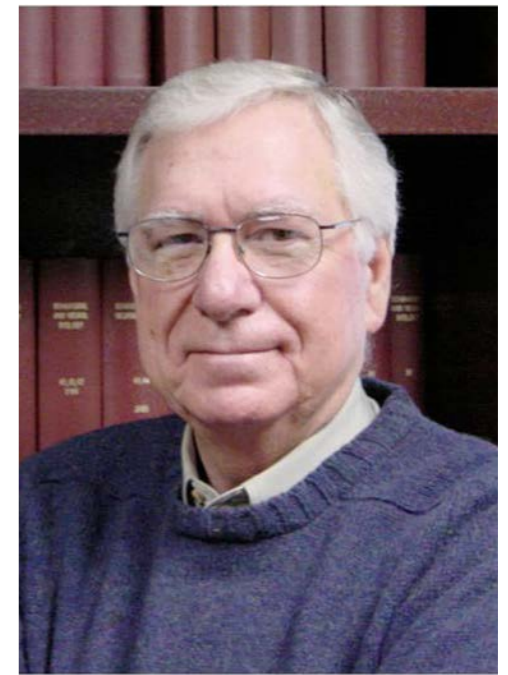
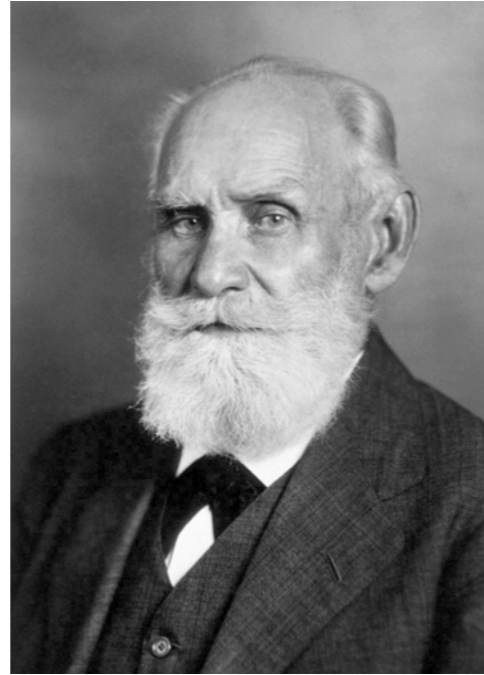


# MULTIPLE MEMORY SYSTEMS

Norbert Fortin, PhD



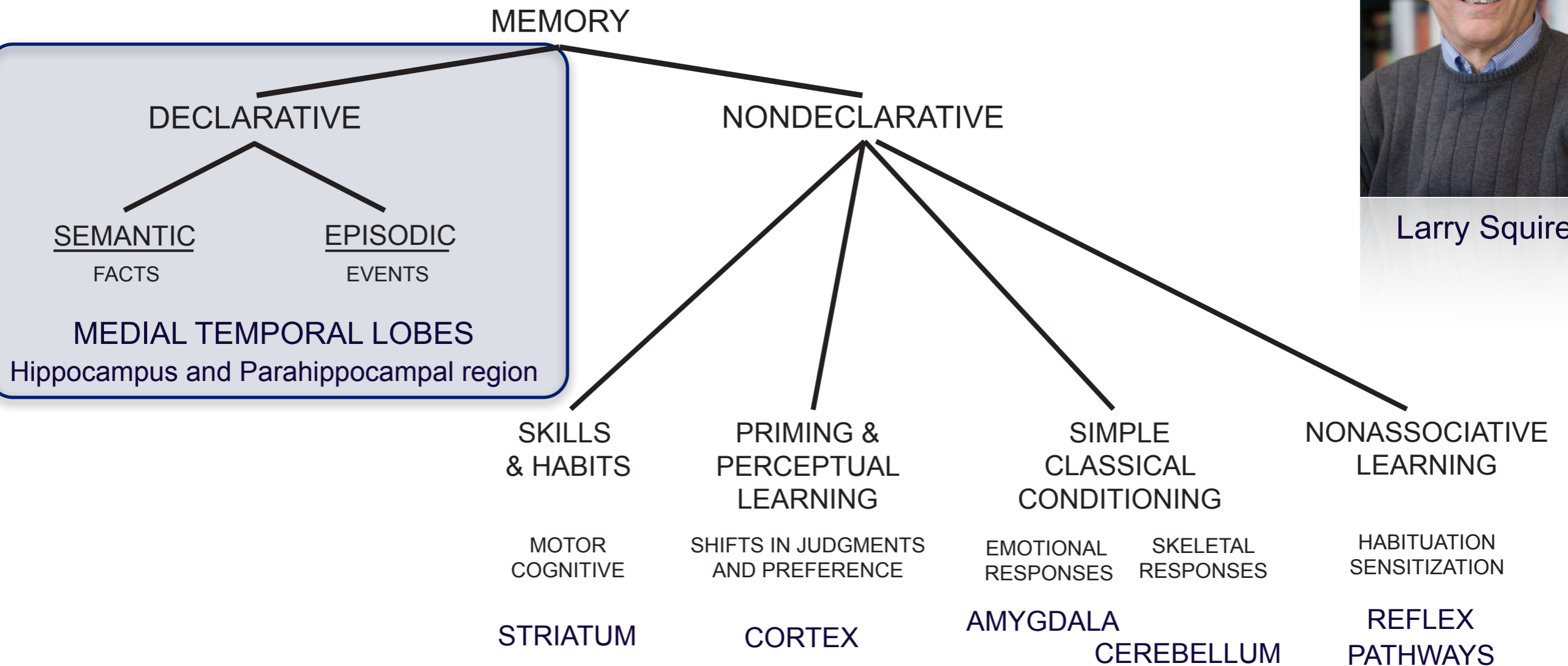
*Bio Sci 38: Mind, Memory, and the Brain*

# MULTIPLE MEMORY SYSTEMS

## DIFFERENT BRAIN SYSTEMS FOR DIFFERENT TYPES OF MEMORIES



Larry Squire



# DECLARATIVE MEMORY SYSTEM

## EPISODIC VS SEMANTIC MEMORY

- Declarative memory:
  - Memories that can be “declared” or made “explicit”
  - Flexible expression
- Two types
  - Episodic (autobiographical) memory
    - Memory for events, personal experiences
    - Memory of the event is tied to the spatial and temporal context in which it occurs
  - Semantic memory
    - Memory for facts, general knowledge of the world
    - Context-independent



# DECLARATIVE MEMORY SYSTEM

## EPISODIC VS SEMANTIC MEMORY

Patient K.C. (interviewed by Endel Tulving)

Episodic memory



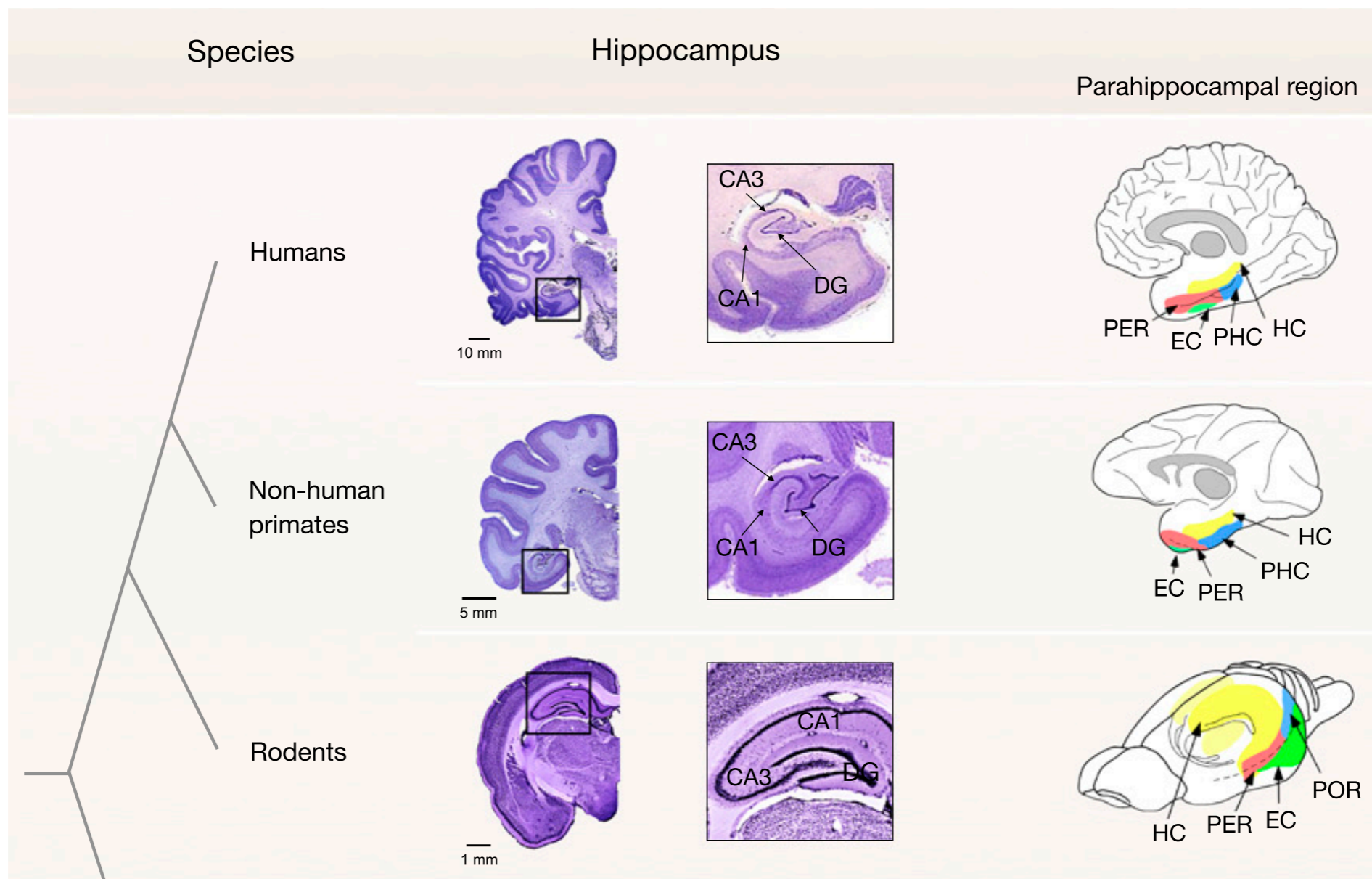
Semantic memory



# DECLARATIVE MEMORY SYSTEM

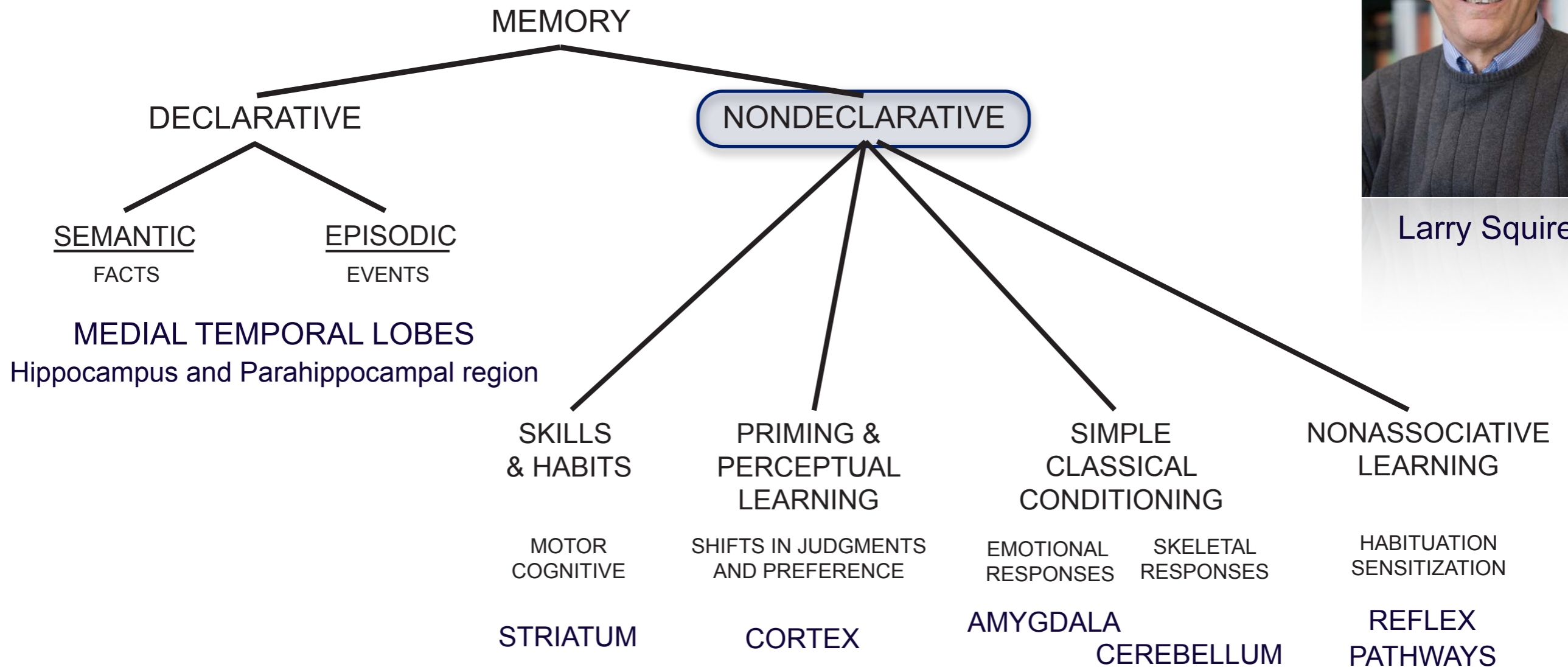
## EPISODIC VS SEMANTIC MEMORY

Depend on the medial temporal lobes  
(hippocampus + parahippocampal region)



# MULTIPLE MEMORY SYSTEMS

## DIFFERENT BRAIN SYSTEMS FOR DIFFERENT TYPES OF MEMORIES



Larry Squire



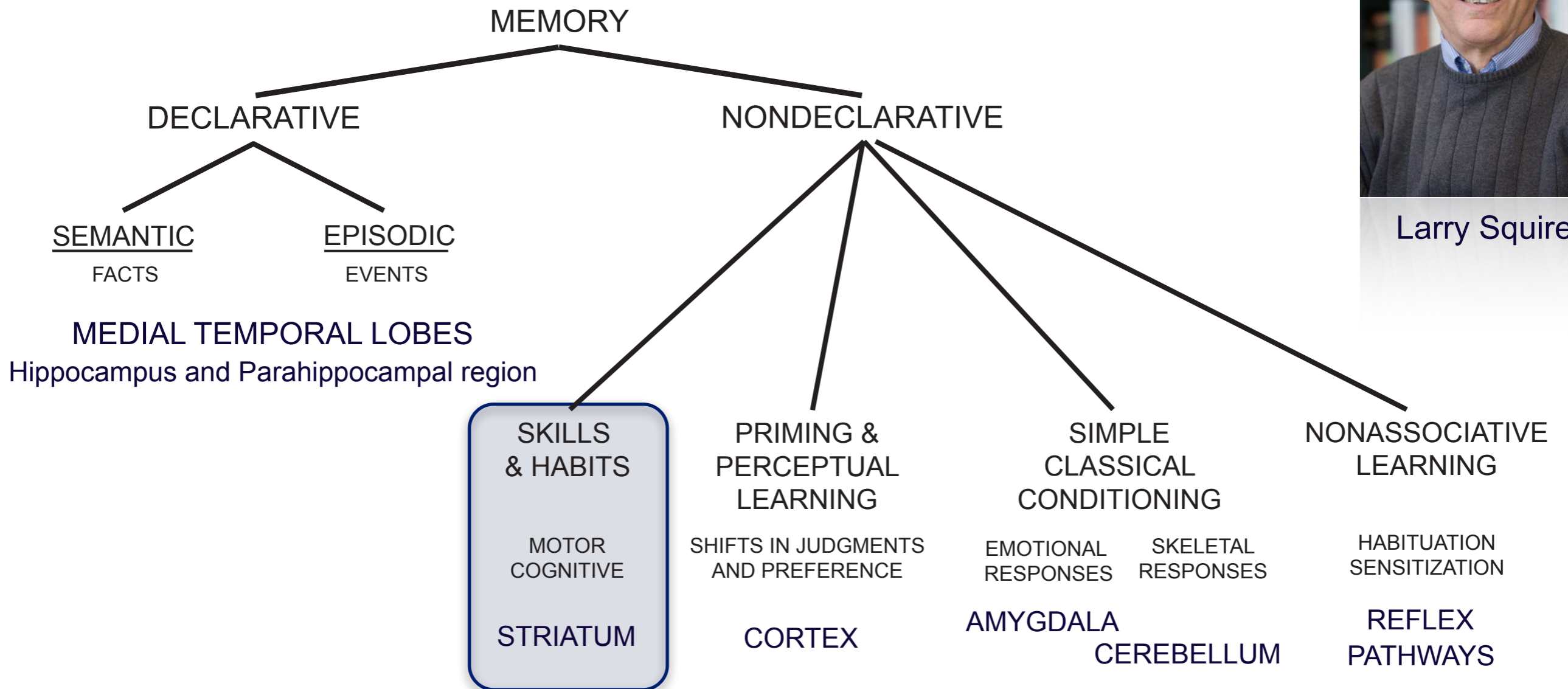
# NON-DECLARATIVE MEMORY SYSTEM

## HETEROGENEOUS GROUP OF MEMORY ABILITIES

- Different types of memory that **cannot** be “declared”, that **cannot** be made “verbally explicit”
- Memory is expressed by changes in performance or a change in bias
- Not flexible
  - Tied to the same stimuli and/or responses

# MULTIPLE MEMORY SYSTEMS

## DIFFERENT BRAIN SYSTEMS FOR DIFFERENT TYPES OF MEMORIES



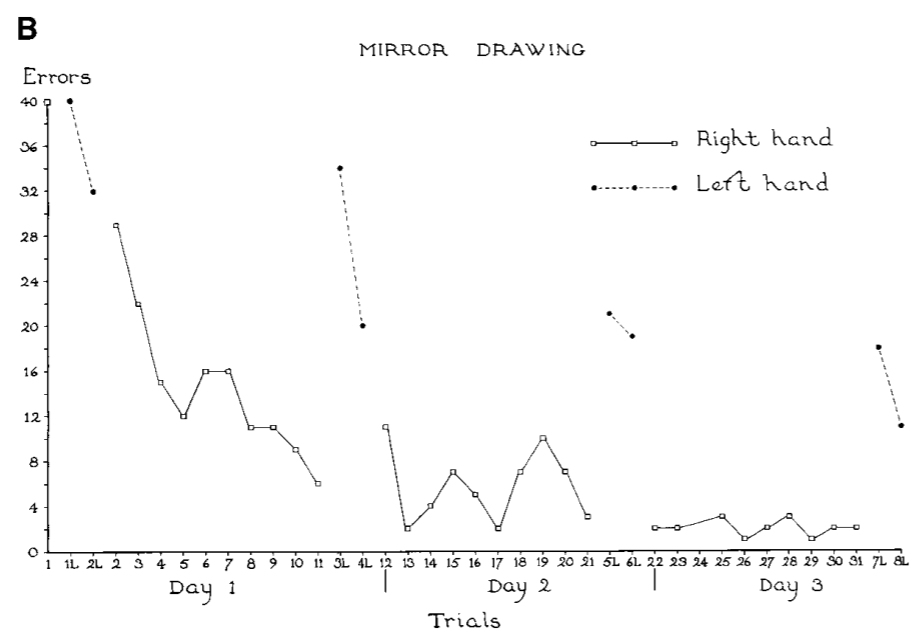
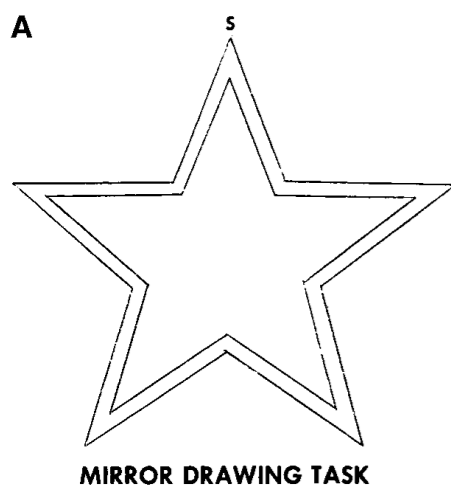
Larry Squire



# NON-DECLARATIVE MEMORY SYSTEM SKILLS AND HABITS

## Motor skills

### Mirror drawing



### Riding a bike



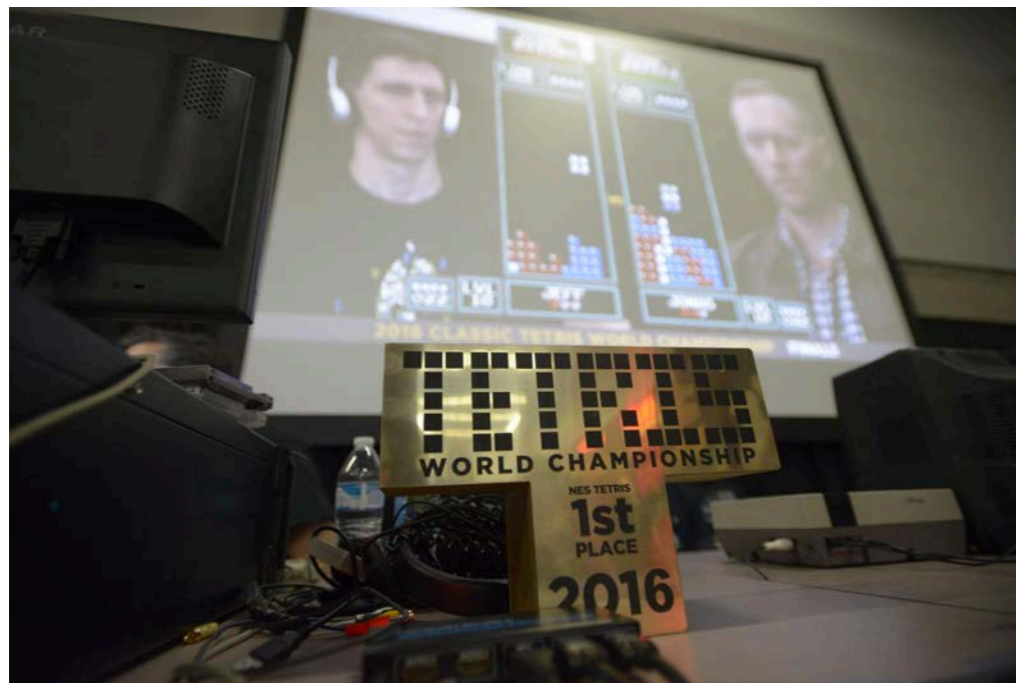
e.g., concept of countersteering  
at higher speeds  
(turning left to go right)

# NON-DECLARATIVE MEMORY SYSTEM

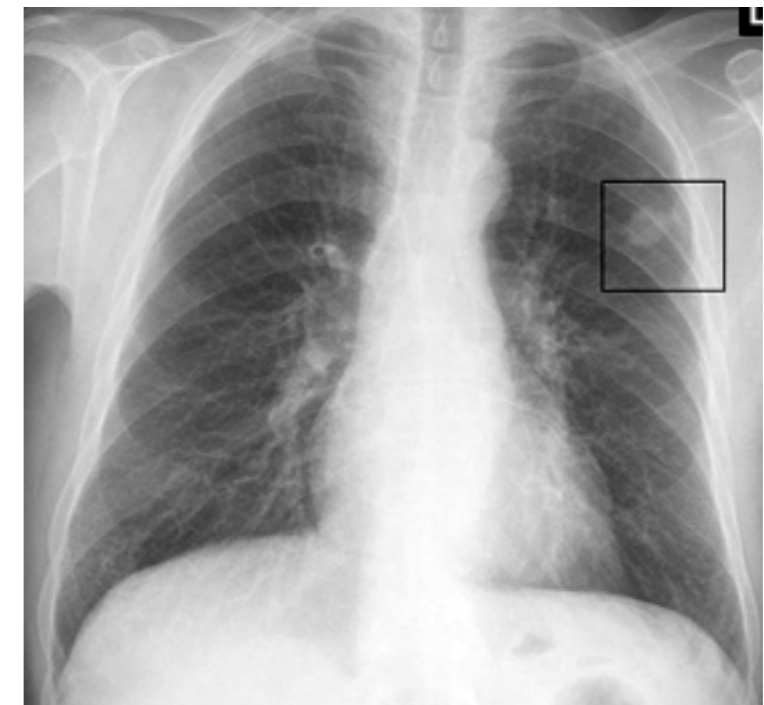
## SKILLS AND HABITS

### Examples of cognitive skills

e.g., mental rotations in gamers



e.g., finding tumors in X-rays

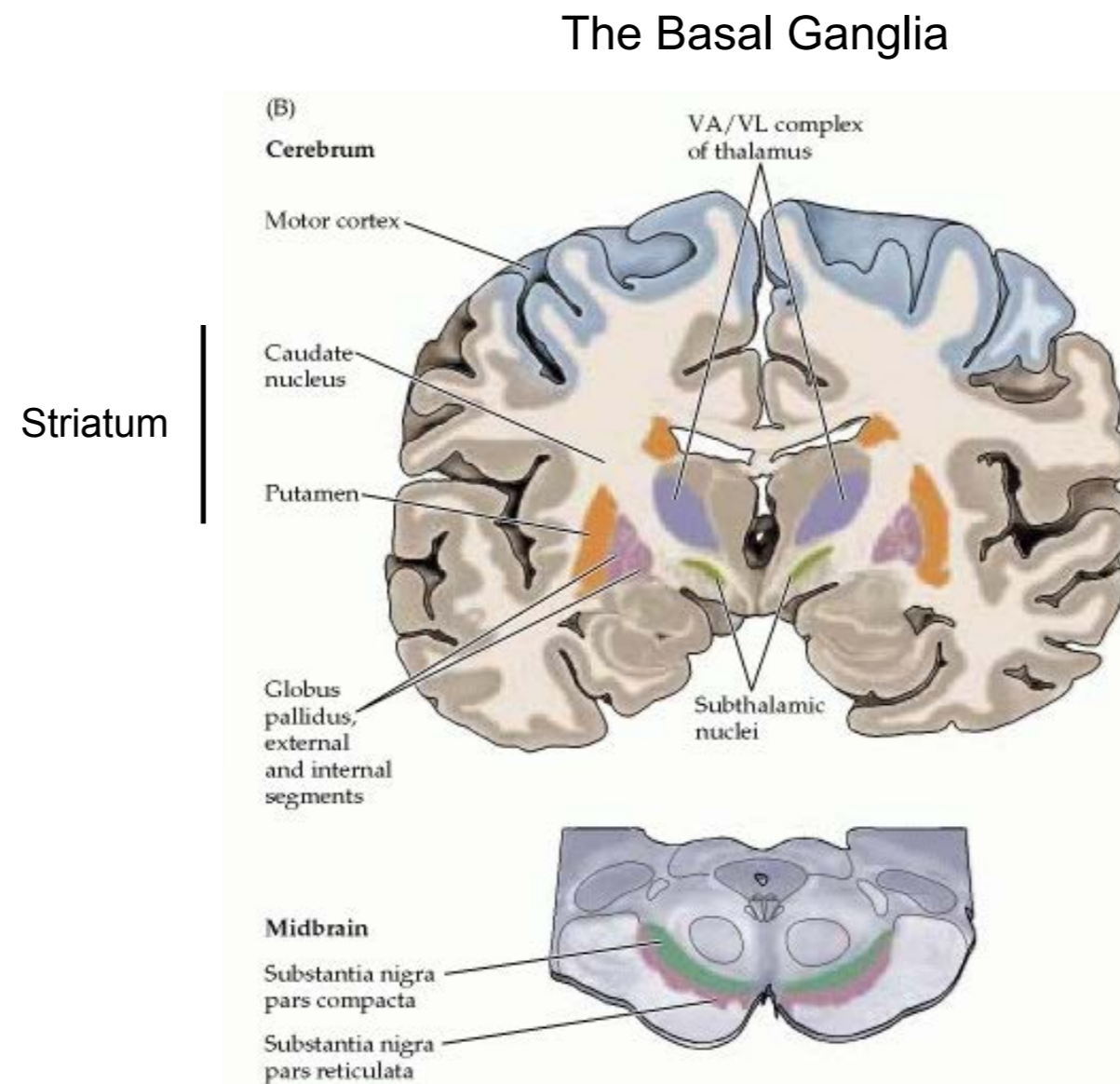


*Note: the line is sometimes blurry between “cognitive skills” and “perceptual learning” (see later)*

*Cognitive skills are thought to involve repeated trial-and-error learning — or stimulus-outcome associations — whereas perceptual learning is thought to develop more gradually and unconsciously*

# NON-DECLARATIVE MEMORY SYSTEM SKILLS AND HABITS

Depend on the striatum (caudate nucleus + putamen)



*Exam:*      *In what brain disorders are those structures affected (basal ganglia)?*  
*How would you expect such patients to perform on tests of skill learning?*



# NON-DECLARATIVE MEMORY SYSTEM

## SKILLS AND HABITS

In addition, your book makes the distinction between actions and habits

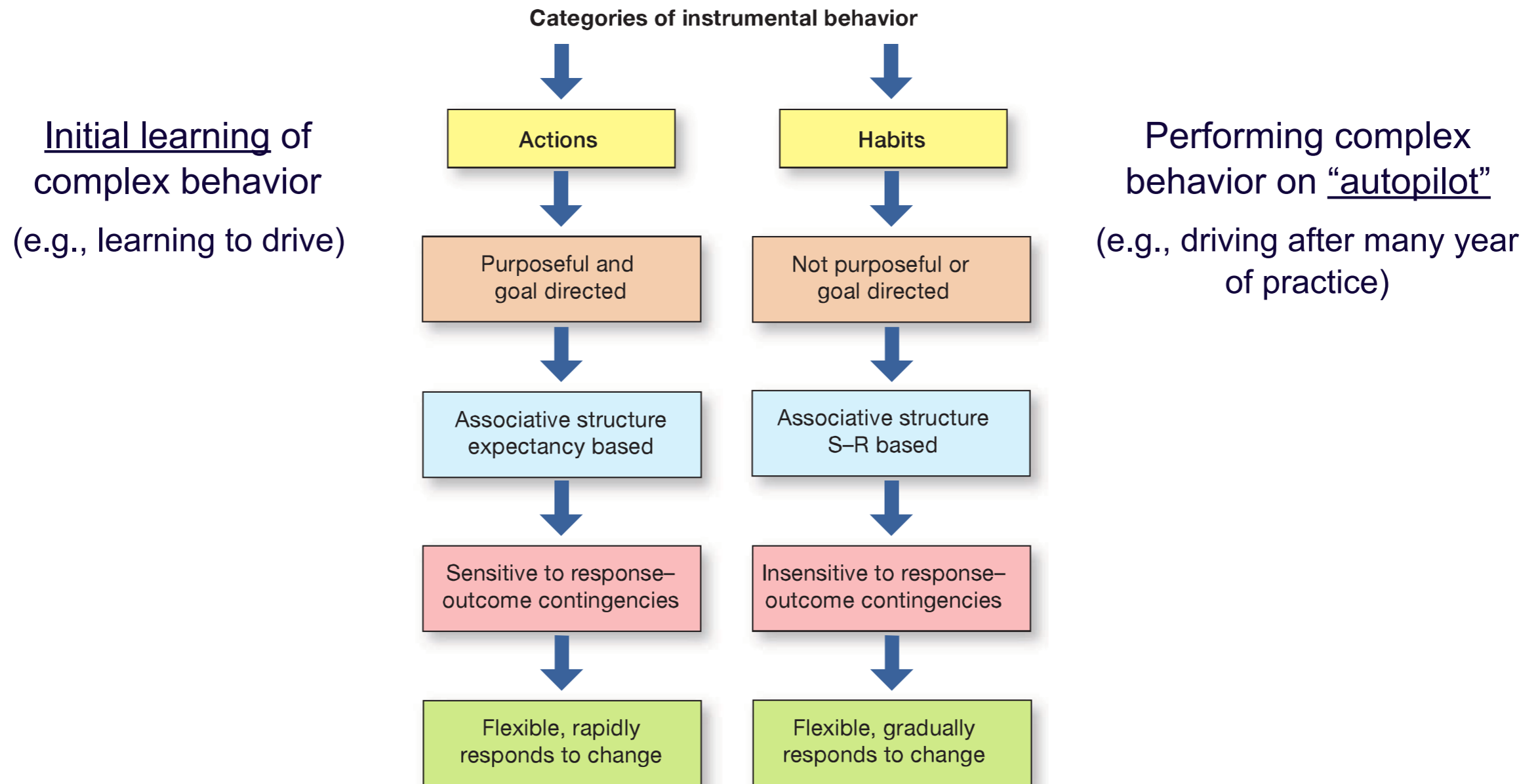


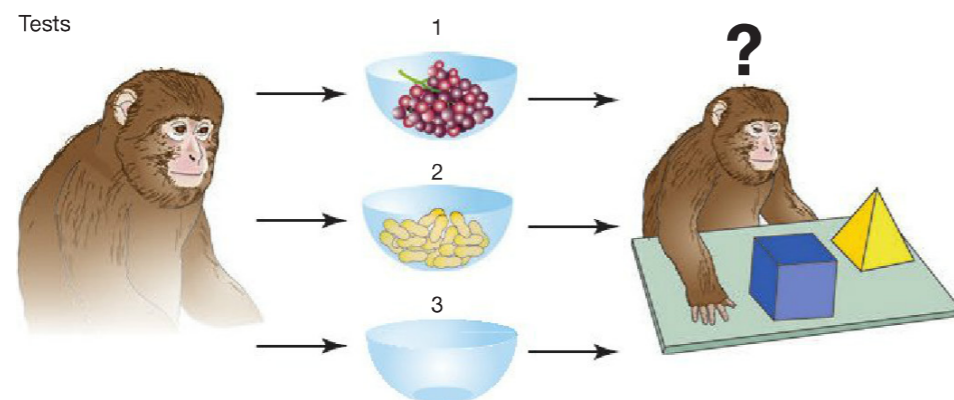
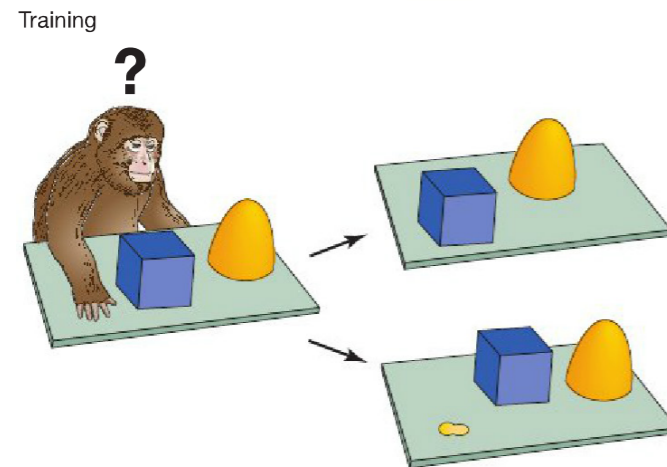
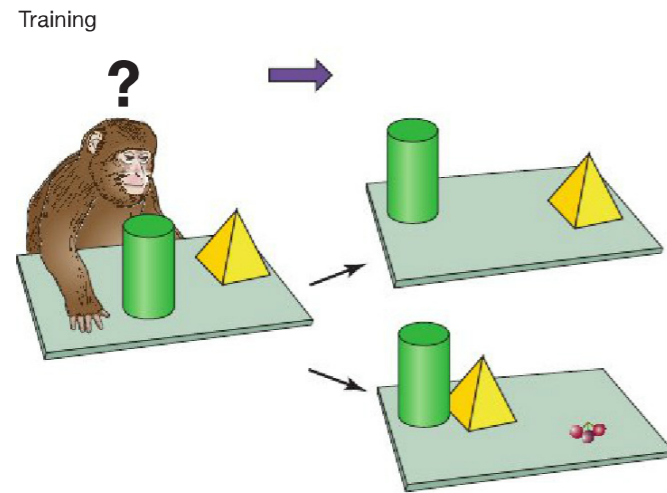
Figure 18.3



# NON-DECLARATIVE MEMORY SYSTEM

## SKILLS AND HABITS

### How to tell action and habits apart?



**Figure 18.4**

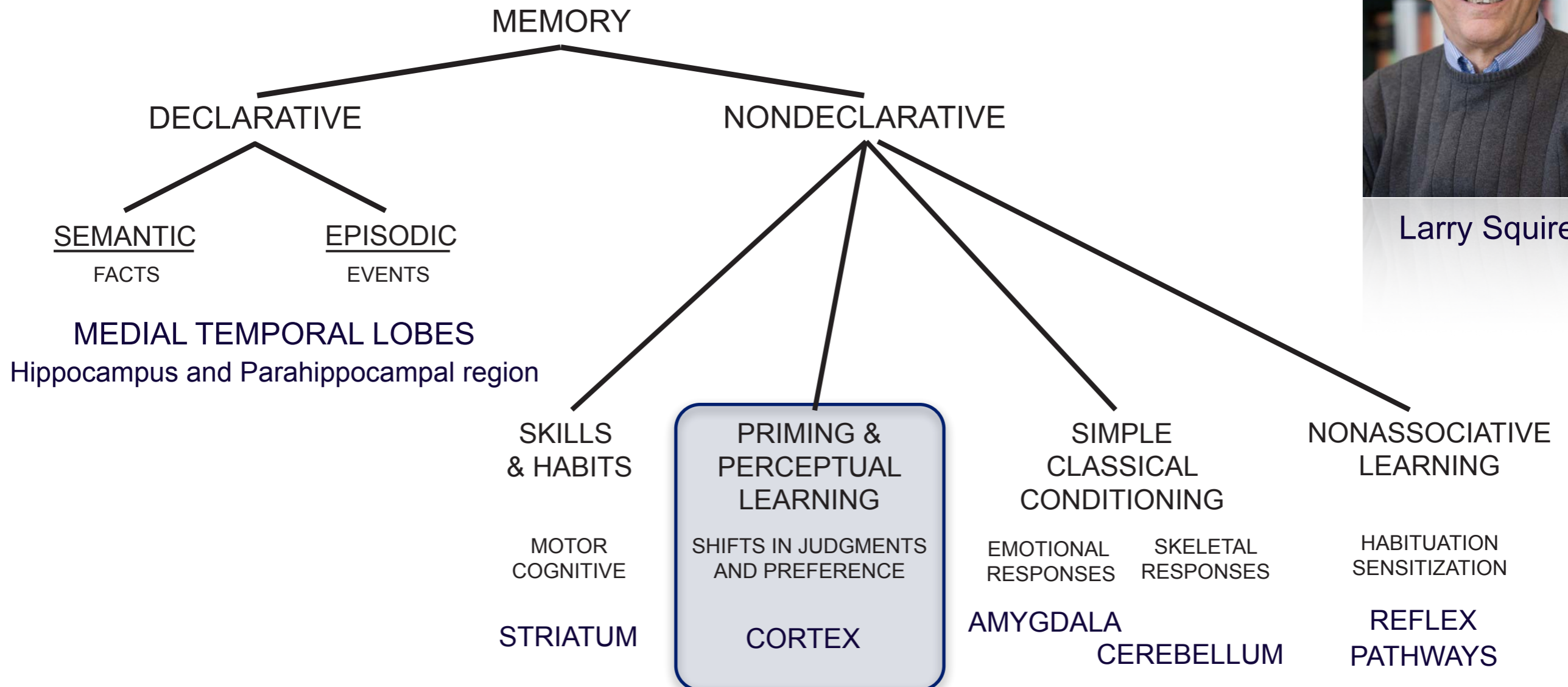
The figure illustrates the satiation method for devaluing a reward. A monkey is trained to solve two discrimination problems. In the first problem the pyramid is the correct choice and the reward is a grape. In the second problem the correct choice is the cube and the reward is a peanut. After solving the two problems, the monkey is given a choice between the two correct objects (cube and pyramid). Before the test, however, the monkey is allowed to have either all the grapes or all the peanuts it wants, thus reducing the value of one of the outcomes. Typically, monkeys choose the object that contains the reward that it was not fed prior to the test. (After Baxter and Murray, 2002.)

If devaluing the outcome has an effect, then the behavior is an action

If it does not have an effect, then the behavior is a habit

# MULTIPLE MEMORY SYSTEMS

## DIFFERENT BRAIN SYSTEMS FOR DIFFERENT TYPES OF MEMORIES



Larry Squire

# NON-DECLARATIVE MEMORY SYSTEM

## PRIMING AND PERCEPTUAL LEARNING

**Priming:** Exposure to one stimulus influences the response to another stimulus

*Example 1: "NURSE" is recognized more quickly following "DOCTOR" than following "BREAD"*

*Example 2: recognizing picture fragments*



**Perceptual learning:**

The more experience you have with some aspect of sensory processing,  
the better you'll be at it (see also "cognitive skills" earlier)

# NON-DECLARATIVE MEMORY SYSTEM PRIMING AND PERCEPTUAL LEARNING

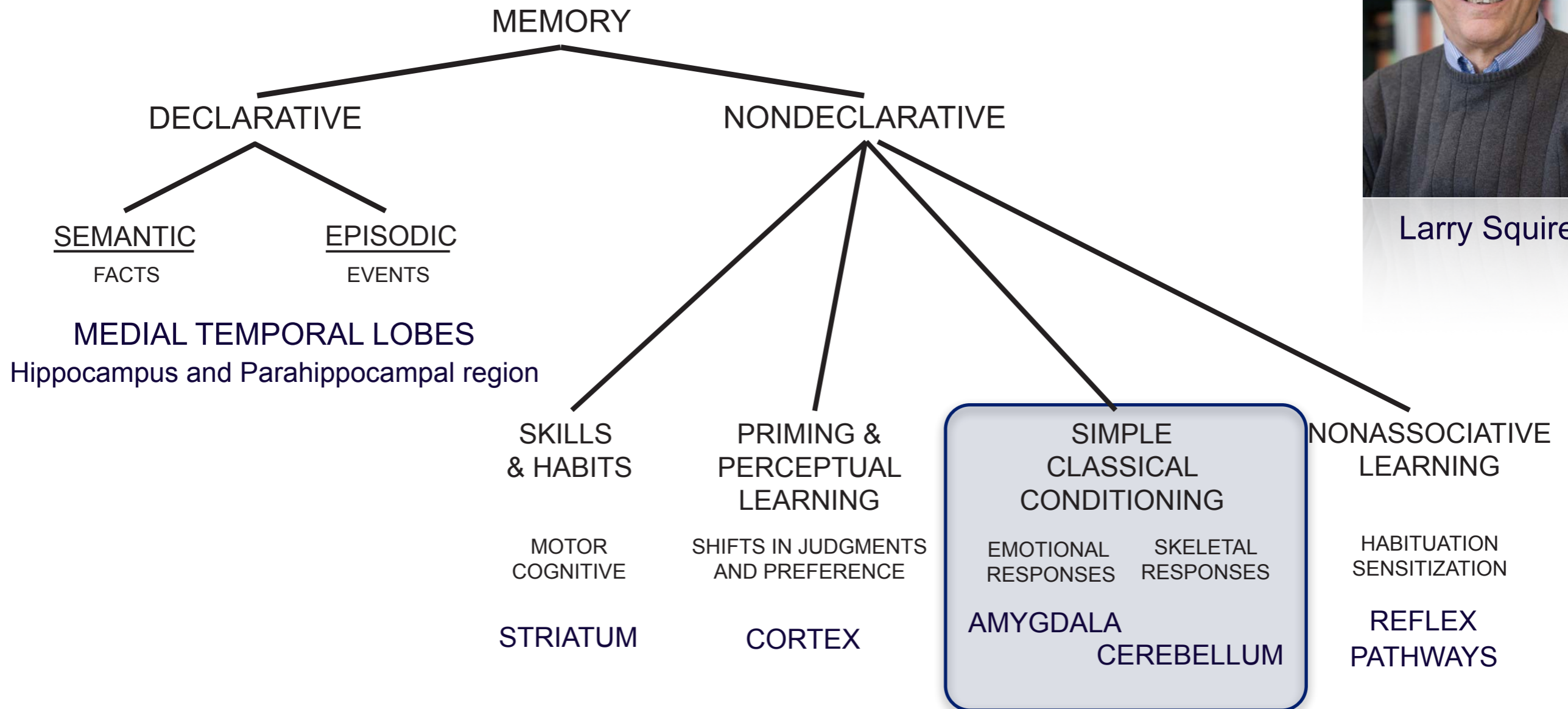
Depend on many cortical areas





# MULTIPLE MEMORY SYSTEMS

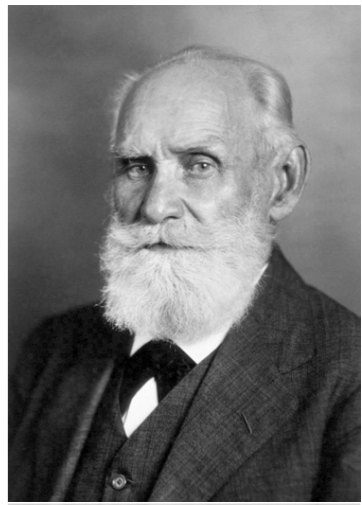
## DIFFERENT BRAIN SYSTEMS FOR DIFFERENT TYPES OF MEMORIES



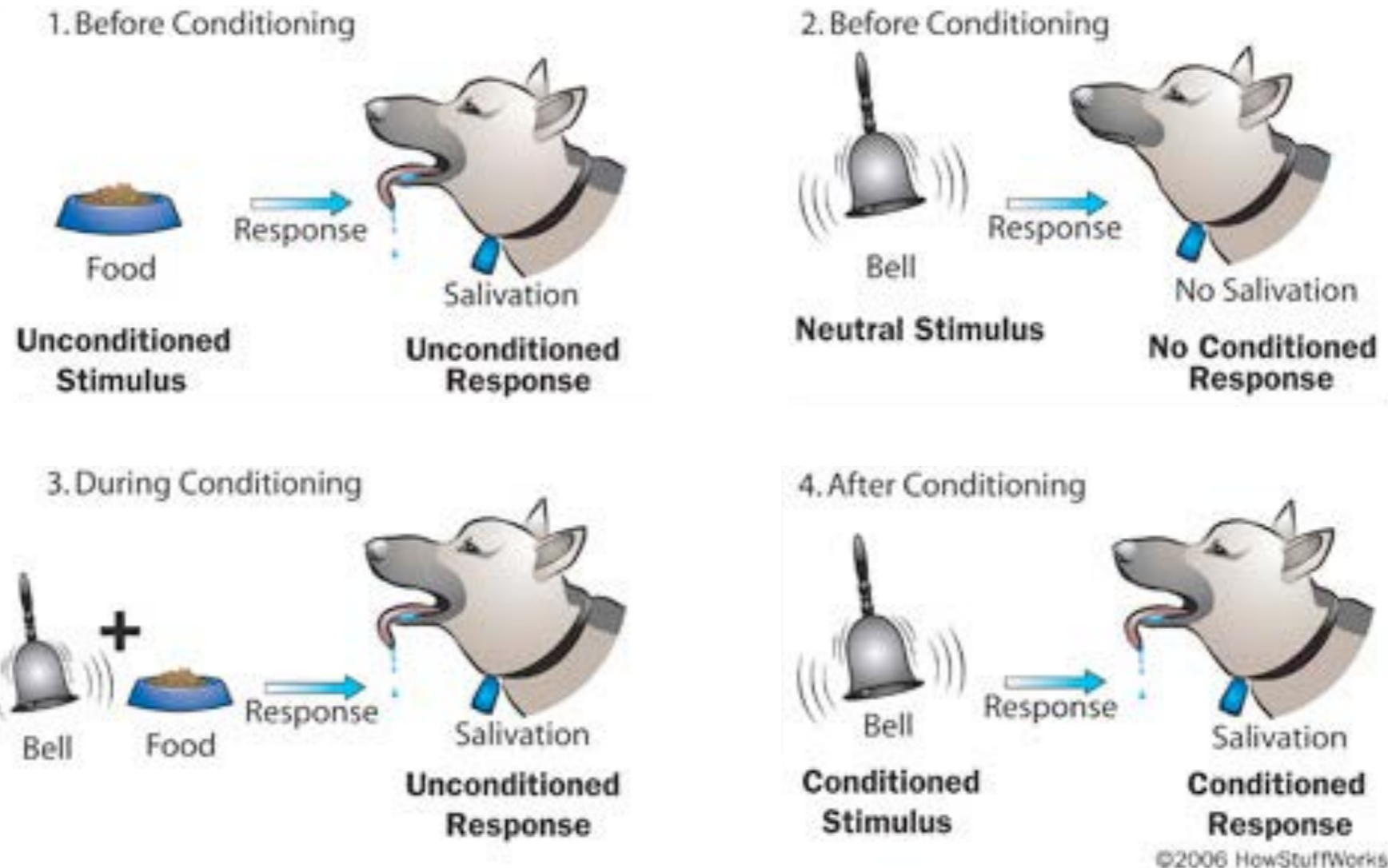
Larry Squire

# NON-DECLARATIVE MEMORY SYSTEM

## CLASSICAL CONDITIONING (PAVLOV, 1927)



Ivan Pavlov



- Involves the pairing of a stimulus of **innate significance** (Unconditioned Stimulus; US) with a **neutral** stimulus (Conditioned Stimulus; CS)
- The CS will then elicit a Conditioned Response (CR) that is similar to the Unconditioned Response (UR)

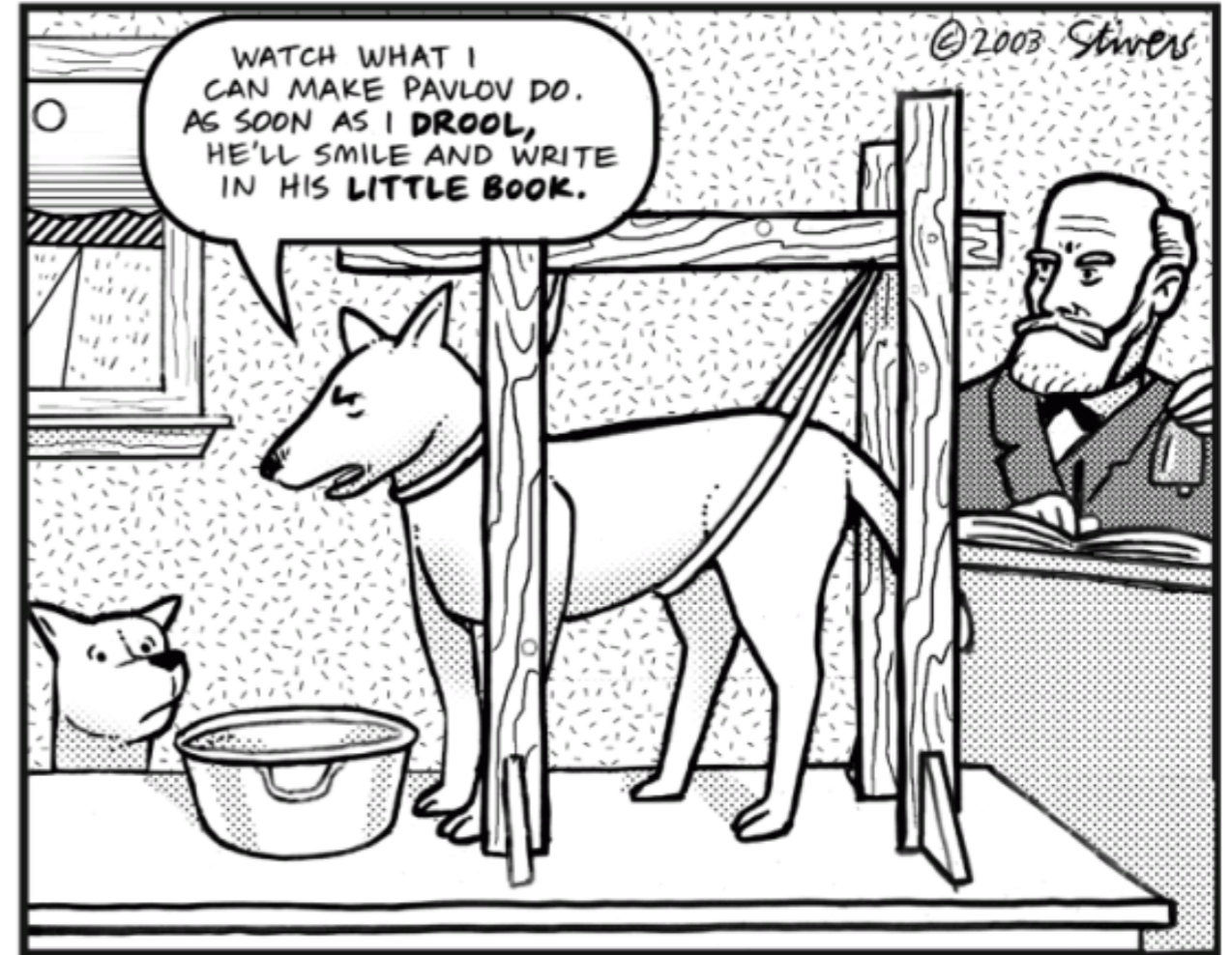


# NON-DECLARATIVE MEMORY SYSTEM

## CLASSICAL CONDITIONING IN POPULAR CULTURE

### PEANUTS

Drawing by Charles Schulz; © 1985 United Feature Syndicate, Inc. Reprinted by permission of UFS, Inc.



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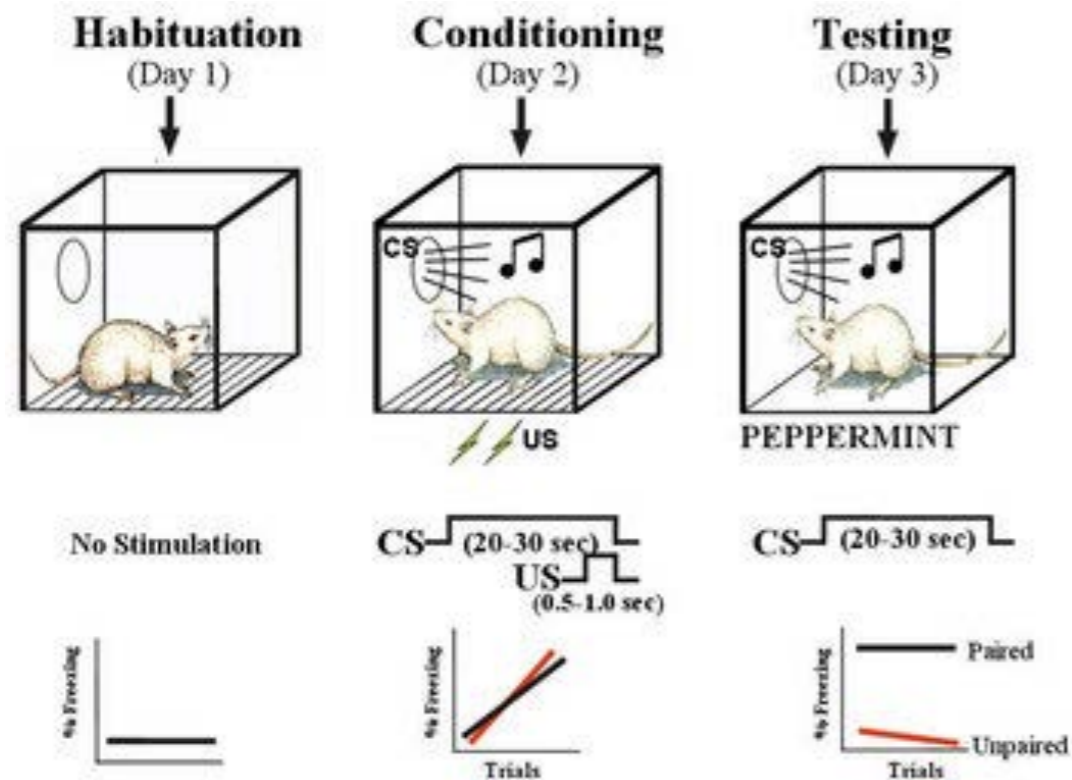


# NON-DECLARATIVE MEMORY SYSTEM

## CLASSICAL CONDITIONING (PAVLOV, 1927)

Some famous examples (there are many others)

Fear conditioning



Depends on the amygdala

Eyeblink conditioning



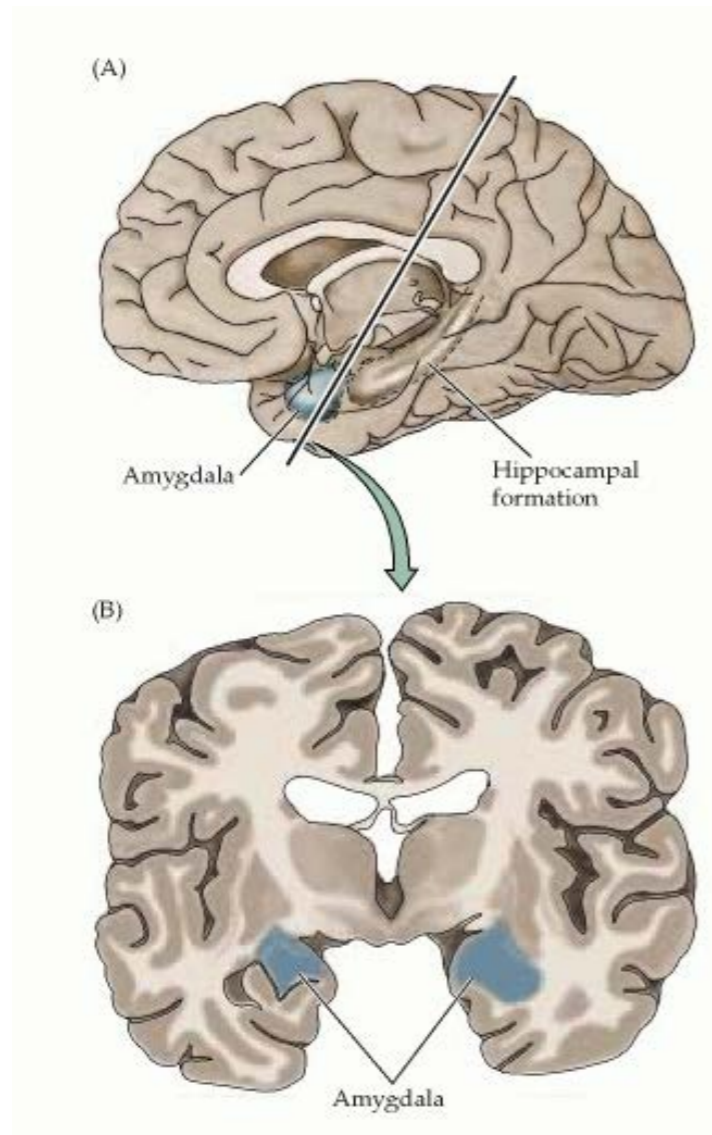
Depends on the cerebellum



# NON-DECLARATIVE MEMORY SYSTEM

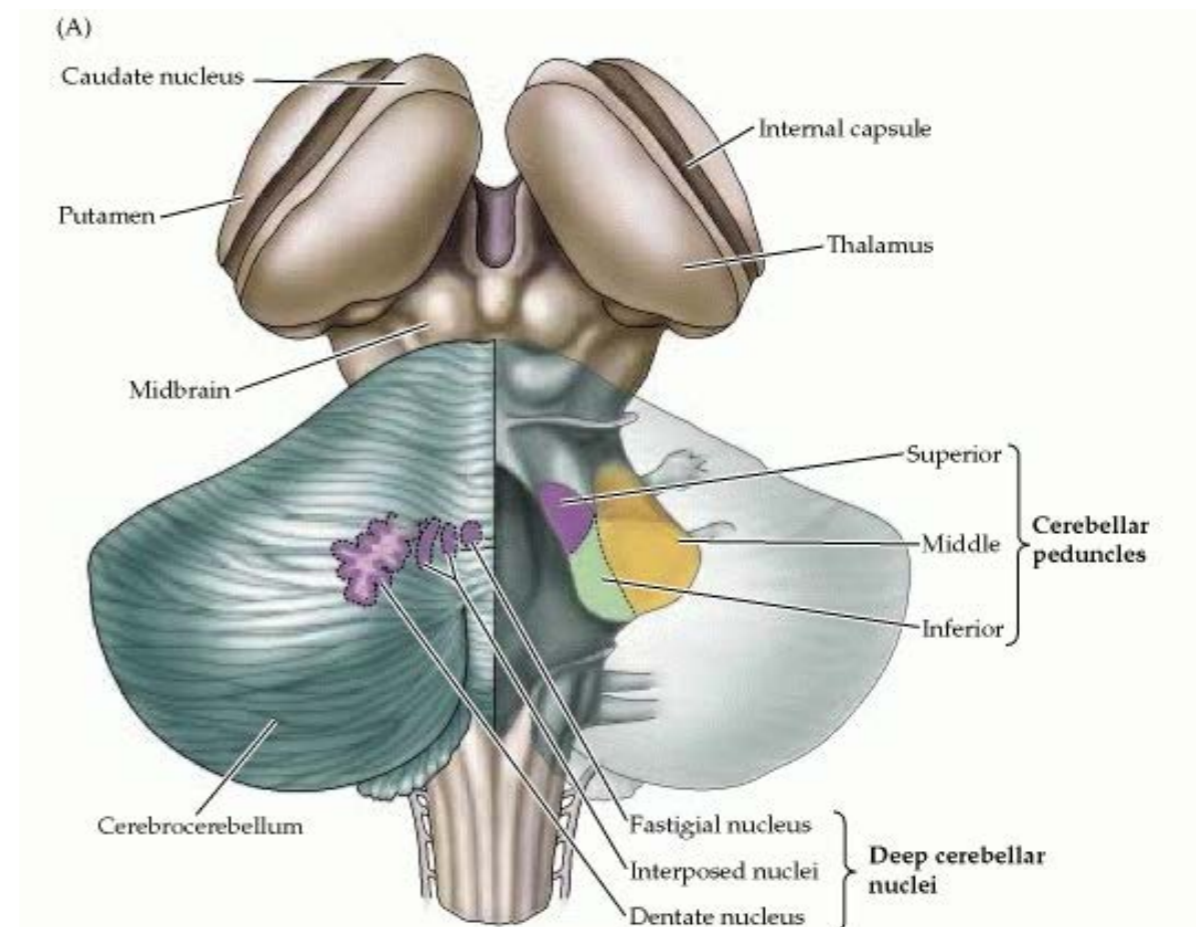
## CLASSICAL CONDITIONING (PAVLOV, 1927)

### Fear conditioning



Depends on the amygdala

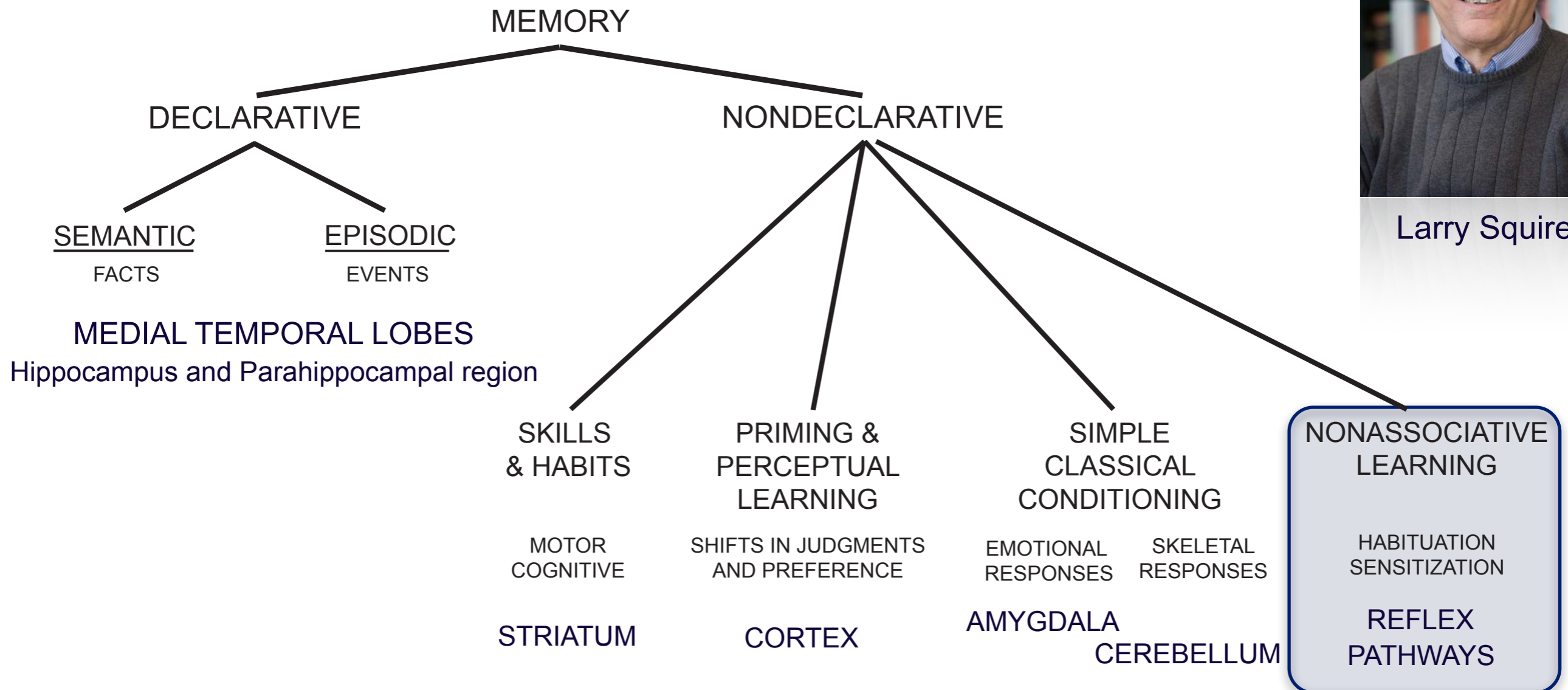
### Eyeblink conditioning



Depends on the cerebellum

# MULTIPLE MEMORY SYSTEMS

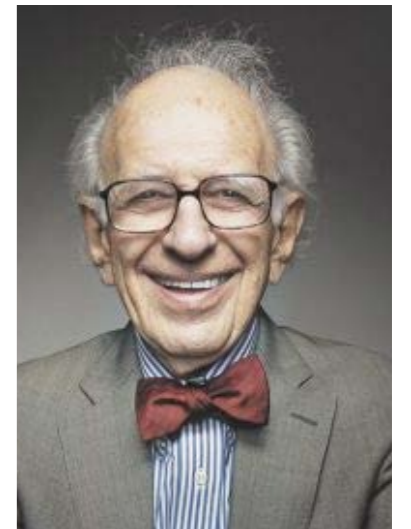
## DIFFERENT BRAIN SYSTEMS FOR DIFFERENT TYPES OF MEMORIES



Larry Squire

# NON-DECLARATIVE MEMORY SYSTEM

## NONASSOCIATIVE LEARNING



Eric Kandel

- Habituation

- Process by which you have a decrease in psychological and behavioral response to a stimulus after repeated exposure to that stimulus over a duration of time
  - e.g., you learn to ignore a new noise if nothing bad happens

- Sensitization

- Process by which you have an amplification of a response after repeated administrations of a stimulus.
  - e.g., rubbing in the same spot



# NON-DECLARATIVE MEMORY SYSTEM

## NONASSOCIATIVE LEARNING

Habituation and sensitization are studied extensively in *Aplysia*



Dr. Kandel received the 2000 Nobel Prize in Physiology or Medicine (with Arvid Carlsson and Paul Greengard) for his research on the physiological basis of memory storage in neurons

# MULTIPLE MEMORY SYSTEMS

## WHICH ONES DO WE USE AND WHEN?

- We are using all of them simultaneously to encode information in parallel
- When we recall info, the systems compete. One of the systems will “win” in each particular situation.
- Examples of multiple memory systems at work

NEUROBIOLOGY OF LEARNING AND MEMORY 65, 65–72 (1996)

Article No. 0007

### Inactivation of Hippocampus or Caudate Nucleus with Lidocaine Differentially Affects Expression of Place and Response Learning

MARK G. PACKARD\* AND JAMES L. MCGAUGH†<sup>1</sup>

*\*Department of Psychology, University of New Orleans 70148; and †Center for the Neurobiology of Learning and Memory and Department of Psychobiology, University of California, Irvine 92717*

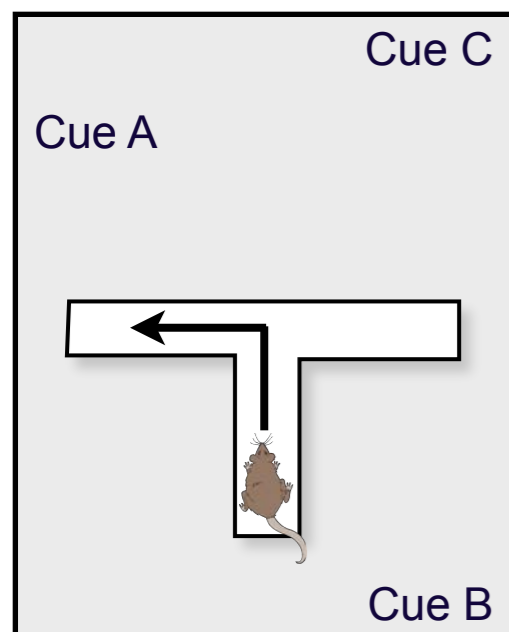
# MULTIPLE MEMORY SYSTEMS

## WHICH ONES DO WE USE AND WHEN?

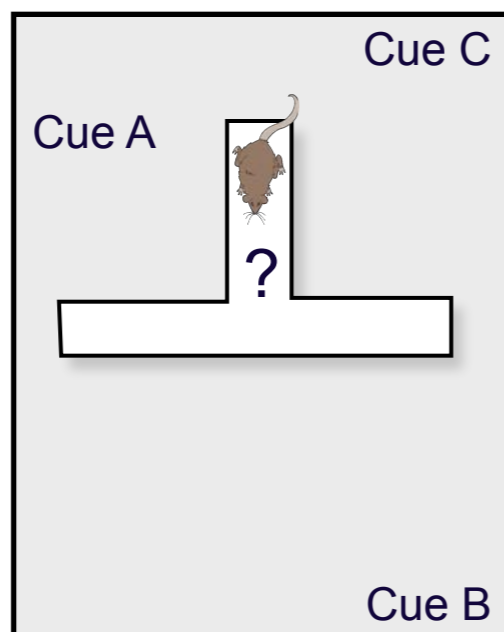


Jim McGaugh (UCI)

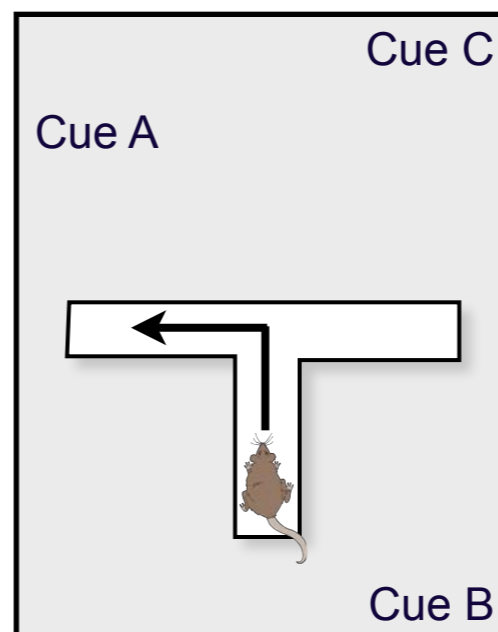
- Packard & McGaugh 1996



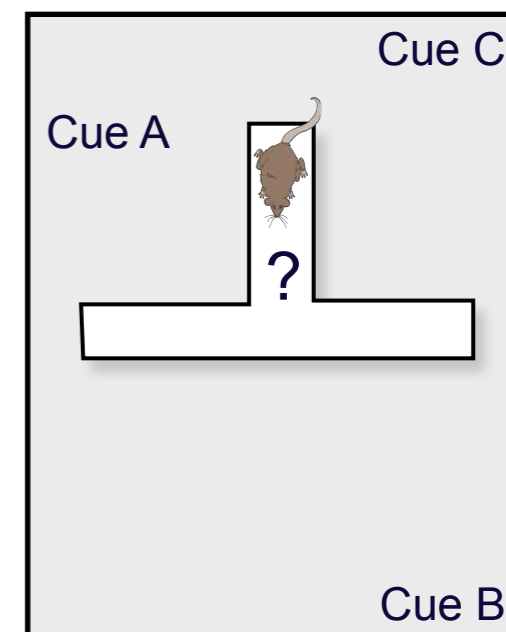
Day 1 ...



Day 8  
(1 probe test)



Day 9 ...



Day 16  
(1 probe test)

Rats go to same side of room  
(unless hippocampus is inactivated)

Rats make a left turn  
(unless striatum is inactivated)