

# The Neural Correlates of True and False Memory Retrieval

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Workshop on Higher Cognition in Adolescents and Young Adults:  
Social, Behavioral, and Biological Influences on Learning

PENNSTATE



# Levels of Retrieval

## □ True Memory

- correct memory for previously presented material
- Recollection v Familiarity

## □ False Memory

- incorrectly endorsing a new item as 'old'
- perceived oldness

# RESEARCH QUESTION

**Are True and False Memories mediated by similar or distinct neural processes? And do these processes change with age?**

# Fuzzy Trace Theory

(e.g., Brainerd & Reyna, 1990, 2002)

## □ Two types of memory traces

### ▪ item-specific traces

-retain the item-specific features of the encoding event

➤ recollection

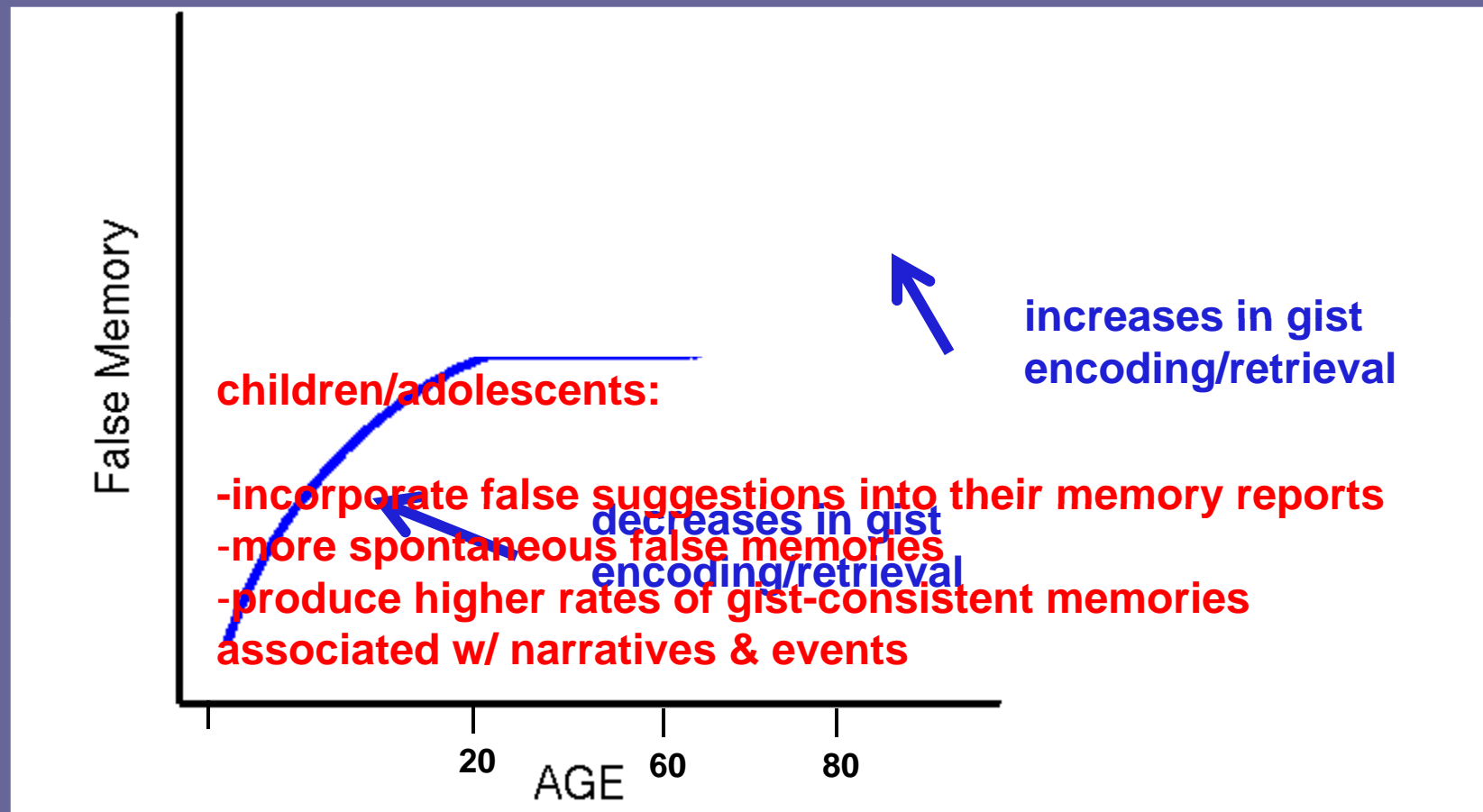
### ▪ gist traces

-retain the general meaning of the event but lack perceptual details or specific instances of the encoding event

➤ familiarity

- helps to endorse an item as old – but reliance on gist can be problematic when there is a strong association between targets and lures

# Development of False Memories



- for reviews see Bruck & Ceci (1997); Howe (2000); Brainerd & Reyna (2001); Bjorklund & Muir (1988)
- see Brainerd, et al. (2002); Brainerd et al. (2008)

# **Deese Roediger McDermott (DRM) paradigm**

# STUDY

bed  
rest  
awake  
tired  
dream  
wake  
snooze  
blanket  
doze  
slumber  
snore  
nap  
peace  
yawn  
drowsy

# RETRIEVAL

blanket

“old”

nap

“old”

house

“new”



“new”

matches the gist  
trace of the  
encoded items

picture

“new”

camera

“new”



# Development of False Memories

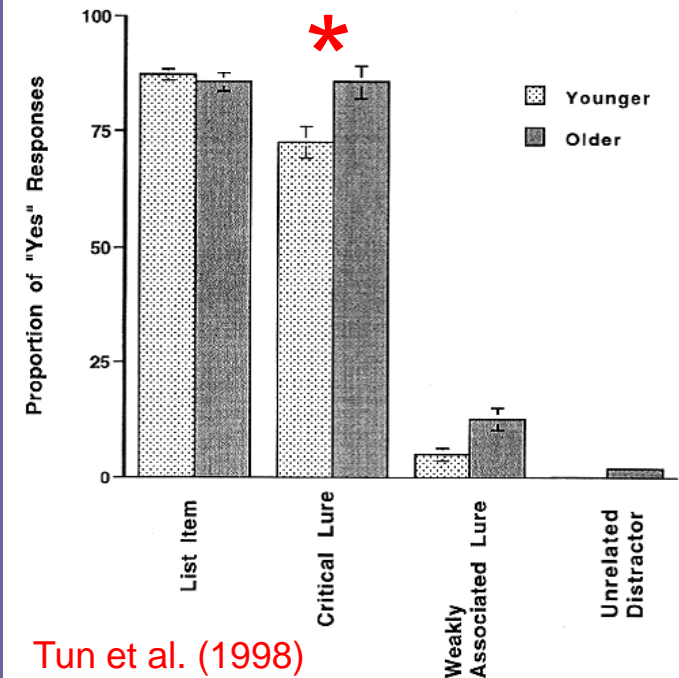
Table 1  
Proportion of Accurate and False Recall and Recognition Performance as a Function of Grade (Age) in Experiment 1

Type of Test	Grade		
	Second	Eighth	College
Accurate			
Recall	.34 <sub>a</sub>	.48 <sub>b</sub>	.59 <sub>c</sub>
Repetition ratio	.47 <sub>a</sub>	.50 <sub>a</sub>	.59 <sub>b</sub>
Recognition	.63 <sub>a</sub>	.79 <sub>b</sub>	.80 <sub>b</sub>
A' presented target words	.63	.89	.83
False lures			
Recall	.02 <sub>a</sub>	.07 <sub>a</sub>	.16 <sub>b</sub>
Recognition	.23 <sub>a</sub>	.58 <sub>b</sub>	.72 <sub>c</sub>
A' nonpresented lures	.66	.80	.88
Accuracy index: accurate/(accurate + lures)			
Recall	.94 <sub>a</sub>	.88 <sub>b</sub>	.75 <sub>c</sub>

Note. Means in the same row that do not share subscripts differ at  $p < .05$ .

Metzger et al. (2008)

Children



Tun et al. (1998)

Figure 2. Mean proportion of "yes" responses to four types of recognition probes for younger and older adults in Experiment 2. Standard error of the mean is shown by error bars.

Older Adults

# Fuzzy Trace Theory - predictions

## □ Young Adults

- true memories are based on item-specific traces and recollection
- false memories are based on gist processing and familiarity

## □ Older Adults

- deficits in item-specific traces, but not gist traces

## □ Children / Adolescents

- deficits for both item-specific traces  
*and more importantly*
- deficits for extracting/encoding gist traces

What are the neural correlates of true and false memories and how are they affected by aging?

**EXPERIMENT**

# fMRI Experimental Predictions

## □ Young Adults

- TRUE MEMORIES
  - item-specific traces and recollection-related processing >> *hippocampus*
- FALSE MEMORIES
  - based on gist and familiarity –related processing >> *cortical MTL regions, frontal-parietal network*

## □ Older Adults

- deficits in item-specific traces, but not gist traces >> *this would be reflected in neural activations associated with each*

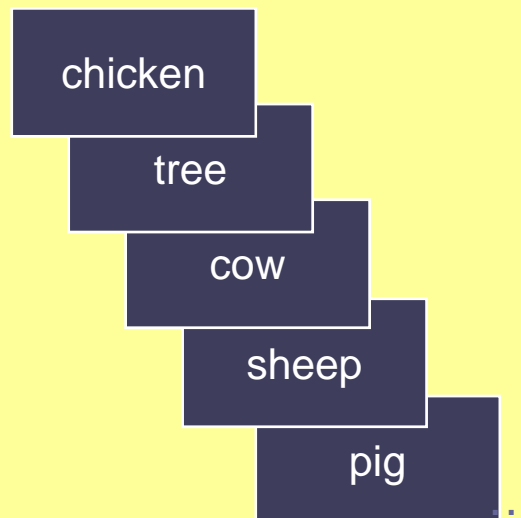
# fMRI Experimental Design

- **Encoding:** 72 “mini” lists of 4 instances per category
- **Retrieval:** Recognition w/ confidence
  - 3 trial types: targets, related lures, unrelated lures

## Encoding



## Retrieval



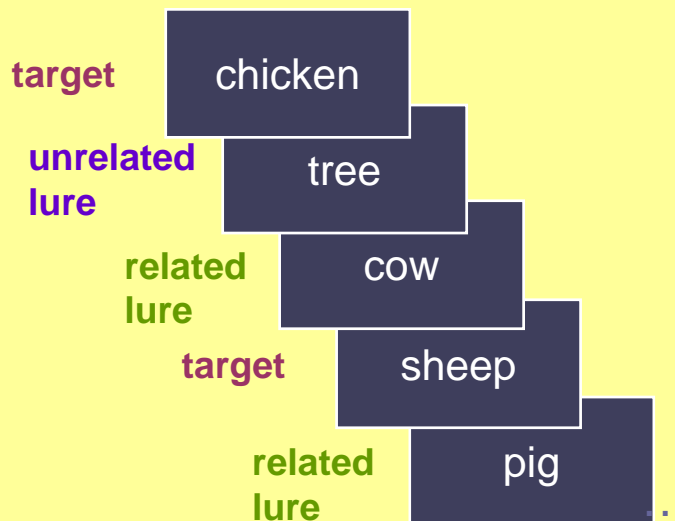
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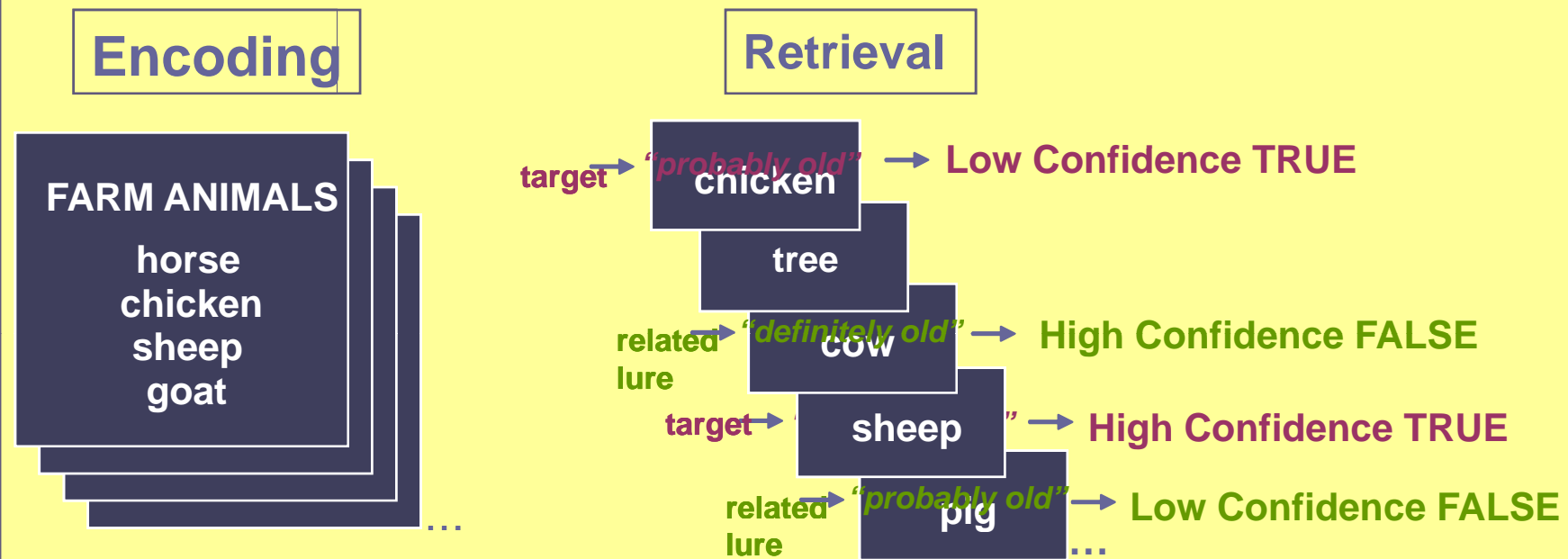
## Encoding



## Retrieval



# fMRI Experimental Design



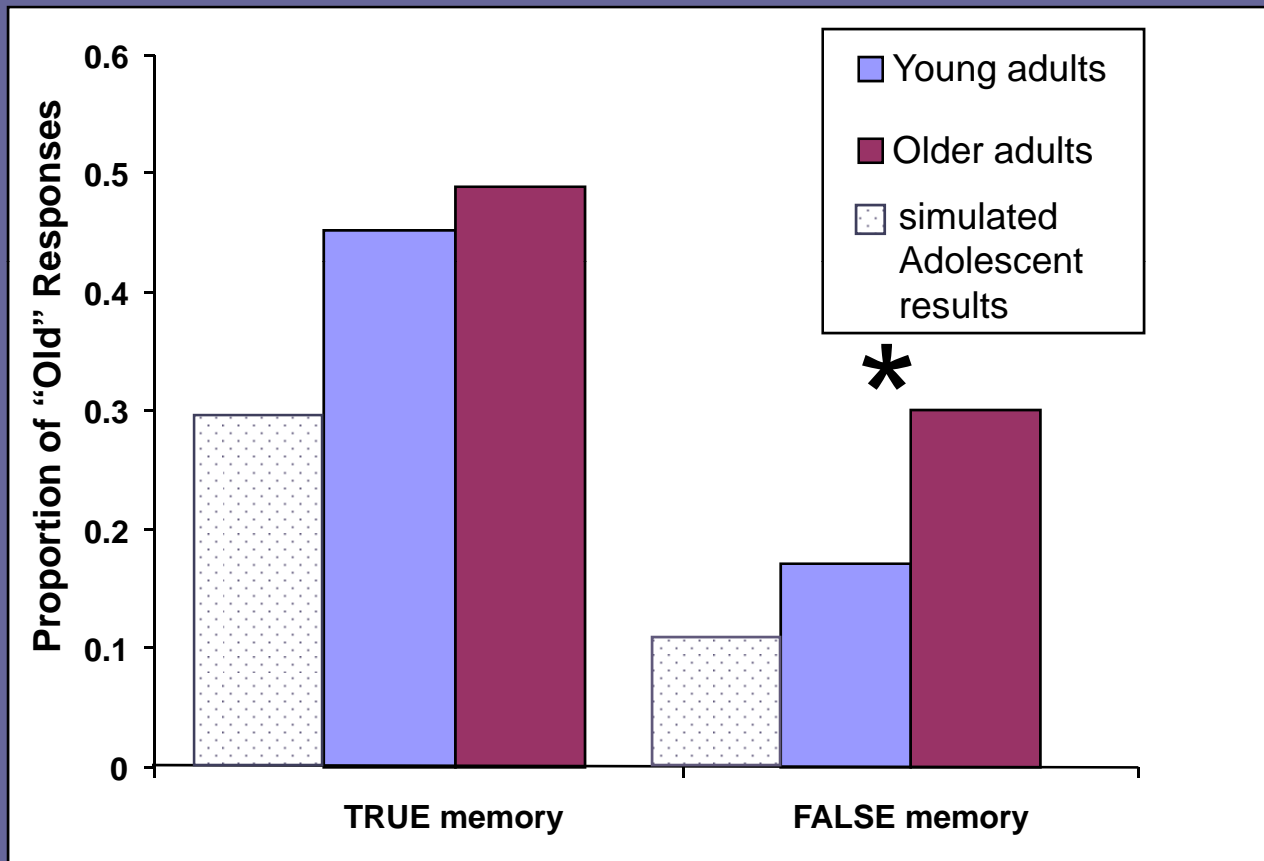
**True memories:**

High Confidence True > Low Confidence True responses

**False memories:**

High Confidence False > Low Confidence False responses

# Behavioral Results

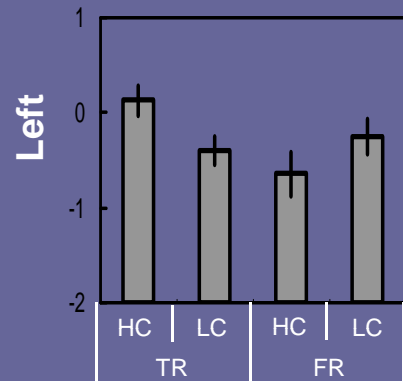


- high confidence trials

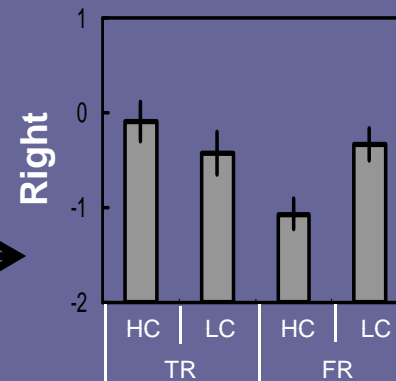
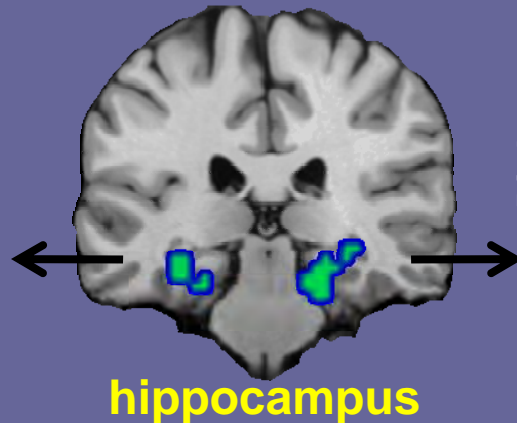


# True Memories - Recollection

## young adults



HC-TR > HC-FR



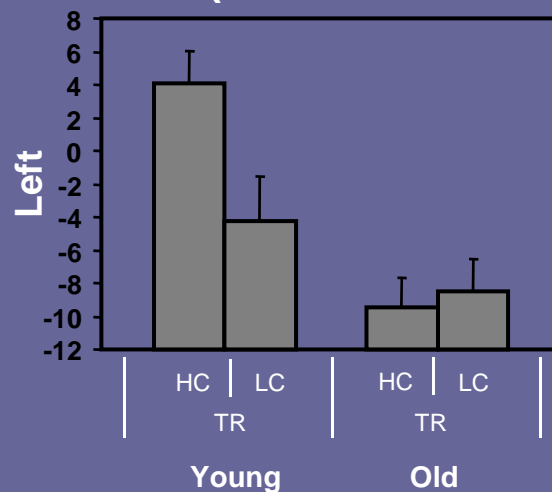
>> retrieval of item-specific traces associated with true recollection

>> hippocampus distinguishes true from false recollection

## young > older adults



Y>O (HC-TR > LC-TR)

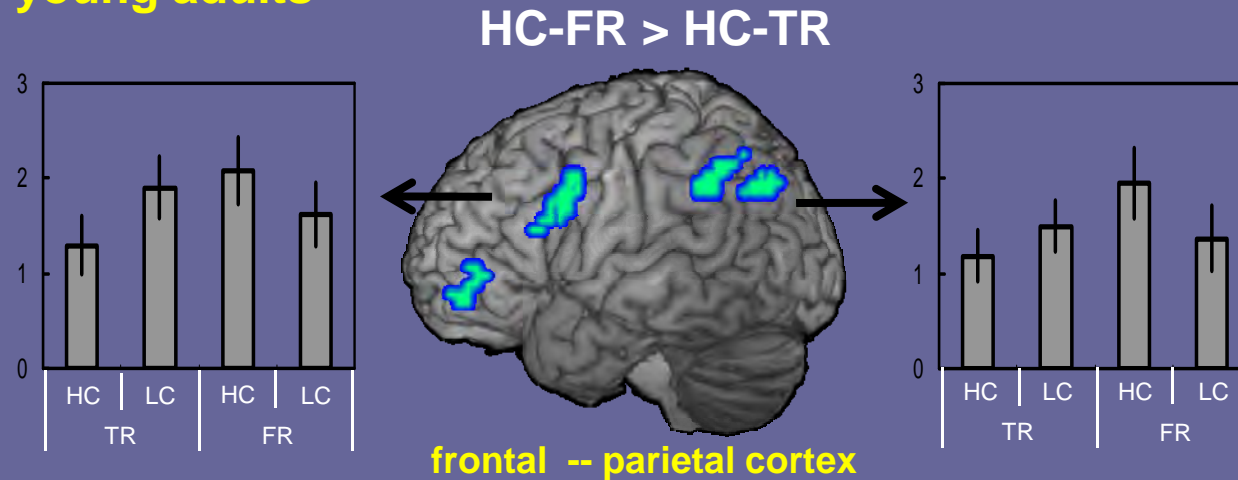


>> age-related decrease in hippocampal activity

>> reflecting age-related decreases in recollection & retrieval of item-specific traces

# False Memories –familiarity & gist

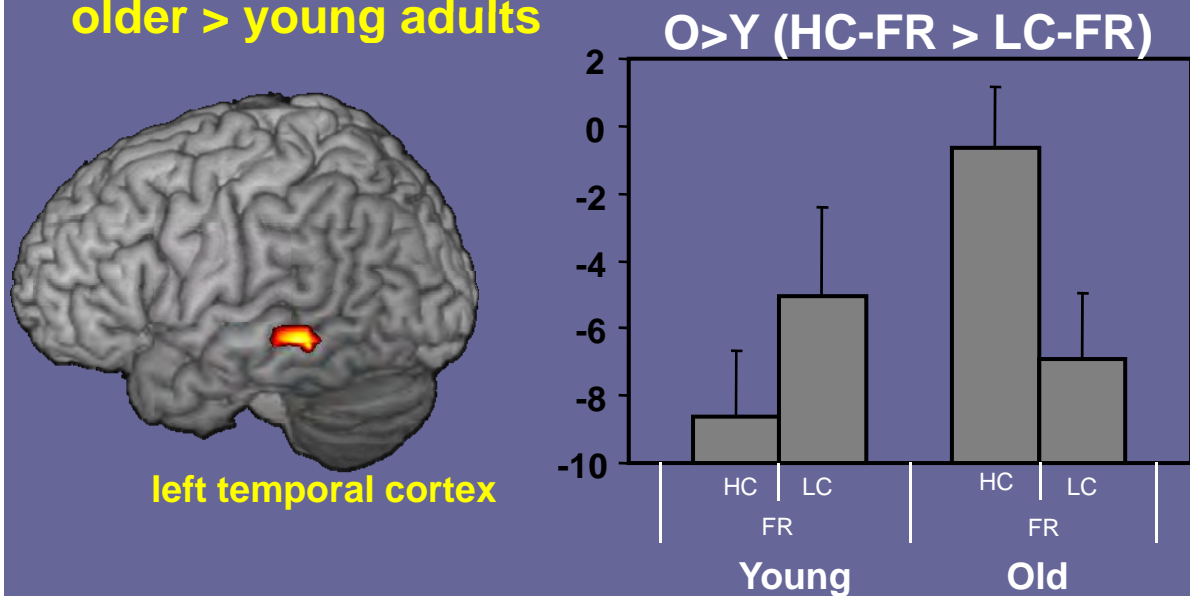
## young adults



➤ familiarity-related activation in frontal-parietal network

➤ retrieval of false memories is associated with familiarity and gist and *not* retrieval of item-specific details

## older > young adults



➤ age-related increase in left temporal cortex

➤ may reflect semantic processing associated with gist retrieval supporting false memories

# Conclusions

## ❑ Young Adults

### ■ TRUE memories

- Recollection-related hippocampal activation
- greater hippocampal activity for True than False memories
- retrieval of item-specific traces support true memories

### ■ FALSE memories

- Familiarity-related frontal-parietal activity
- familiarity processing supporting false memories

## ❑ Older Adults

- decreased Recollection-related activity in hippocampus for True Memories
  - reduction in item-specific traces
- increased activity in left lateral temporal gyrus for False Memories
  - greater semantic gist processing supporting false memories

# Thank You

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Kim, H., & Cabeza, R. (2007). Trusting our memories: Dissociating the neural correlates of confidence in veridical versus illusory memories. *J Neurosci*, 27(45), 12190-12197.  
Dennis, N. A., Kim, H., & Cabeza, R. (2008). Age-related differences in brain activity during true and false memory retrieval. *J Cogn Neurosci*, 20(8), 1390-1402.

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