

# Long Term Memory

Dog - Balloon

Wine - Pencil

Hammer - Football

Moon - Chair

Carrot - Fence

Baby - Market

Parcel - Lamp

River - Cheese

Parcel - Water

Carrot - Milk

River - Book

Moon - Ankle

Baby - Petal

Hammer - Sky

Dog - Paper

Wine - Cat

Baby - ?

Dog - ?

Wine - ?

Hammer - ?

Carrot - ?

Parcel - ?

River - ?

Moon - ?

Dog - Balloon

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Parcel - Lamp

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Parcel - Water

Carrot - Milk

River - Book

Moon - Ankle

Baby - Petal

Hammer - Sky

Dog - Paper

Wine - Cat

Baby - ?

Dog - ?

Wine - ?

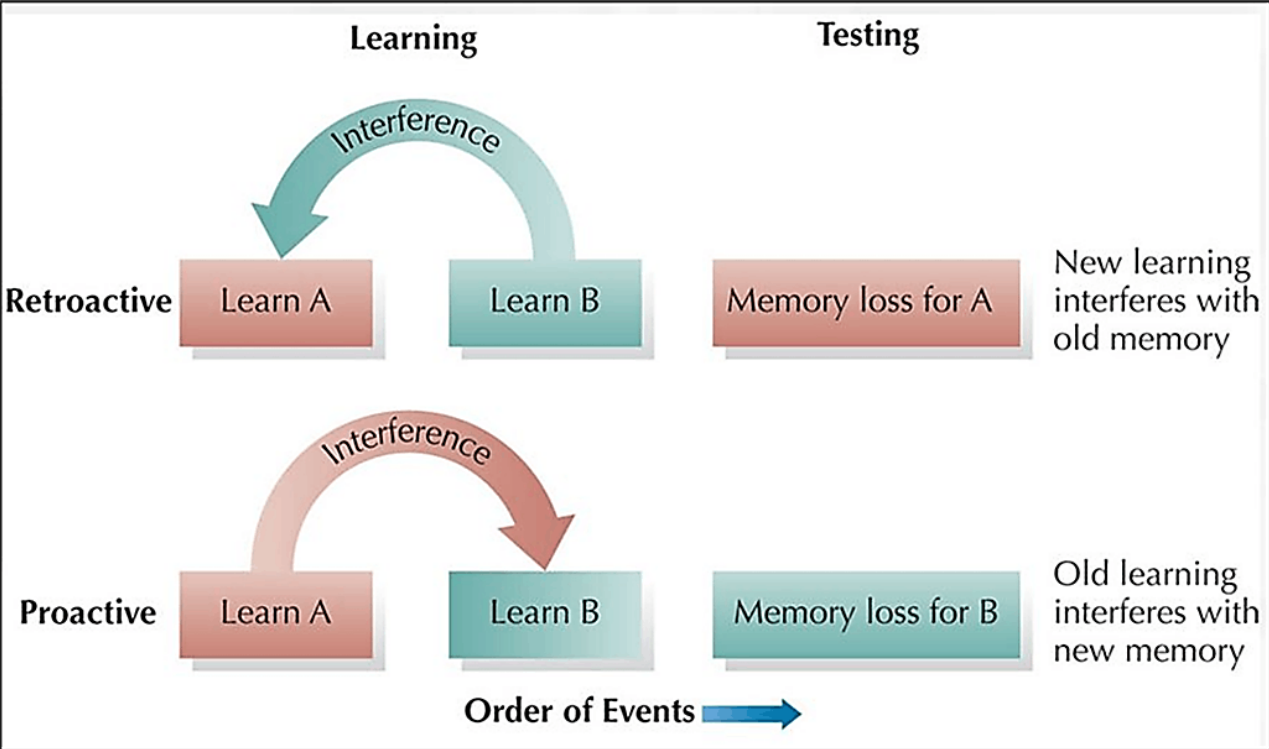
Hammer - ?

Carrot - ?

Parcel - ?

River - ?

Moon - ?



Interference  
Proactive interference  
Retroactive interference

Proactive  
interference

Early event

Later event

Learn friend's e-mail  
address at college  
flaming23@mymail.edu

Familiar old address  
interferes with recall of  
new e-mail address  
nflaming@????

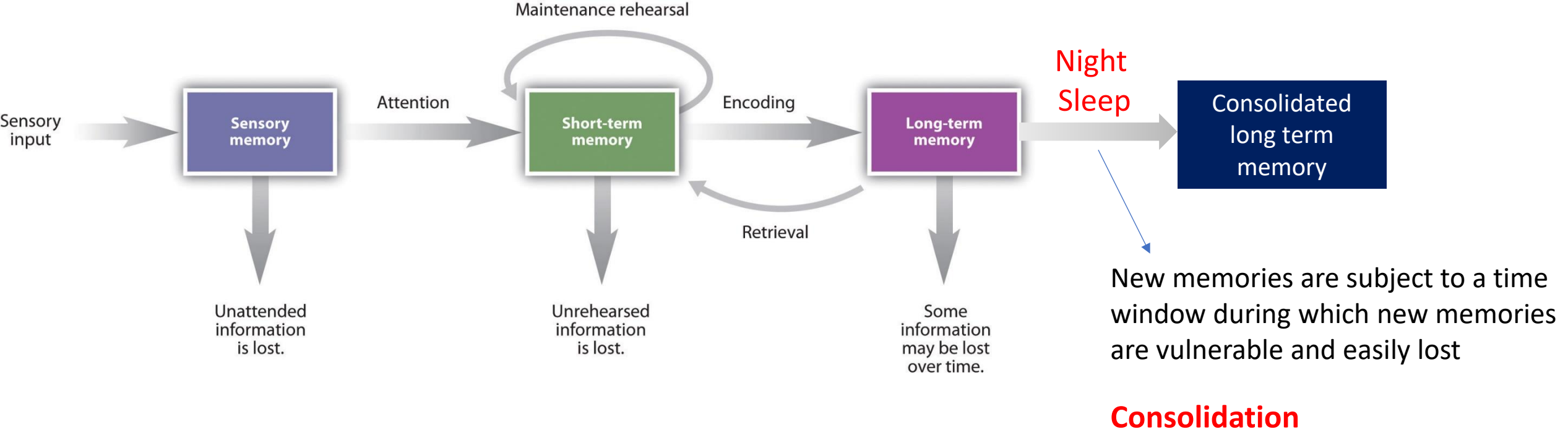
Retroactive  
interference

Can no longer recall  
password for using  
ATM card  
my ... ???

Learn password for  
using bank debit card  
my99money

We learn everyday...

How does our brain prevent interference?



**Non-REM sleep:** All stages of sleep except REM sleep.

**Awake**

Alpha activity      Beta activity

Eyelids open and close

**Stage 1 sleep**

Theta activity  
10 min

Keeps a person  
asleep, inhibits  
sounds, prevents  
disturbance

**Stage 2 sleep**

Sleep spindle  
K complex  
Seconds

**Stage 3 sleep**

15 min  
weaker Delta activity

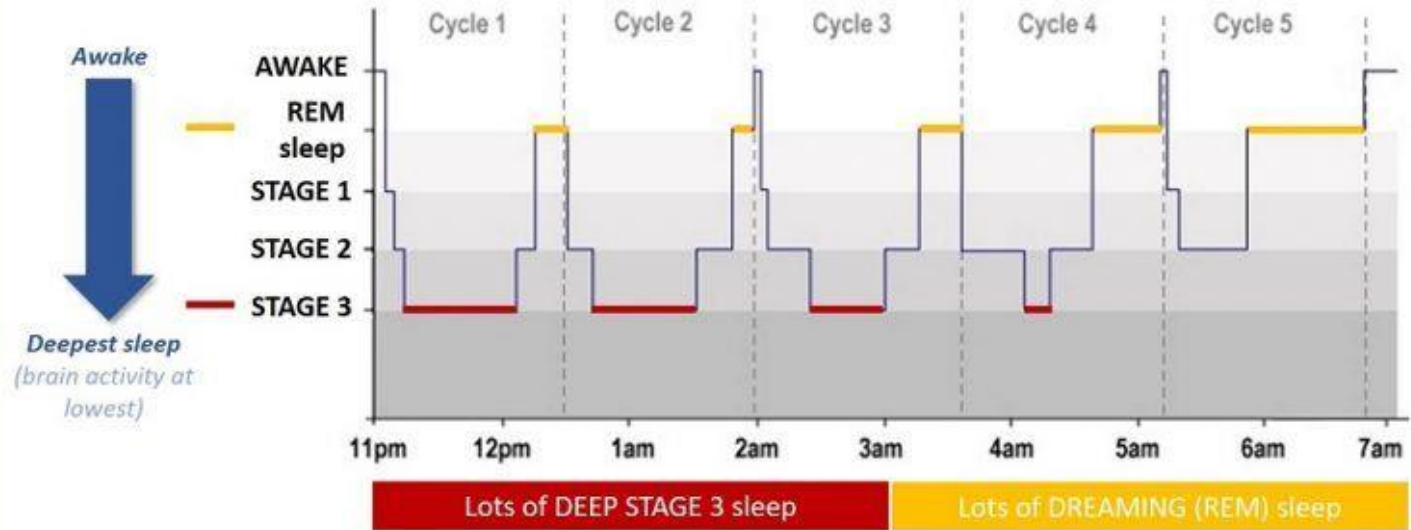
**Stage 4 sleep**

Delta activity stronger  
45 min

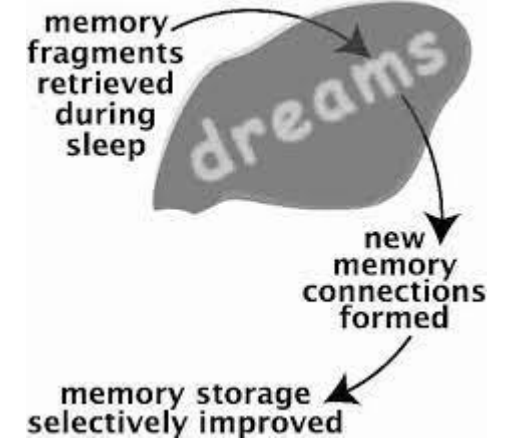
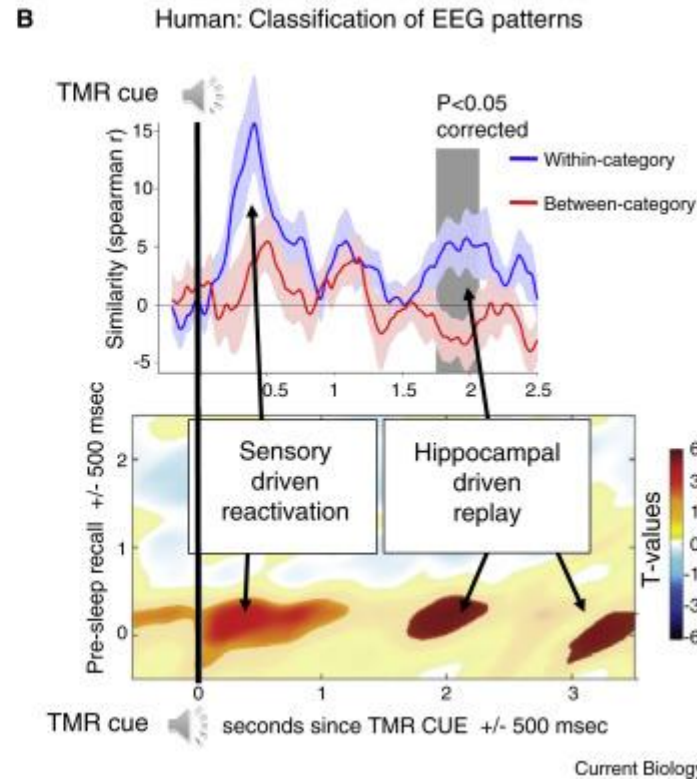
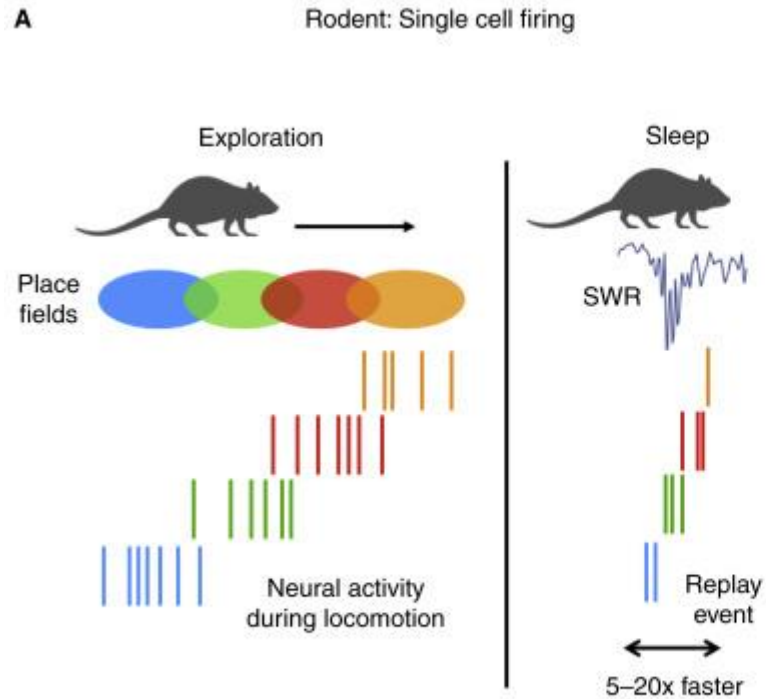
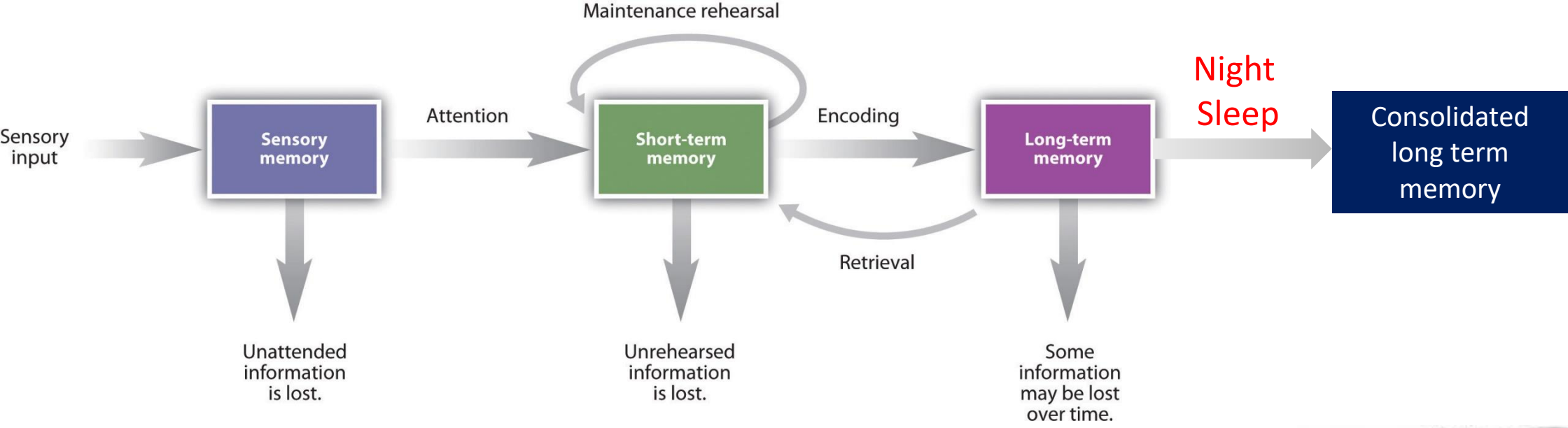
**REM sleep**

Theta activity      Beta activity

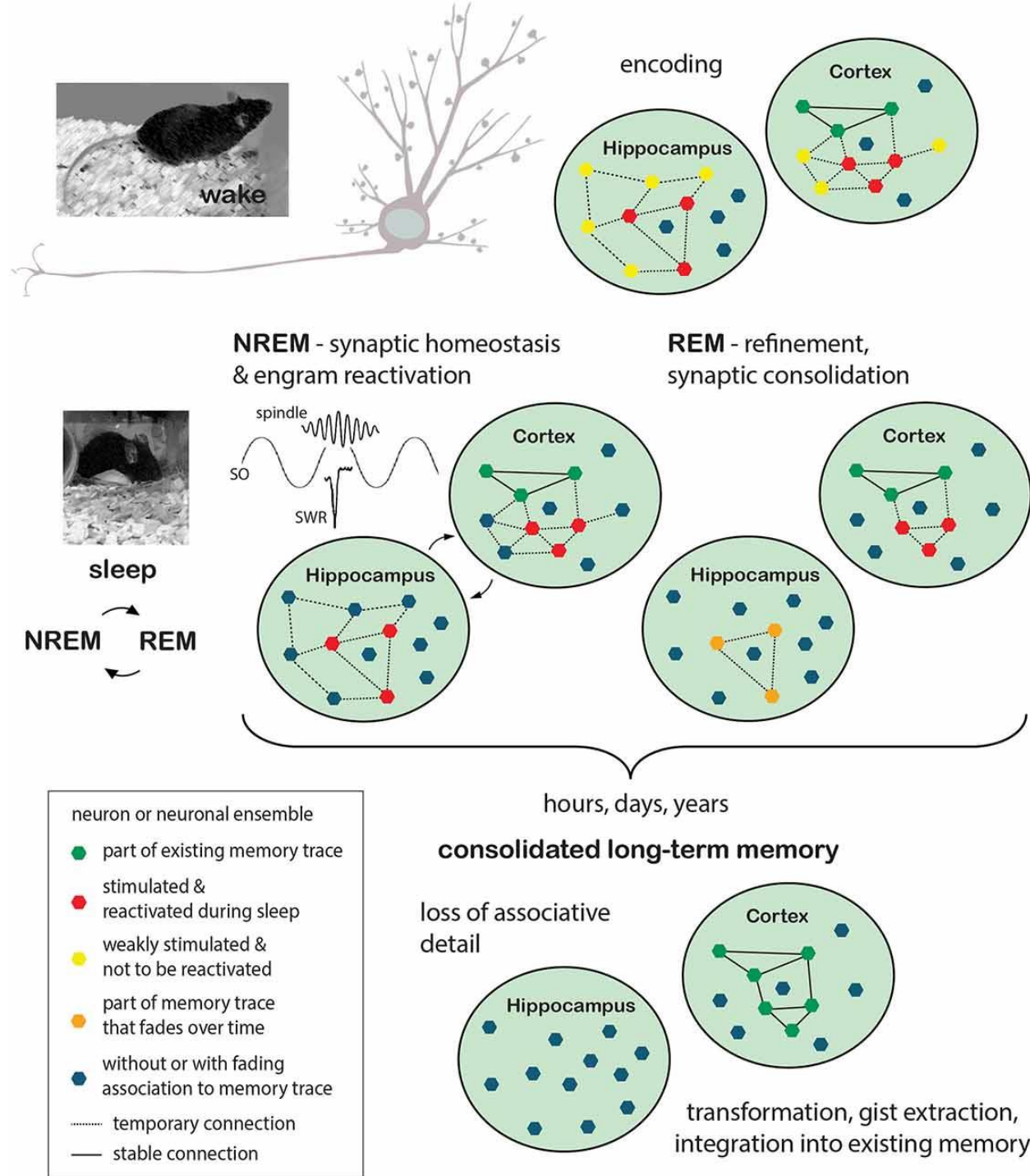
Hypnogram of Adult Sleep Showing Typical Sleep Cycles Through The Night



- **Alpha activity:** A smooth electrical activity of 8–12 Hz recorded from the brain; generally associated with a state of relaxation.
- **Beta activity:** Irregular electrical activity of 13–30 Hz recorded from the brain; generally associated with a state of arousal.
- **Theta activity:** EEG activity of 3.5-7.5 Hz that occurs intermittently during early stages of slow-wave and REM sleep, a transition between sleep and wakefulness.
- **Delta activity:** Regular, synchronous electrical activity of less than 4 Hz recorded from the brain; occurs during the deepest stages of slow-wave sleep.

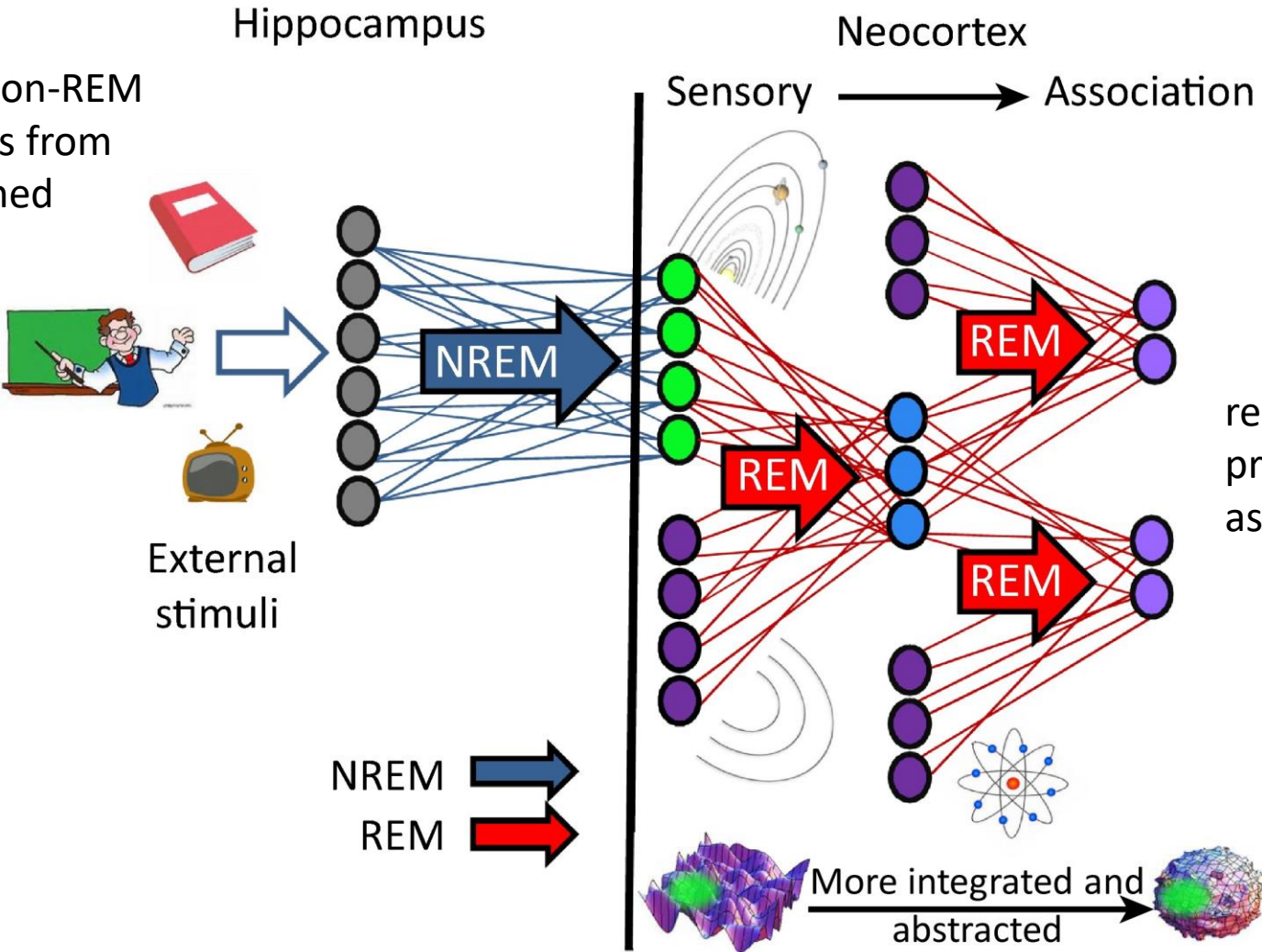






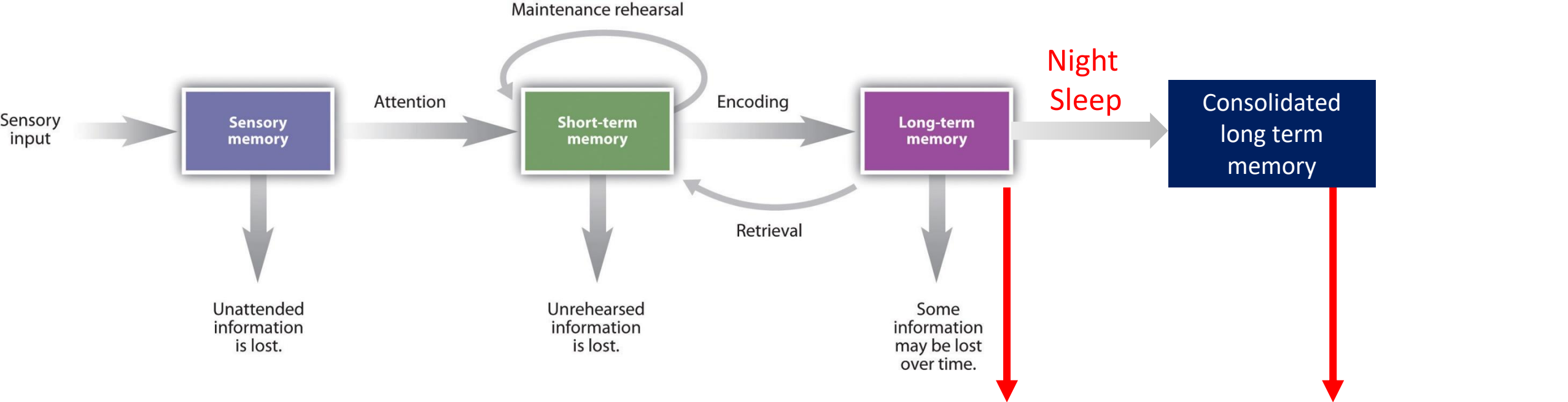
# How Memory Replay in Sleep Boosts Creative Problem-Solving

Memory replay mechanisms in non-REM can abstract rules from corpuses of learned information



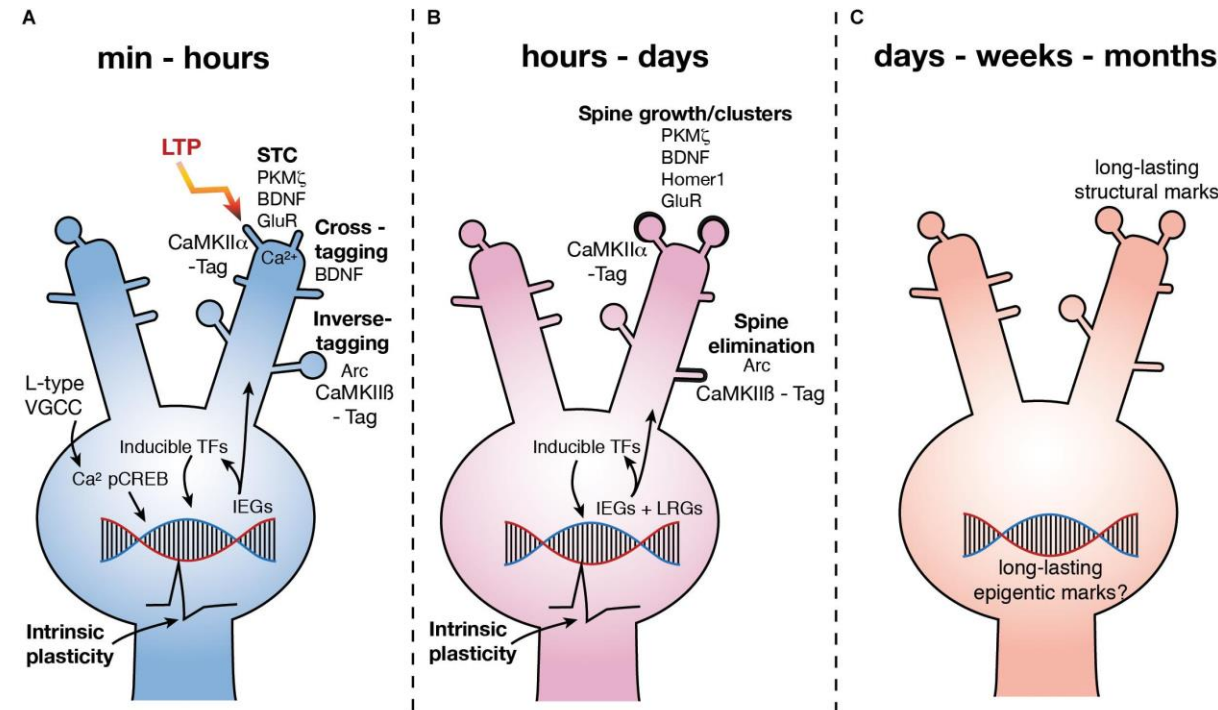
replay in REM may promote novel associations

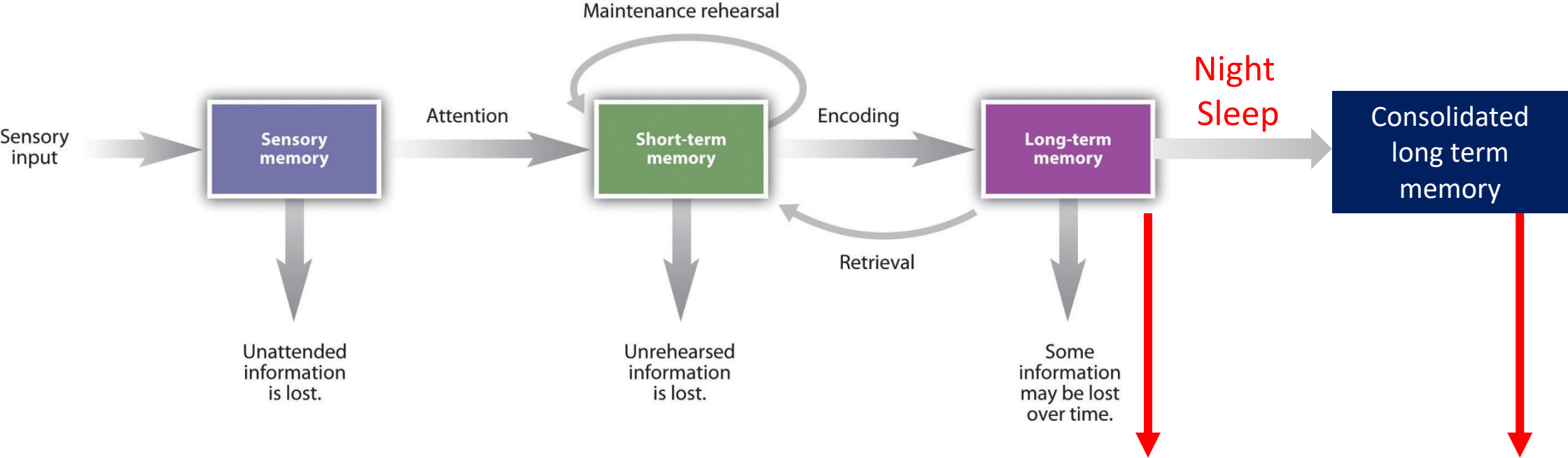
iterative interleaving of REM and non-REM across a night boosts the formation of complex knowledge frameworks, and allows these frameworks to be restructured, thus facilitating creative thought.



### Cellular consolidation

### Systems consolidation



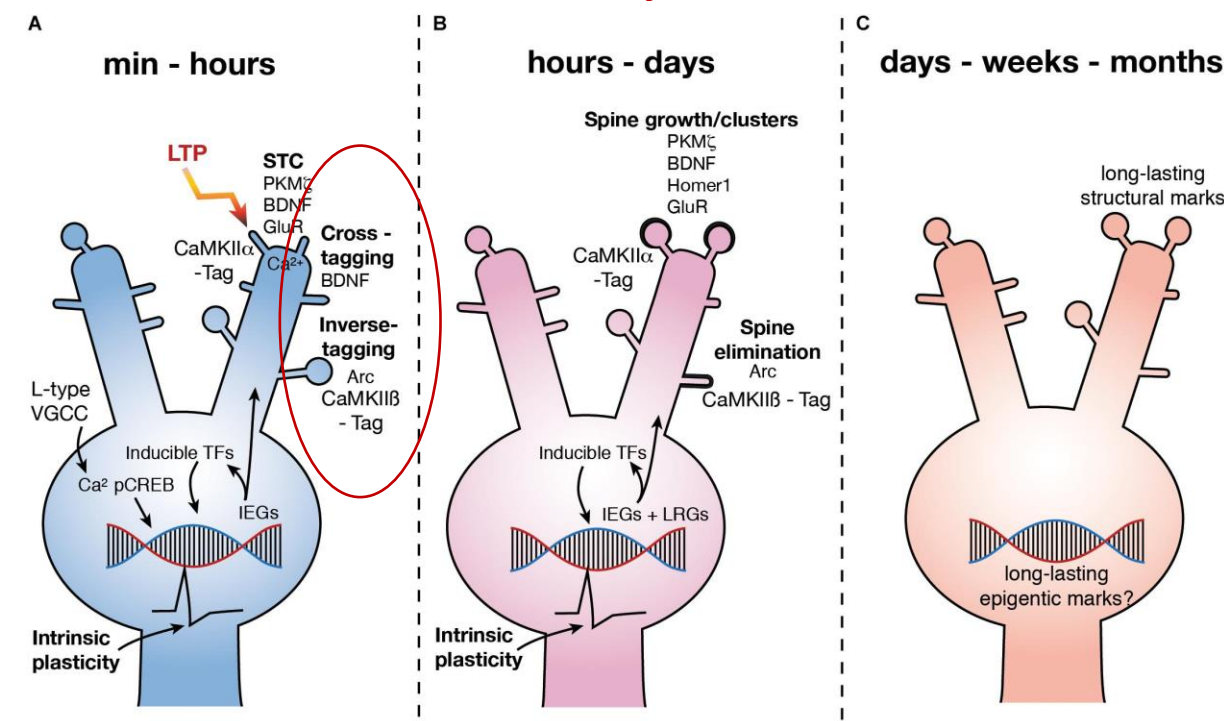


### Cellular consolidation

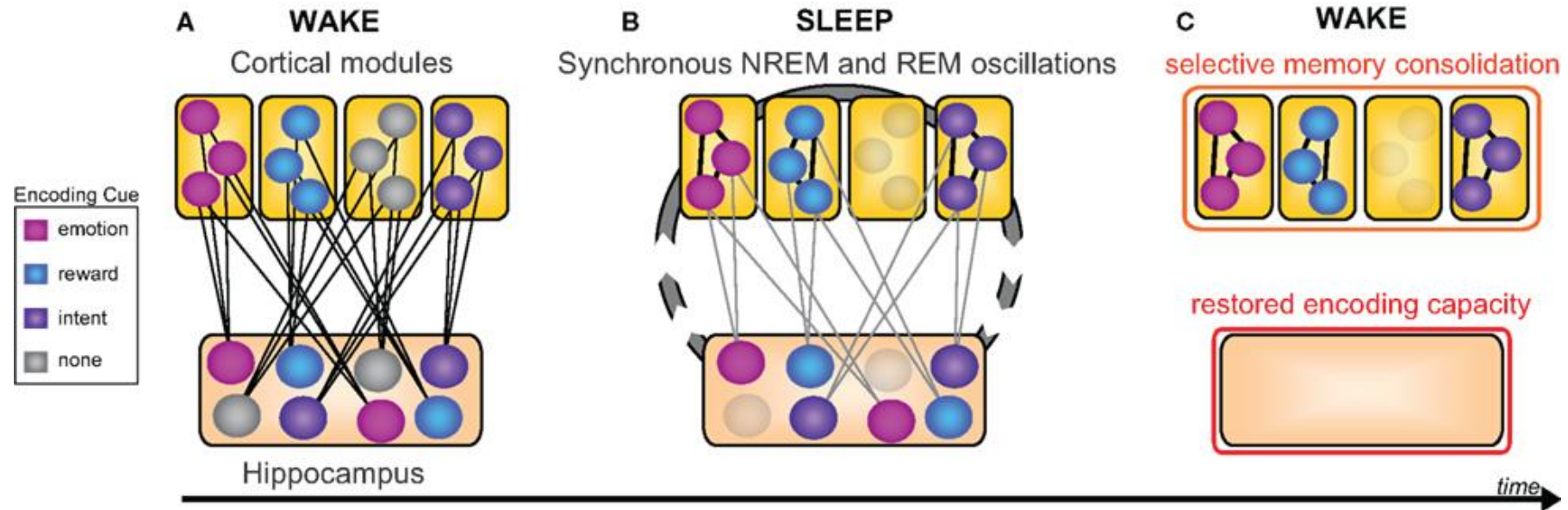
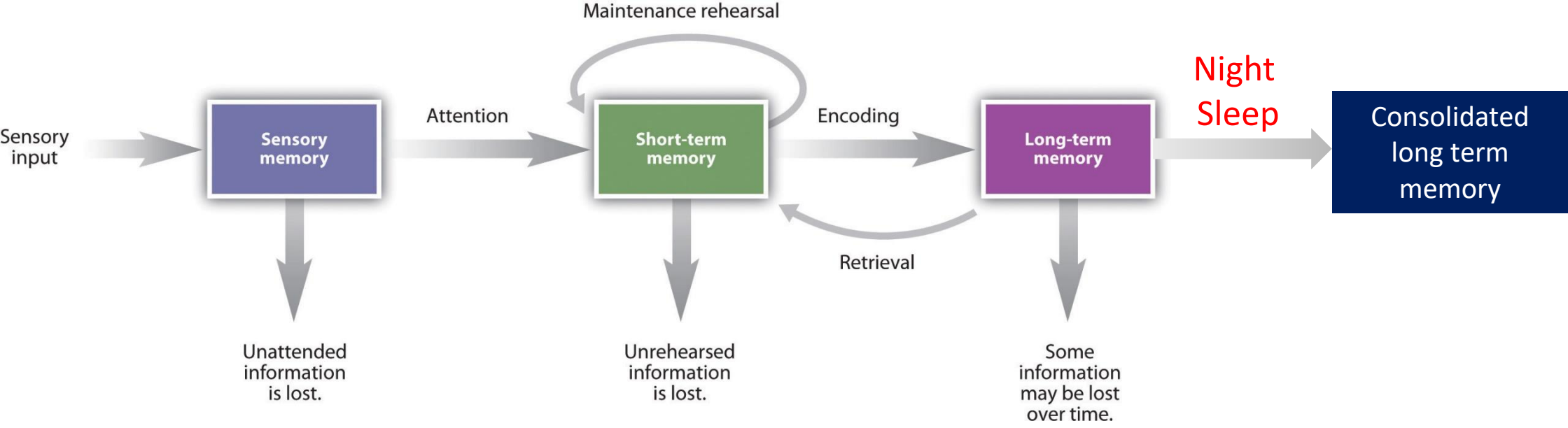
### Systems consolidation

Experiments strongly suggest that the frontal lobes help determine what new information gets encoded and what gets forgotten

Maintain a balance between remembering and forgetting

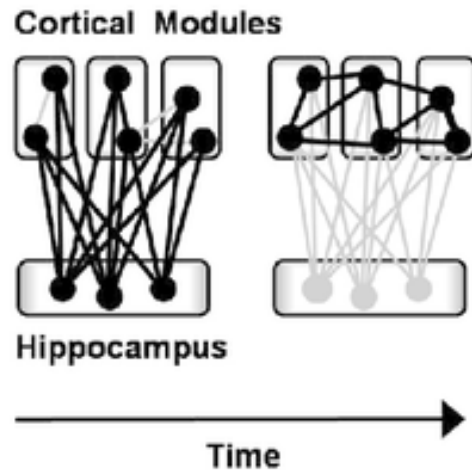






# Memory Consolidation Theory

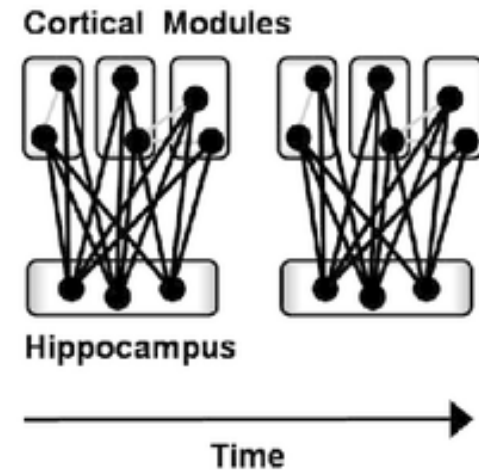
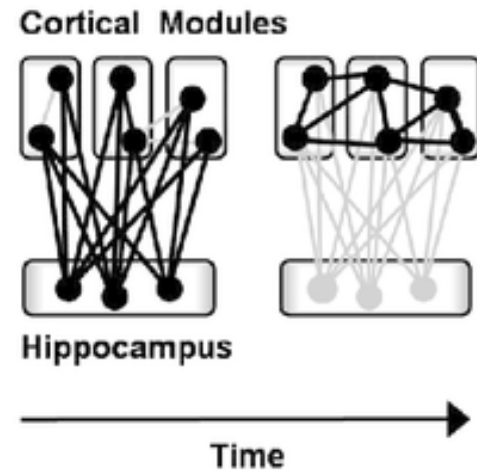
A) Standard Theory



B) Multiple Trace Theory

Semantic,  
Context-Free  
Memories

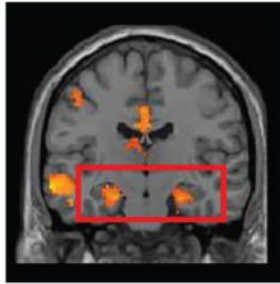
Episodic,  
Contextually-Rich  
Memories



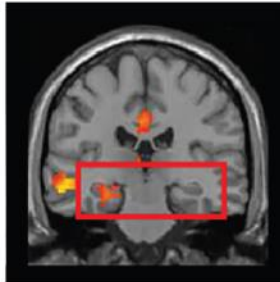
# Evidence from Healthy Brains

**A** Three days after viewing

"I remember seeing this one."

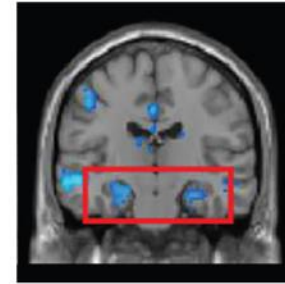


"I remember seeing this one, too."

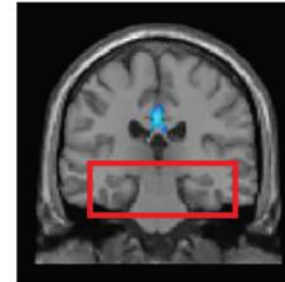


**B** Three months after viewing

"I remember seeing this one."



"I know I saw this one..."



Harand C, Bertran F, La Joie R, Landeau B, Mézenge F, Desgranges B, et al. (2012)  
The Hippocampus Remains Activated over the Long Term for the Retrieval of Truly Episodic Memories. PLoS ONE 7(8).

In adult humans with normal memory function, fMRI shows that the hippocampus is active even for retrieval of very old episodic information (Ryan et al., 2001). Does this prove that episodic memories always remain at least partially dependent on the hippocampus?

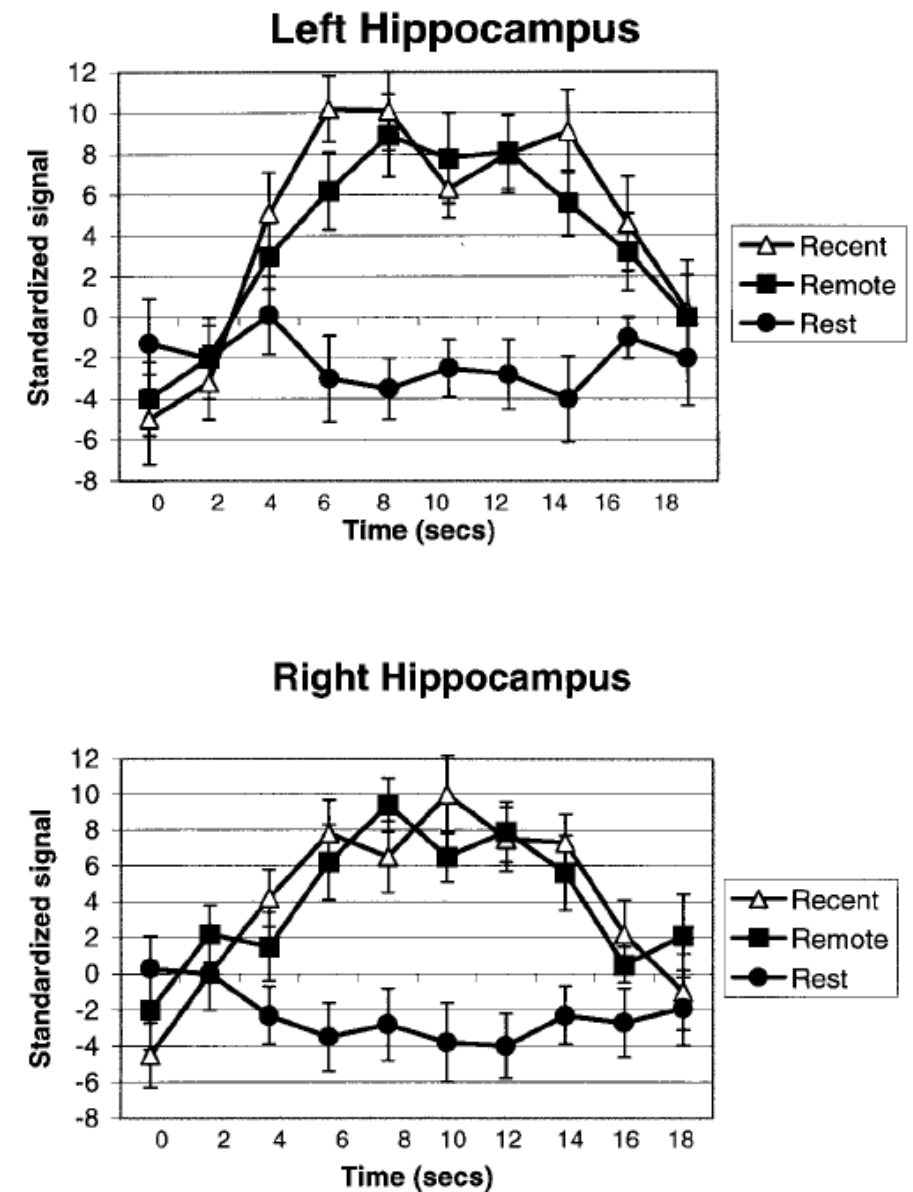


FIGURE 3. Mean (SEM) activations in left and right hippocampus for recollection of recent events, remote events, and rest, from three subjects who were unaware of the event cues that were to be presented in the scanner.



- Do we remember as it was learned?
- Can you trust your memory?

Hot  
Snow  
Warm  
Winter  
Ice  
Wet  
Frigid  
Chilly  
Heat  
Weather  
Freeze  
Air  
Shiver  
Arctic  
Frost



# Word list memory

Cold

# DRM (Deese-Roediger-Mc Dermott) – Paradigm

(Deese, Roediger, & McDermott, 1995)

Hot  
Snow  
Warm  
Winter  
Ice  
Wet  
Frigid  
Chilly  
Heat  
Weather  
Freeze  
Air  
Shiver  
Arctic  
Frost



**COLD**

(critical lure)

## False Memory

Incorrectly associating words or experiences to our memories

Mental context that links all the words



- Color of the two cars in the picture?
- What was written on the building behind?
- Car number?

[Elizabeth Loftus](#)

Instances of false memory – eye witness testimony

[Crime, law, memory – Ted talk](#)



# Creating False Memories in the Real World

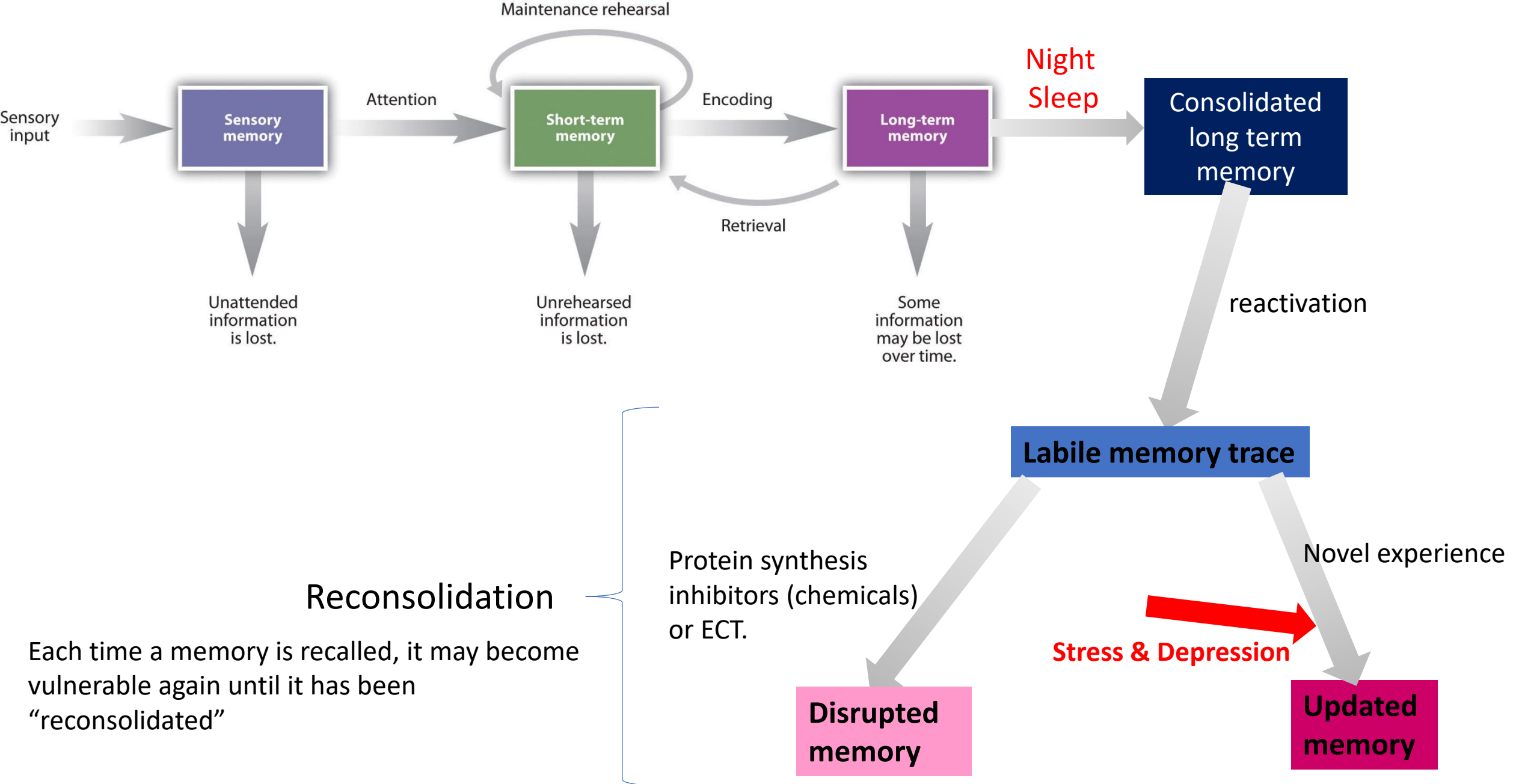
A



B



Photo illustration by Slate, original images by Getty; left: SAUL LOEB/AFP/Getty Images, right: JUAN BARRETO/AFP/Getty Images.





# Memory Updating

