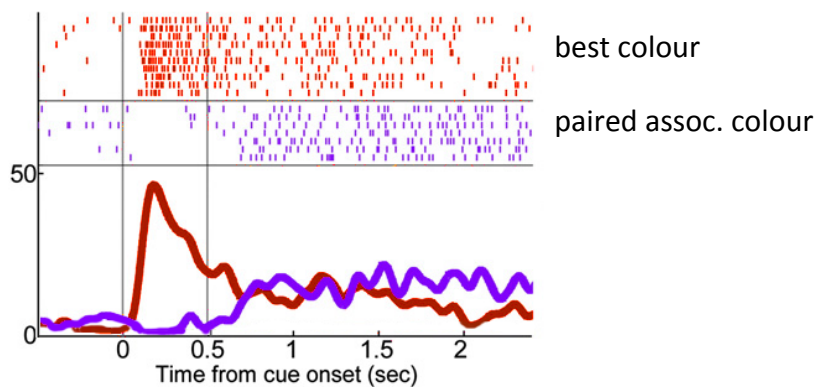
n = 375 stimulus selective	pair coding	pair recall
colour	19%	11%
shape	30%	7.7 %



**PAIR
CODING**



**PAIR
RECALL**

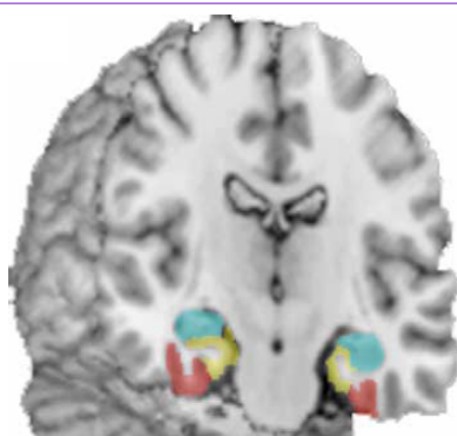
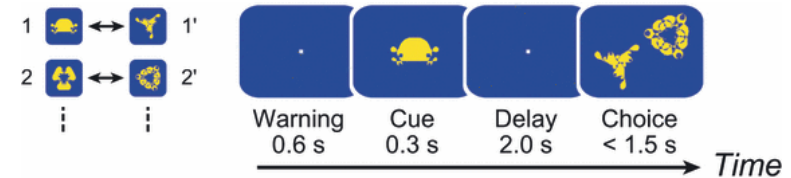


Yamashita, Miyashita *et al.* (2009) **Memory consolidation in IT cortex (human fMRI)** [ref 9]

Subjects required to learn 2 sets of pairings:

'remote learning' = 8 weeks before scan

'recent learning' = 30 minutes before scan



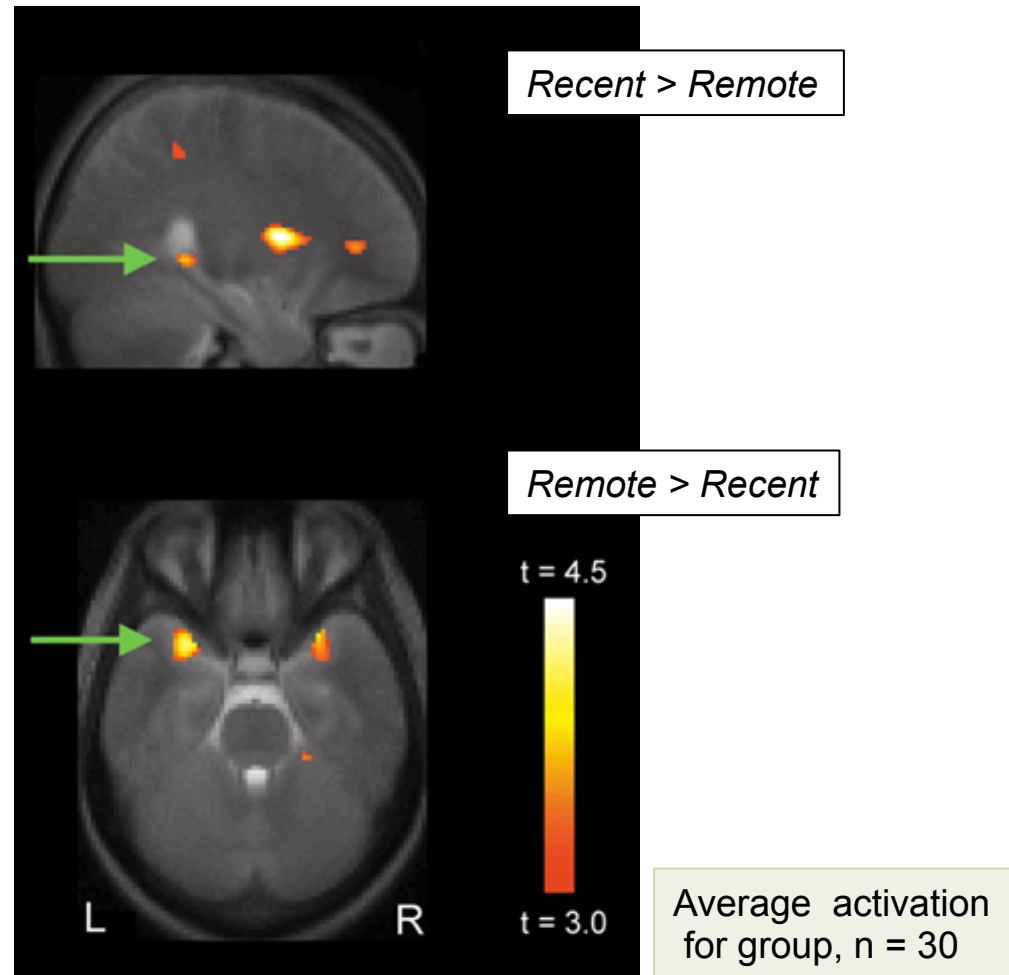
Hippocampus
(novel objects
and associations)

Medial temporal
(multimodal object
representations)

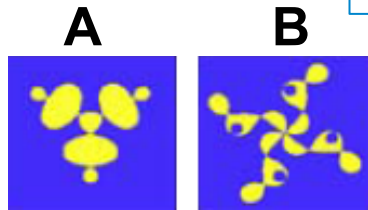
Inferior temporal
(visual object
representations)

Hippocampus

Anterior IT cortex



Pair associate recall – hypothetical neural mechanism



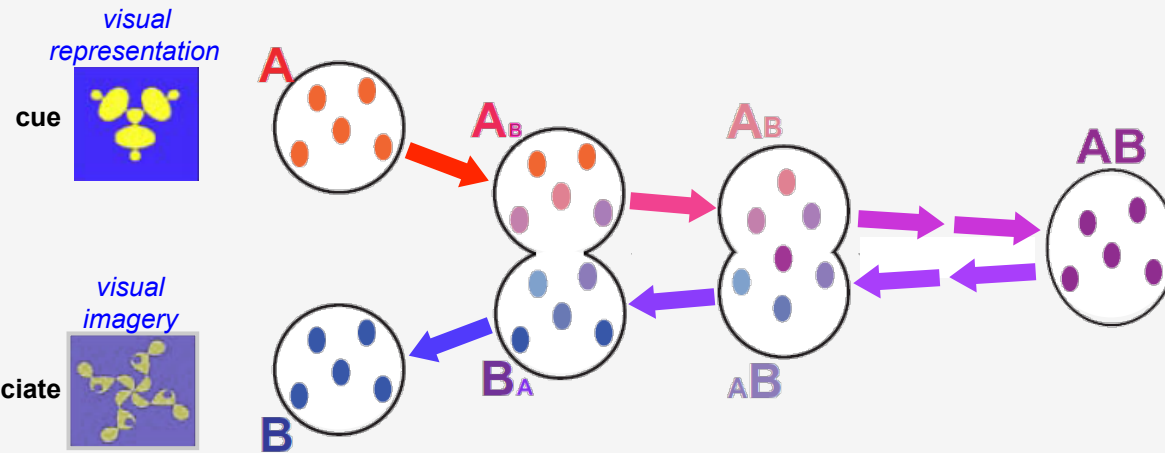
learnt pair

TE

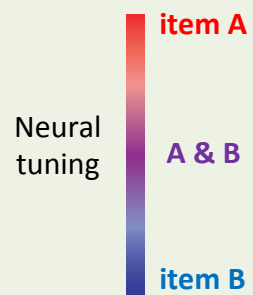
A36

A35

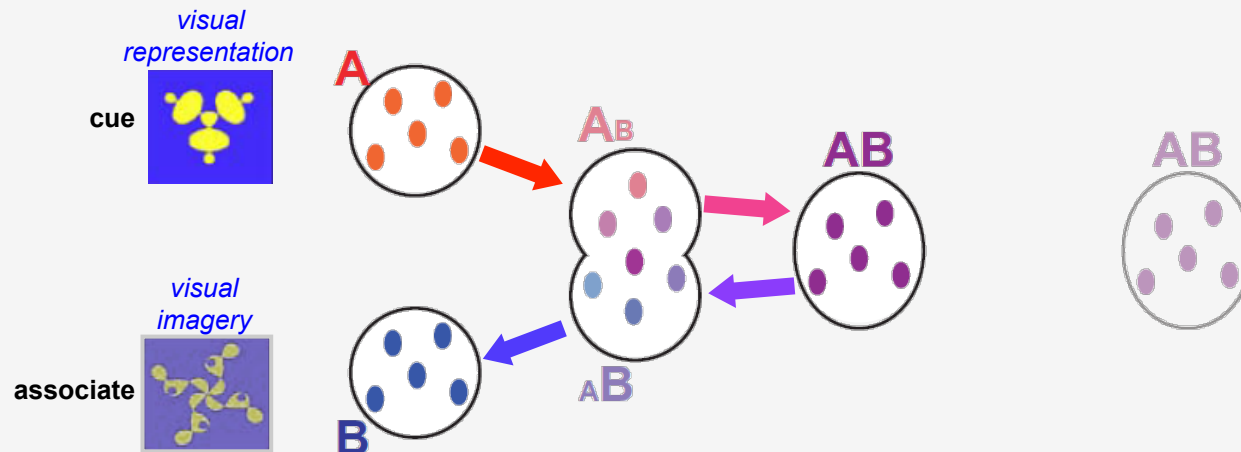
Hippocampus



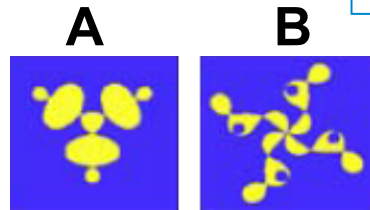
RECENT LEARNING



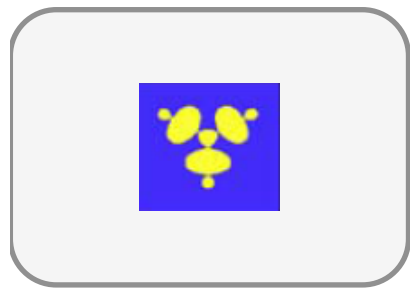
REMOTE LEARNING
(as observed in highly trained macaques)



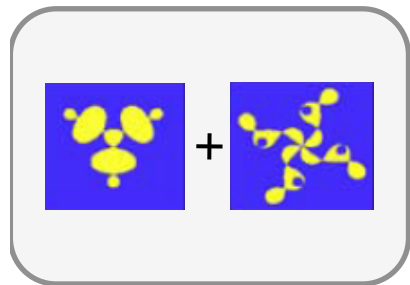
Pair associate recall – hypothetical neural mechanism (including display)



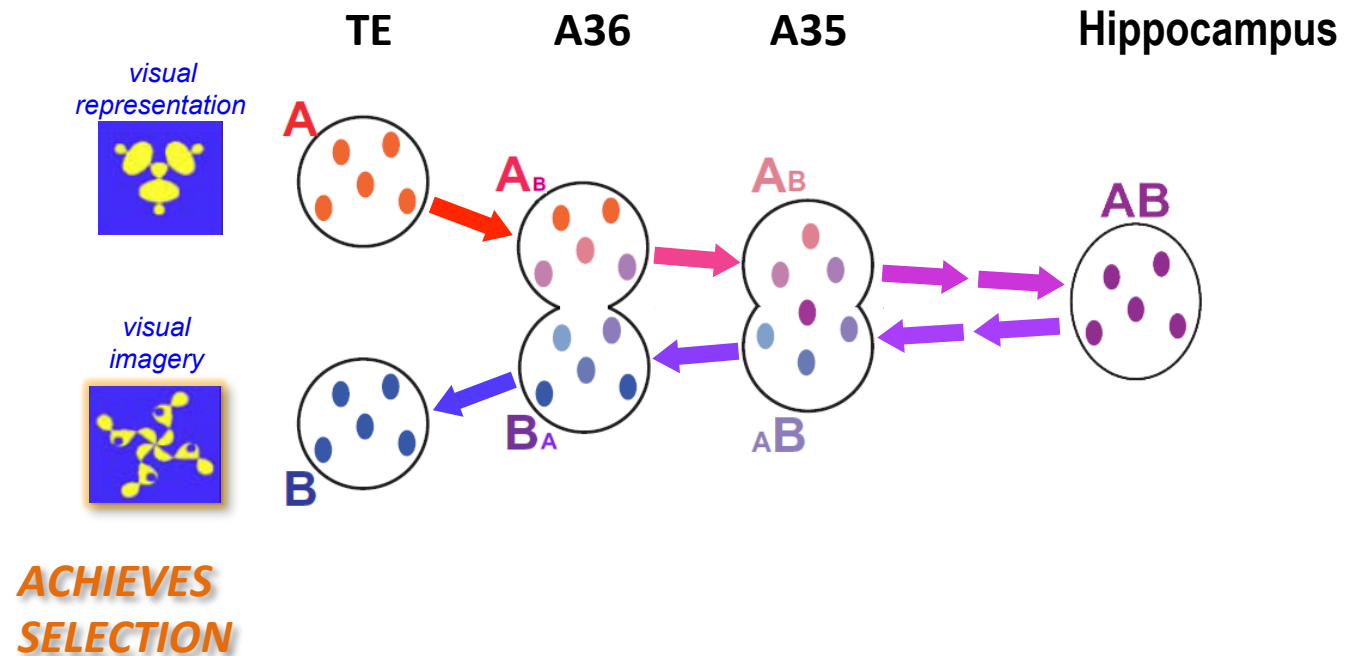
learnt pair



cue



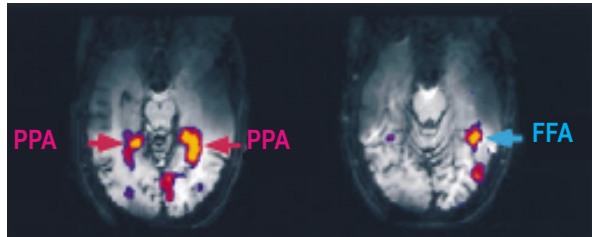
choice



Ranganath *et al.* (2004) Pair Associate recall (human fMRI) [ref 10]

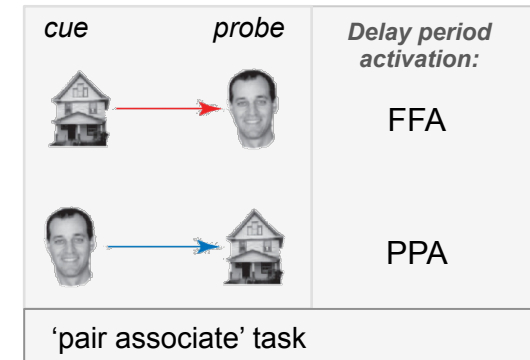
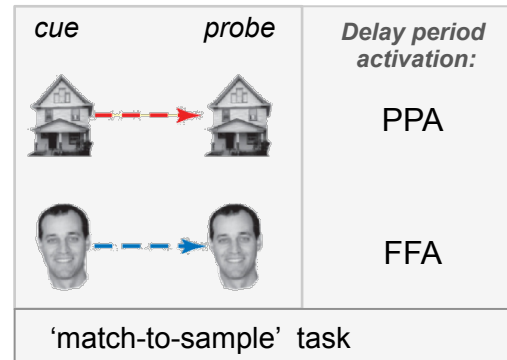
Task:

1. Pre scan: learn face-house pairs;
2. In scan: recall pair associate,
OR
Perform match to sample task.

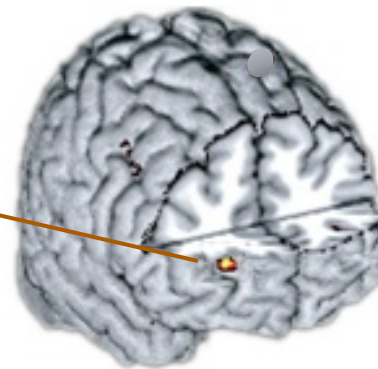
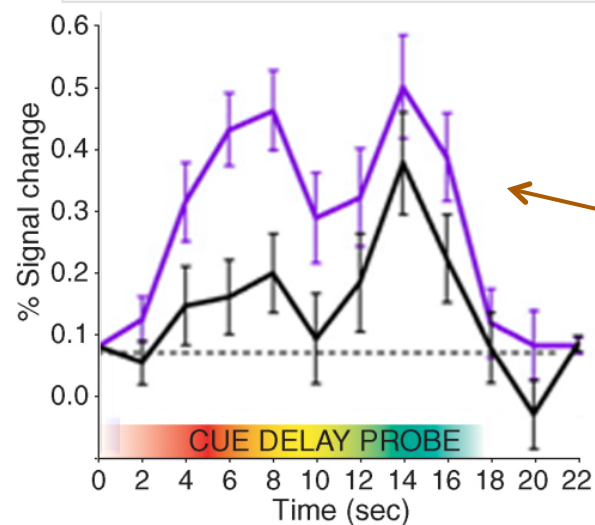


PARAHIPPOCAMPAL
PLACE AREA

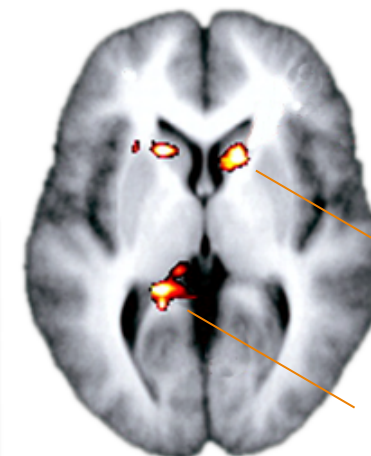
FUSIFORM
FACE AREA



Pair associates task v. Match-to-sample task



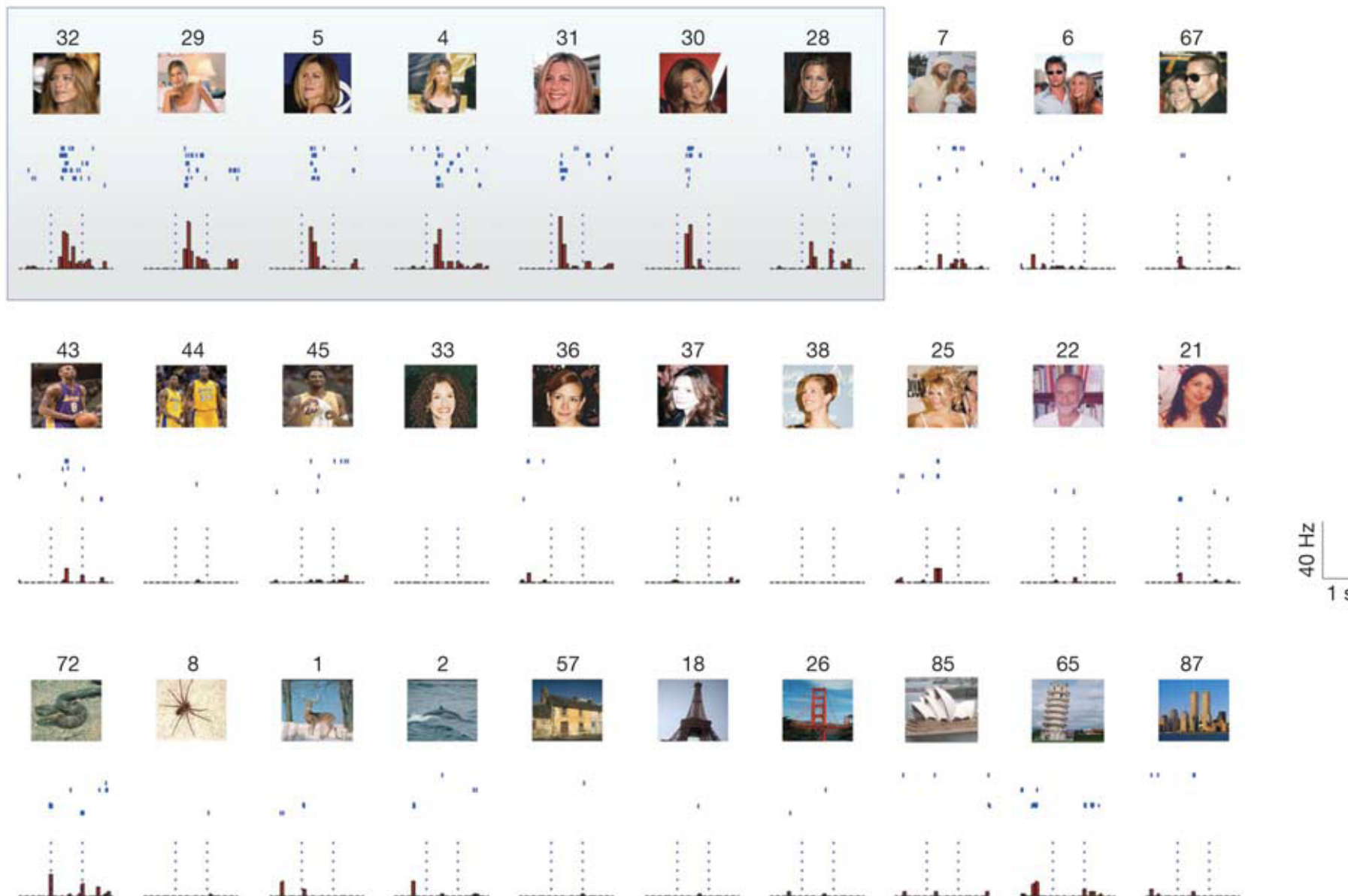
Anterior
Prefrontal
Cortex



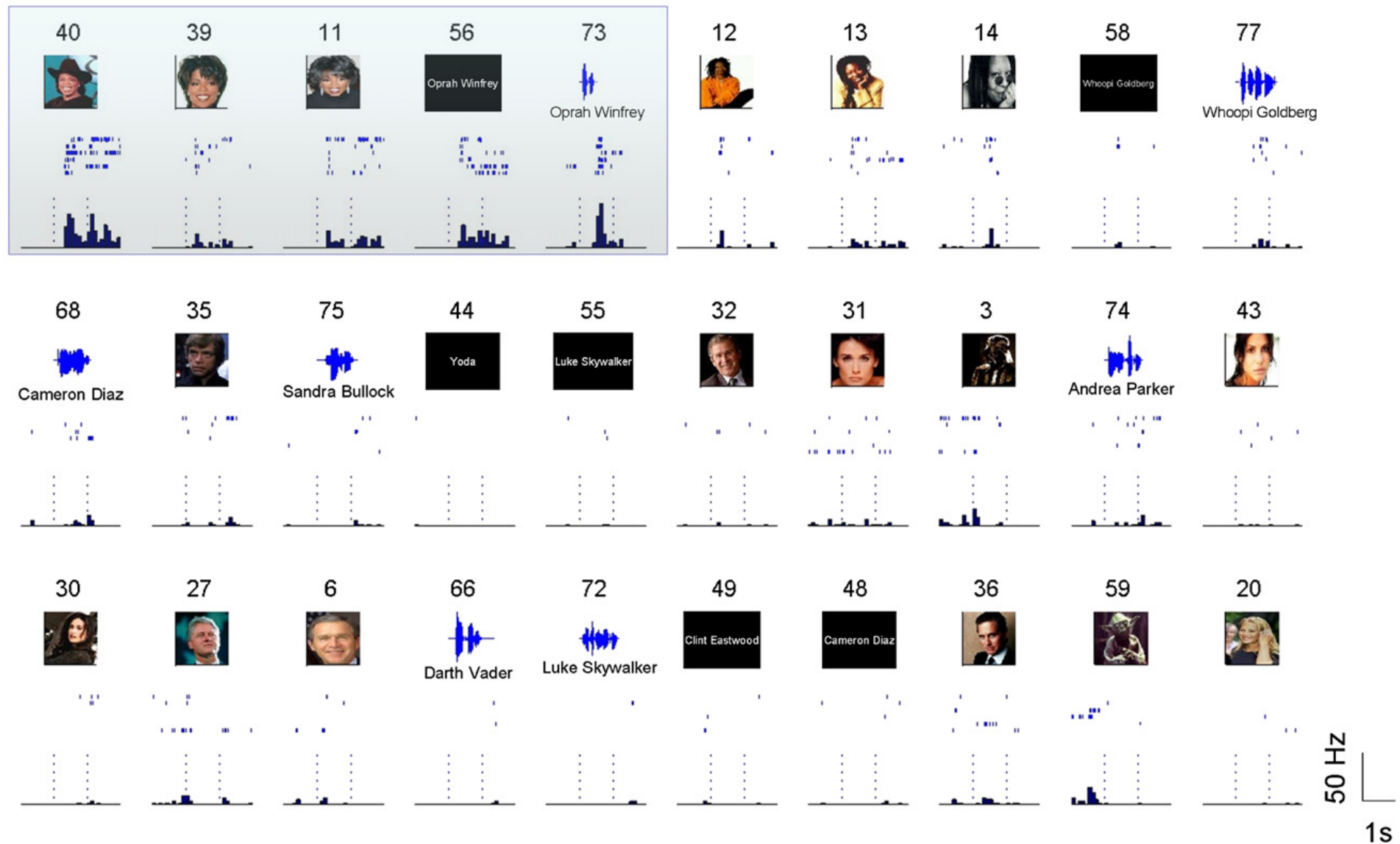
Caudate
Nucleus

Hippocampus

SEMANTIC	EPISODIC	Quiroga <i>et al.</i> (2009) Single unit recordings from human: [ref 11]	
		familiarity	- left posterior hippocampus: 'Jennifer Aniston' cell
X		recollection	



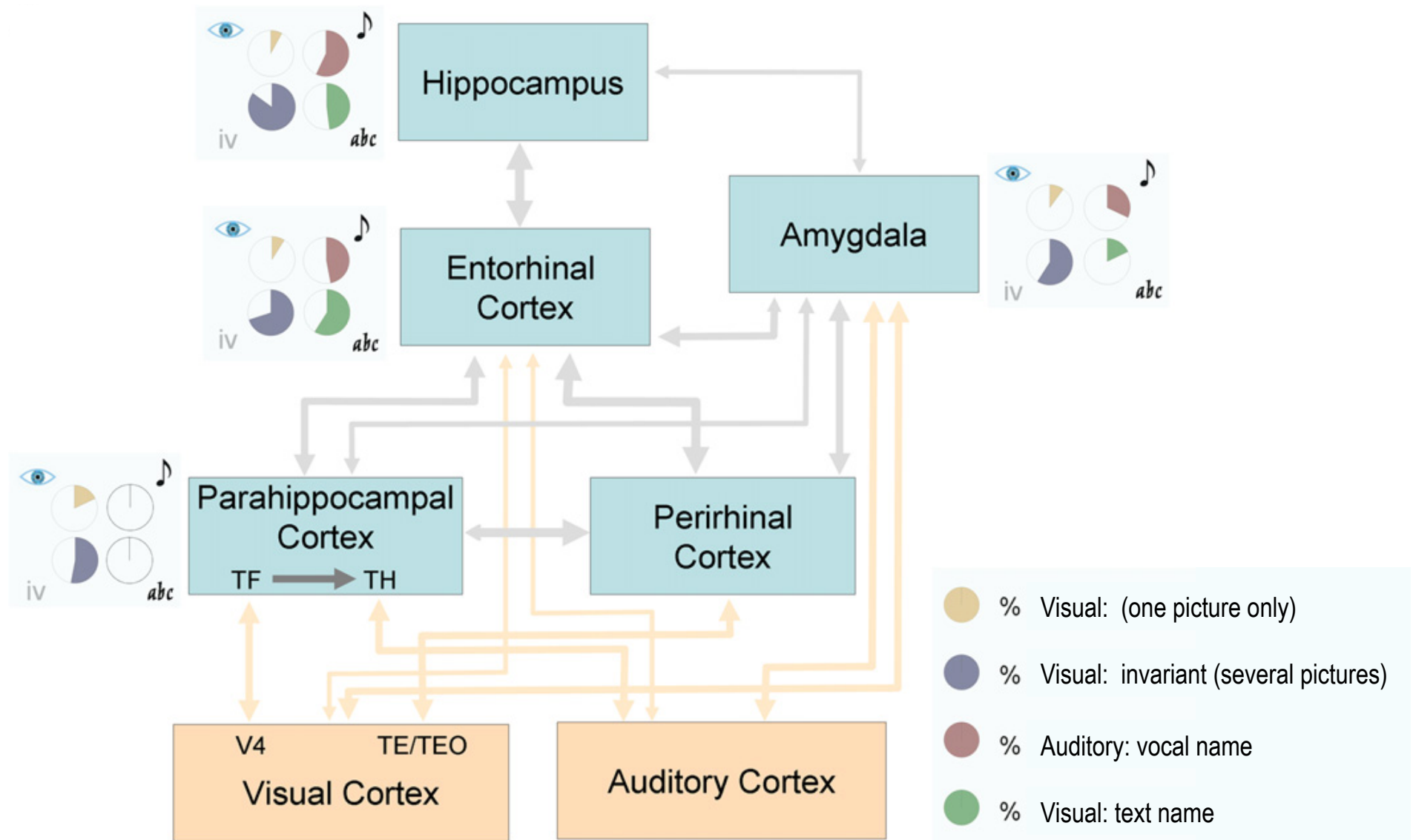
SEMANTIC	EPISODIC	Quiroga <i>et al.</i> (2009) Single unit recordings from human: [ref 11]	
		familiarity	- left anterior hippocampus: 'Oprah Winfrey' cell
X		recollection	



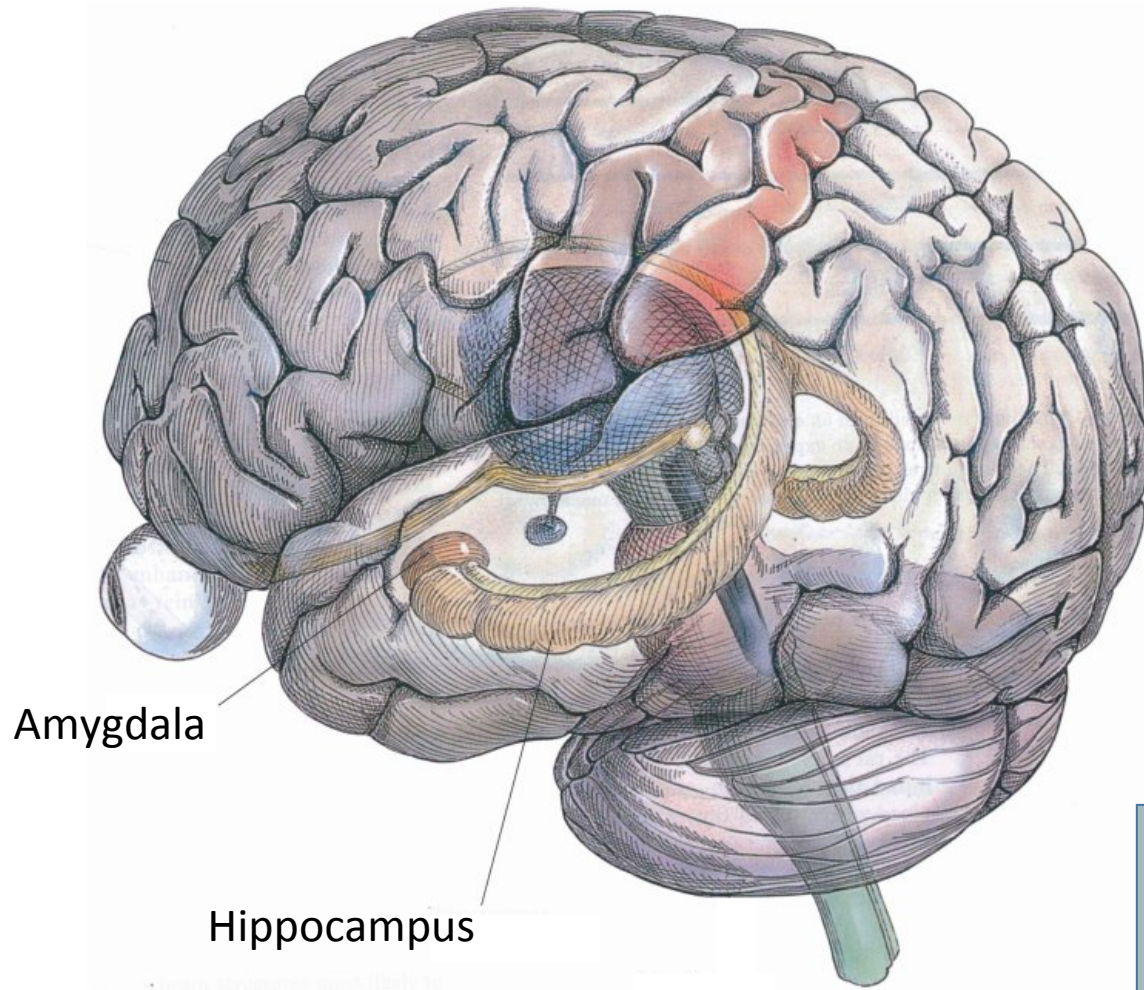
SEMANTIC	EPISODIC	Quiroga <i>et al.</i> (2009) Single unit recordings from human [ref 11]	
		familiarity	
X	(X)	recollection	

- left amygdala: ‘Arne’ (one of the research team)





The hippocampus forms the curled-up, lateral rim of the cortical sheet



Hippocampal learning:

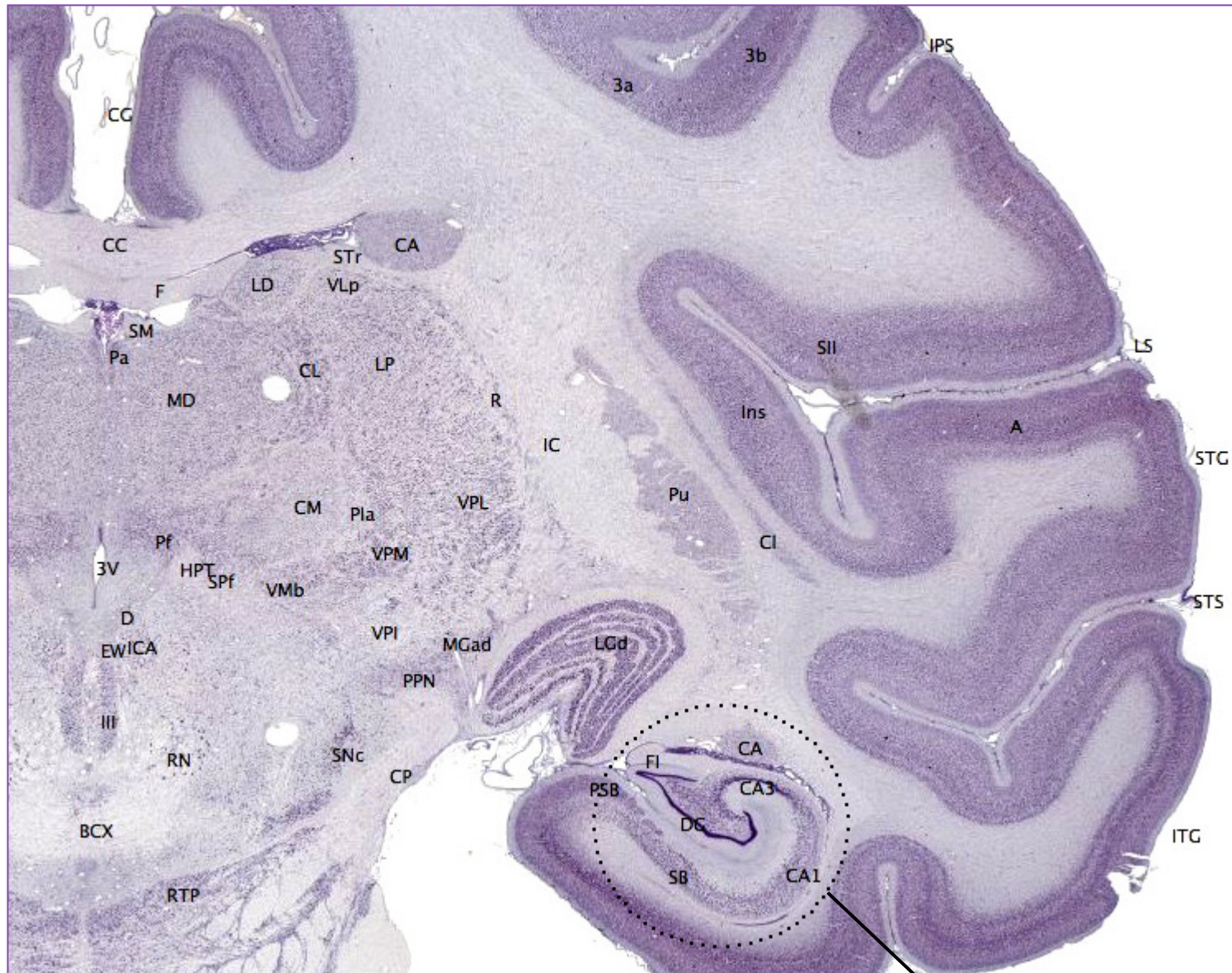
- Arbitrary associations;
- Multimodal;
- One shot;

All episodic in character.

Hippocampus is Latin for 'sea-horse'.

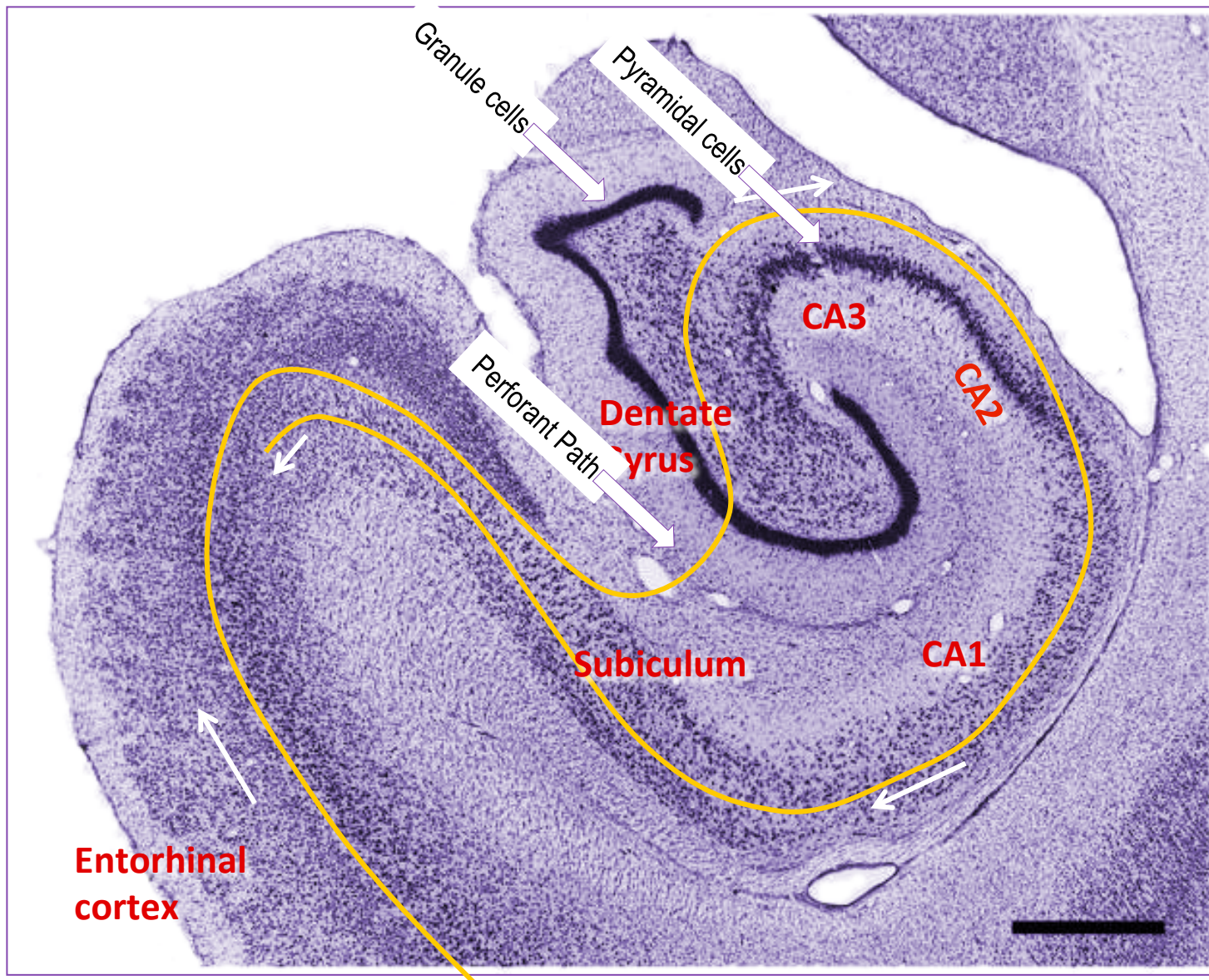


Coronal brain section in nonhuman primate (Macaque monkey)

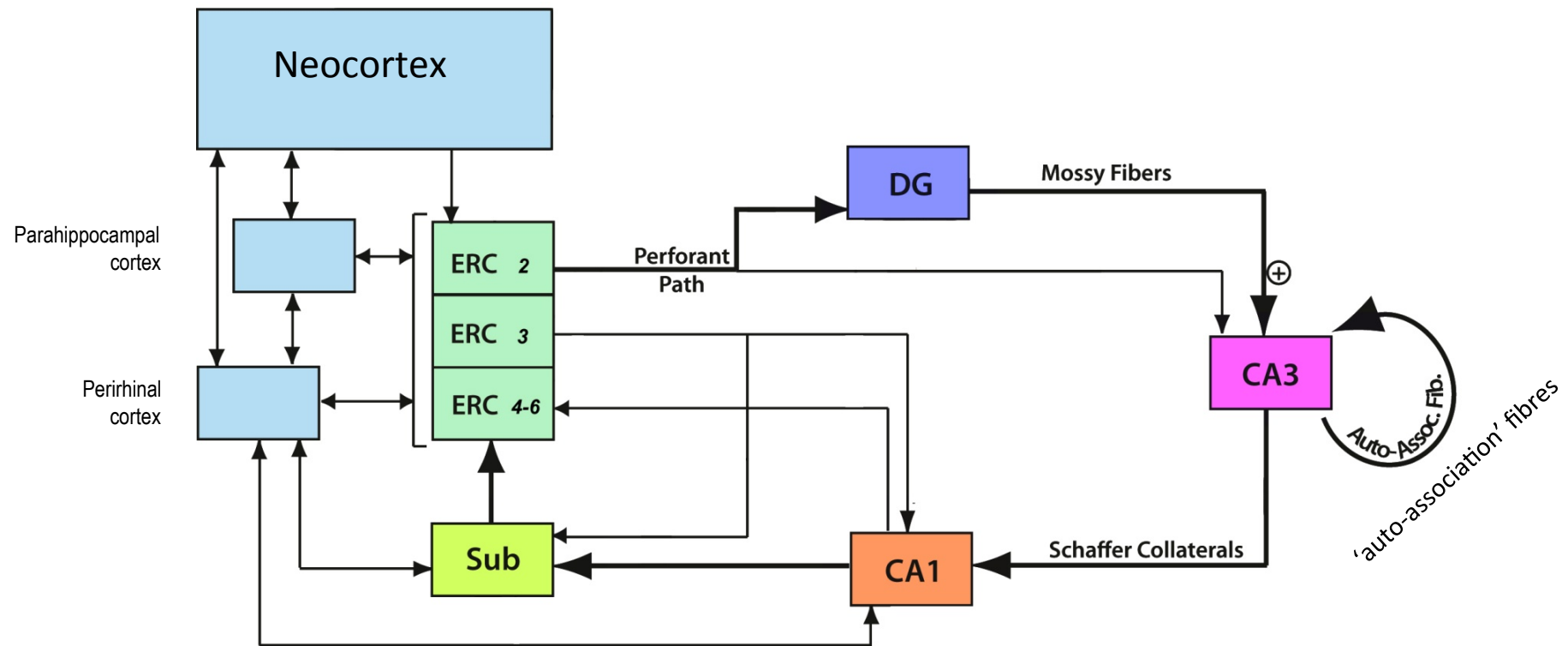


Hippocampus

The Hippocampal Loop

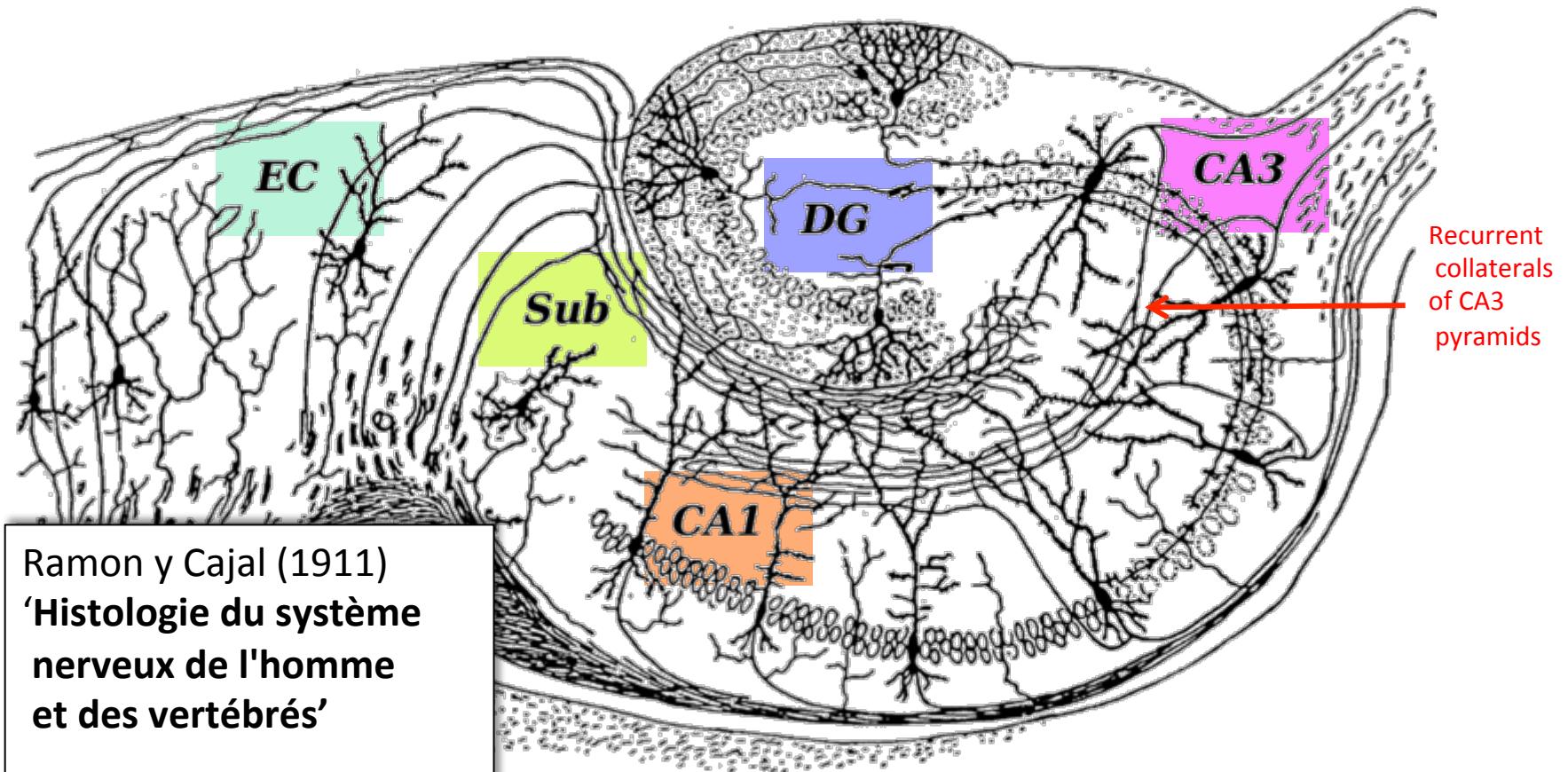


The hippocampal loop: circuitry

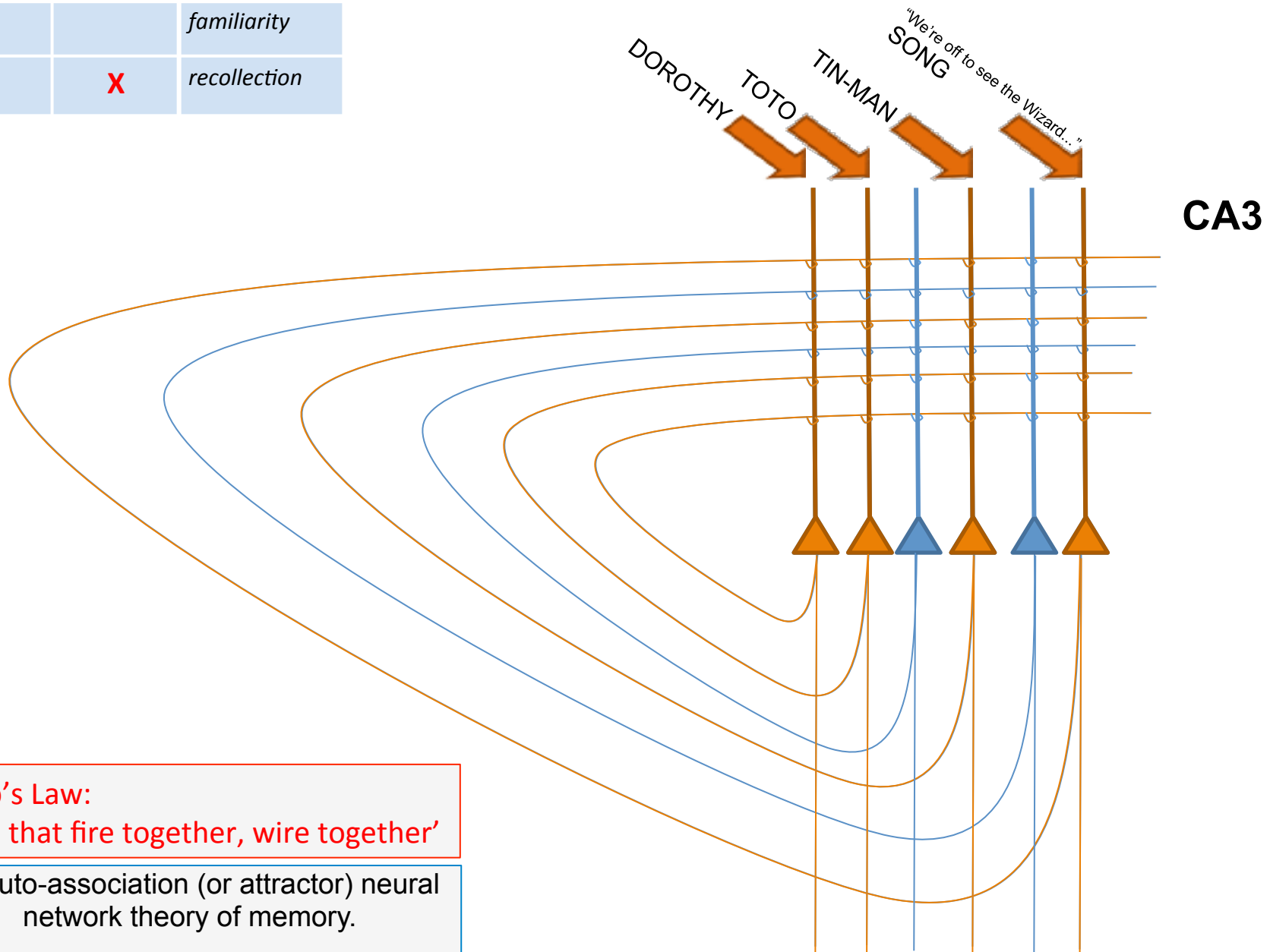


ERC = Entorhinal Cortex
DG = Dentate Gyrus
CA = Cornu Ammonis
Sub = Subiculum

The hippocampal loop: circuitry



SEMANTIC	EPISODIC	
		<i>familiarity</i>
	X	<i>recollection</i>



Hebb's Law:
'Cells that fire together, wire together'

An auto-association (or attractor) neural network theory of memory.

ENCODING

SEMANTIC	EPISODIC	
		<i>familiarity</i>
	X	<i>recollection</i>

An auto-association (or attractor) neural network theory of memory.

RETRIEVAL

