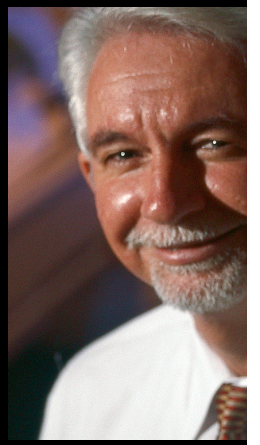
CNTRICS III: Memory Constructs

Relational Memory

Item Memory

Reinforcement Learning



Constructs

I. Item encoding and retrieval
II. Relational encoding and retrieval
III. Reinforcement learning

Item Encoding and Retrieval

Definition:

The processes involved in memory for individual stimuli or elements, *irrespective* of contemporaneously presented context or elements

Examples

- Recognition memory ("Familiarity")
  - Yes-No
  - Forced Choice
    - Animal Model: Delayed NonMatching to Sample
  - *Caveat:*
    - *Recognition may be supported by item familiarity strength or by recollection of context information*
- Other measures
  - Judgments of Recency
  - Judgments of Frequency

Relational Memory

Definition:

The processes involved in memory for stimuli/events and how they were associated with coincident context, stimuli, or events.

Examples

- “Relational recognition” tasks
  - Source memory
  - Associative Recognition
- Free recall
- Animal Model: Transitive/Associative Inference*

Methods to assess Item & Relational memory

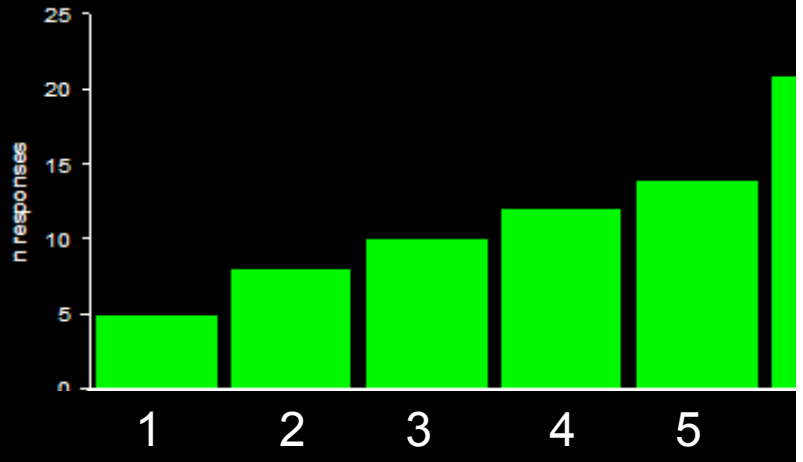
- “Remember-Know”
- Process Dissociation Procedure
- Receiver Operating Characteristic (ROC) analyses

Reciever Operating Characteristic (ROC) curves

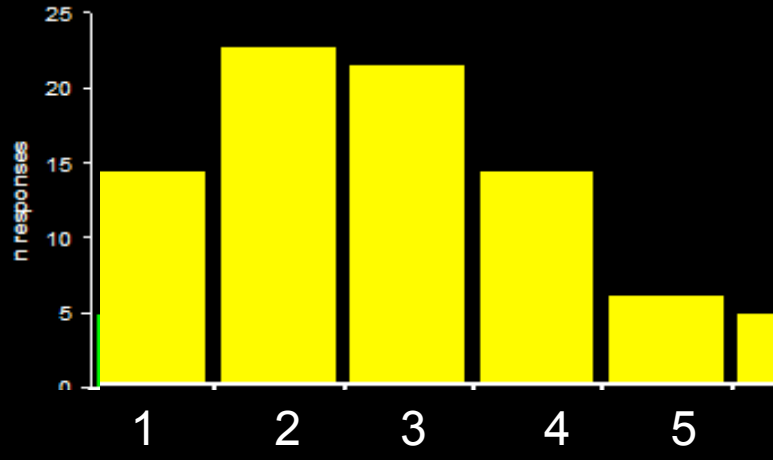
Subjects respond to old and new items

NEW					OLD
1	2	3	4	5	6

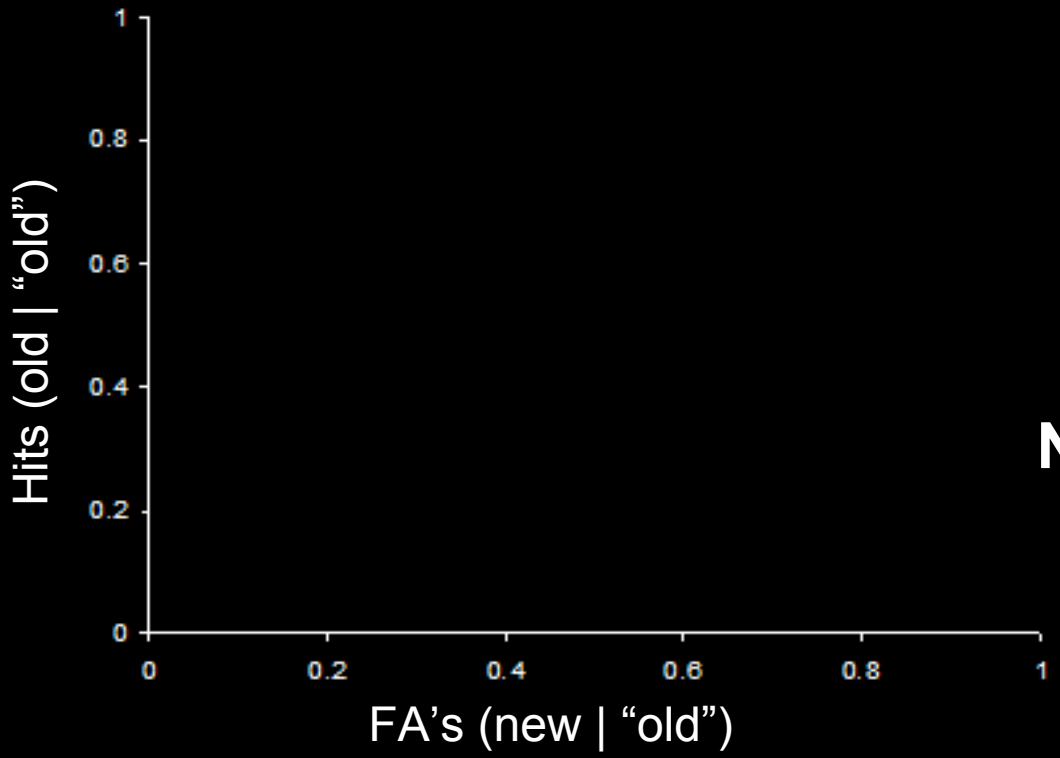
OLD



NEW



ROCs


Hits (old | “old”)
FA’s (new | “old”)
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0.2
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0.8
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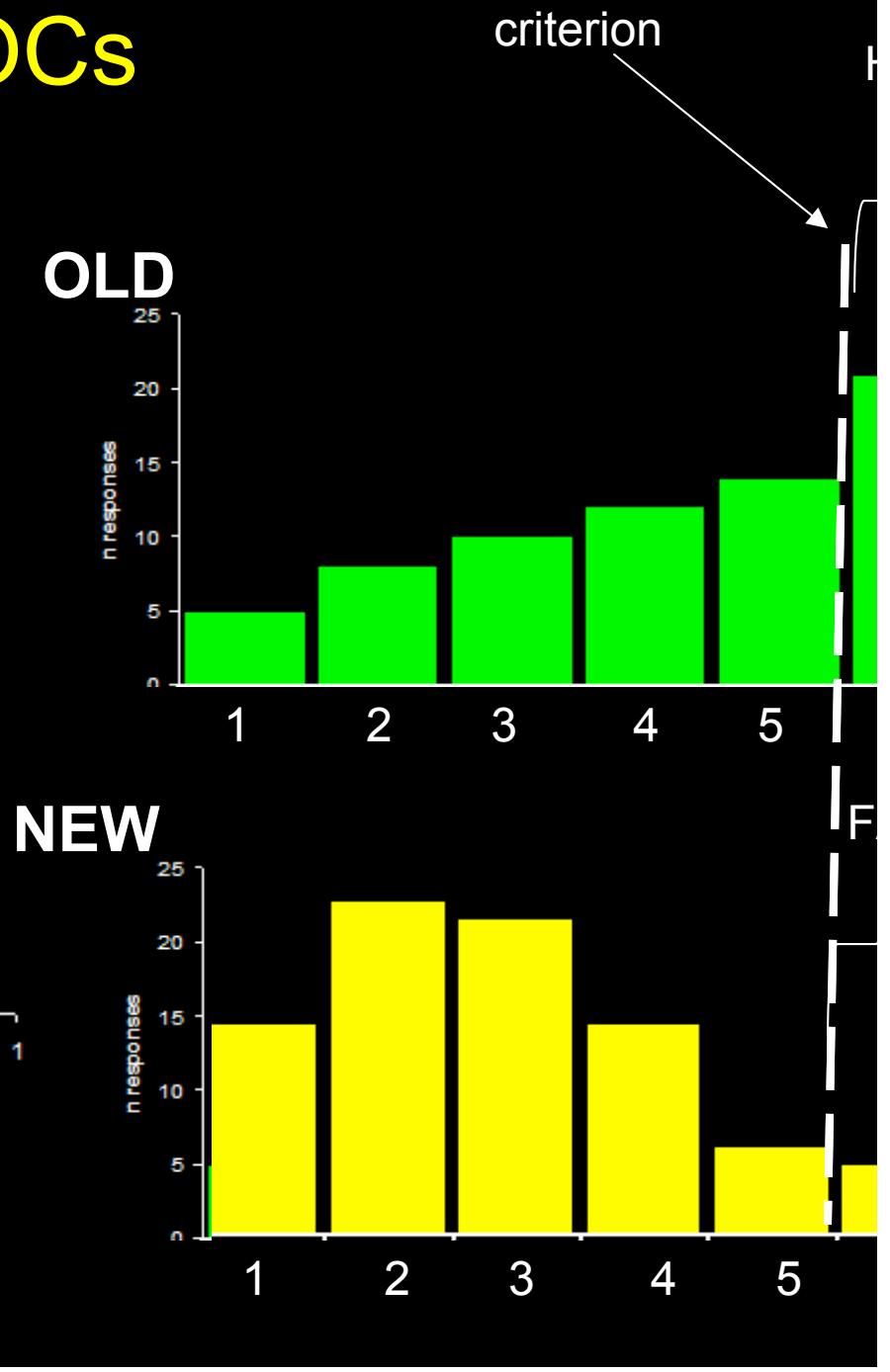
criterion
OLD
NEW
n responses
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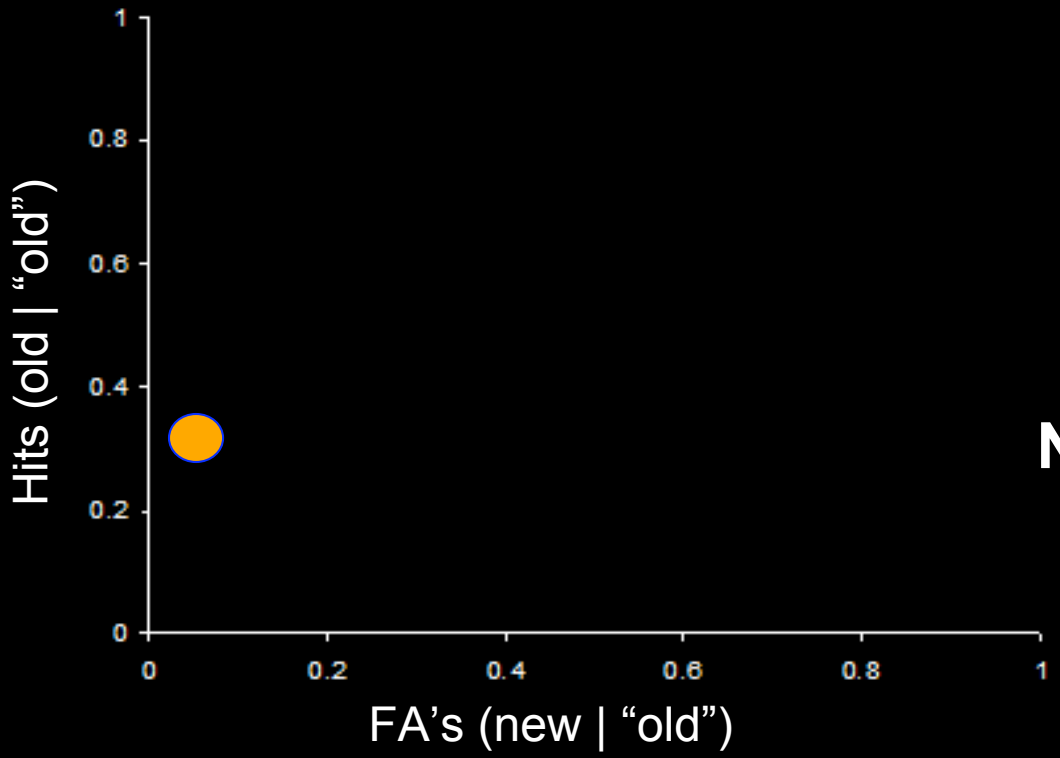
ROCs



criterion

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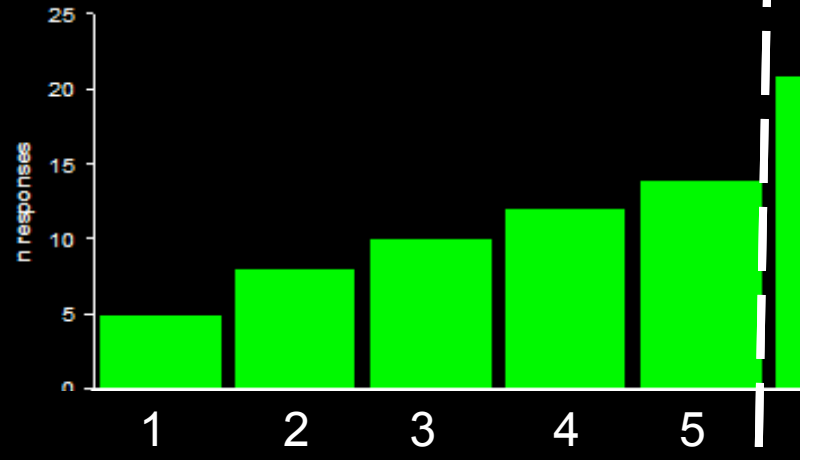

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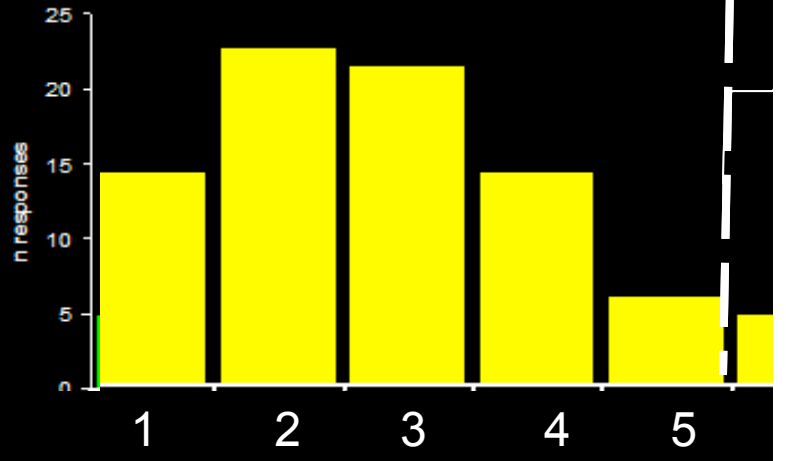
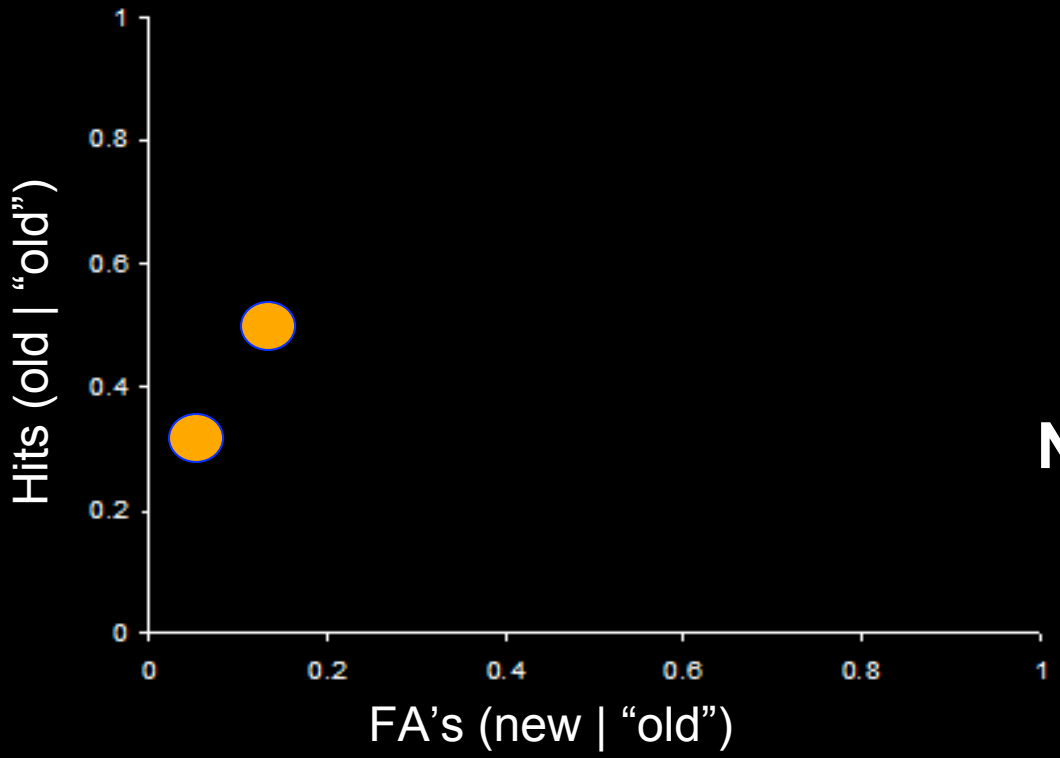


ROCs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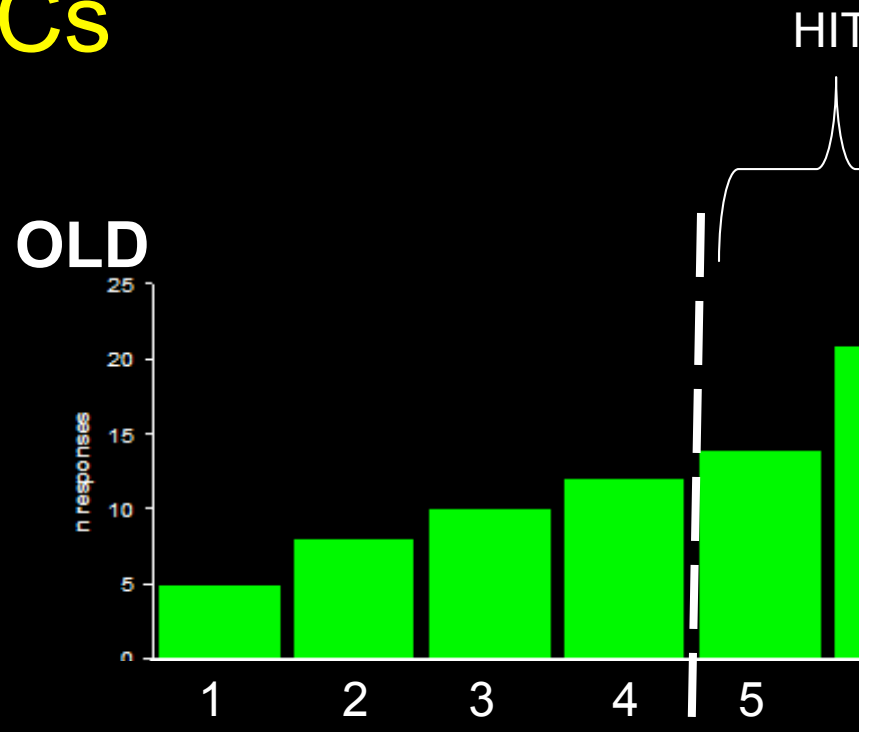
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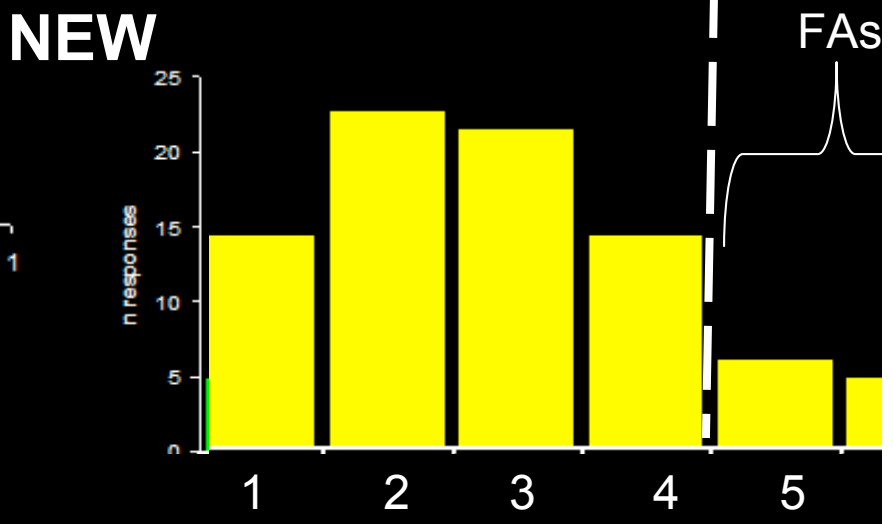
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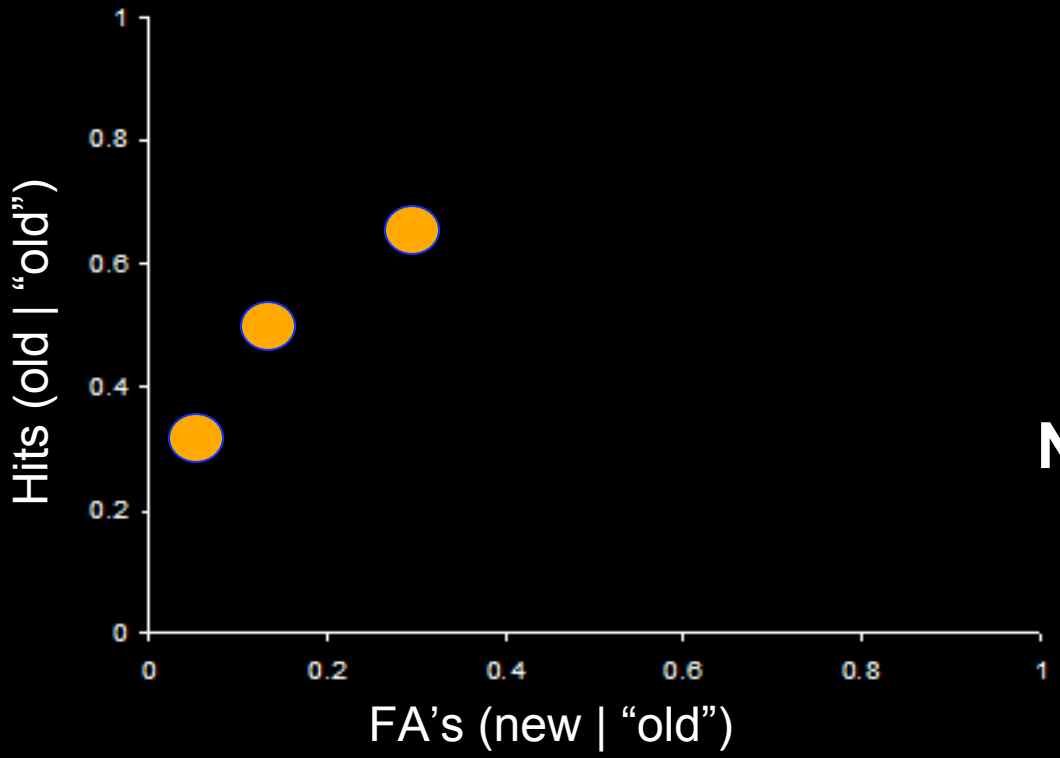
ROCs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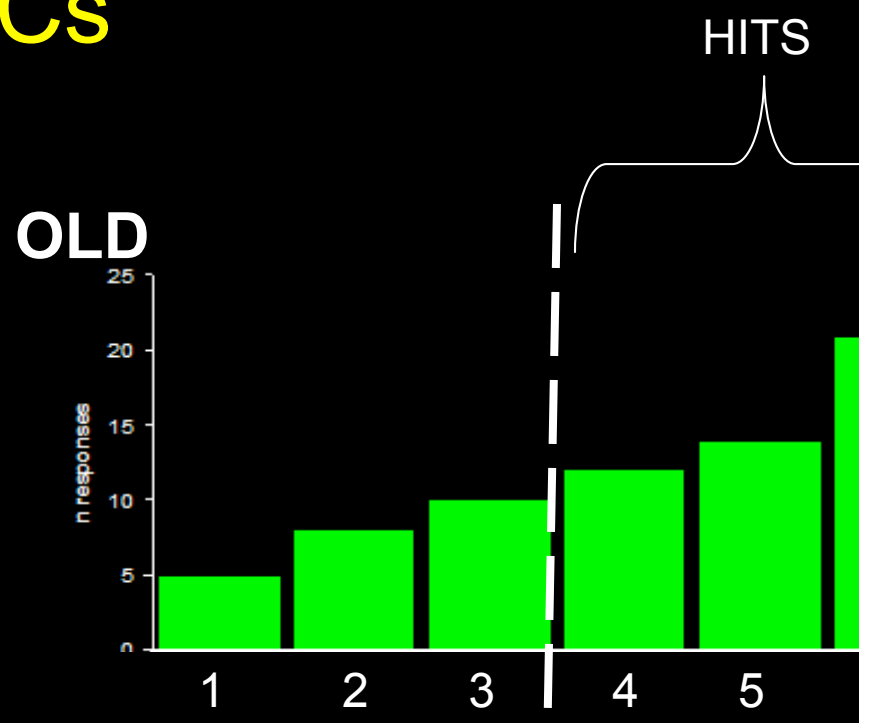
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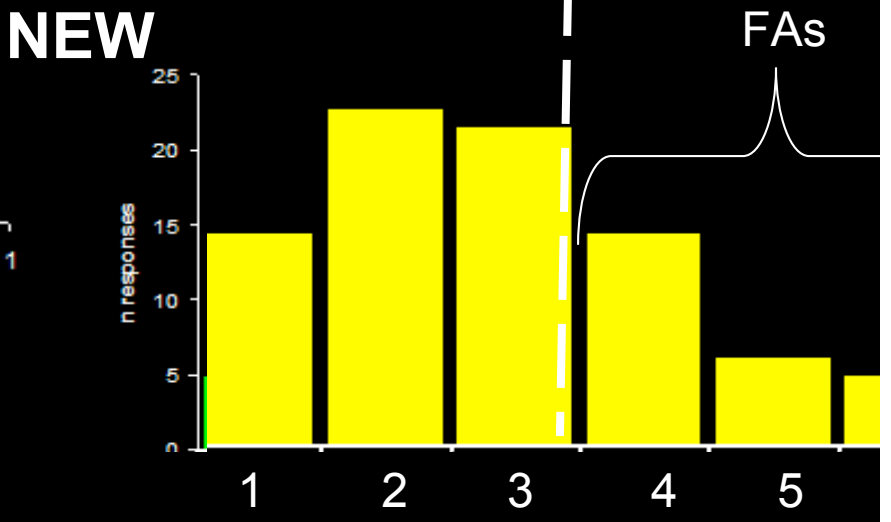
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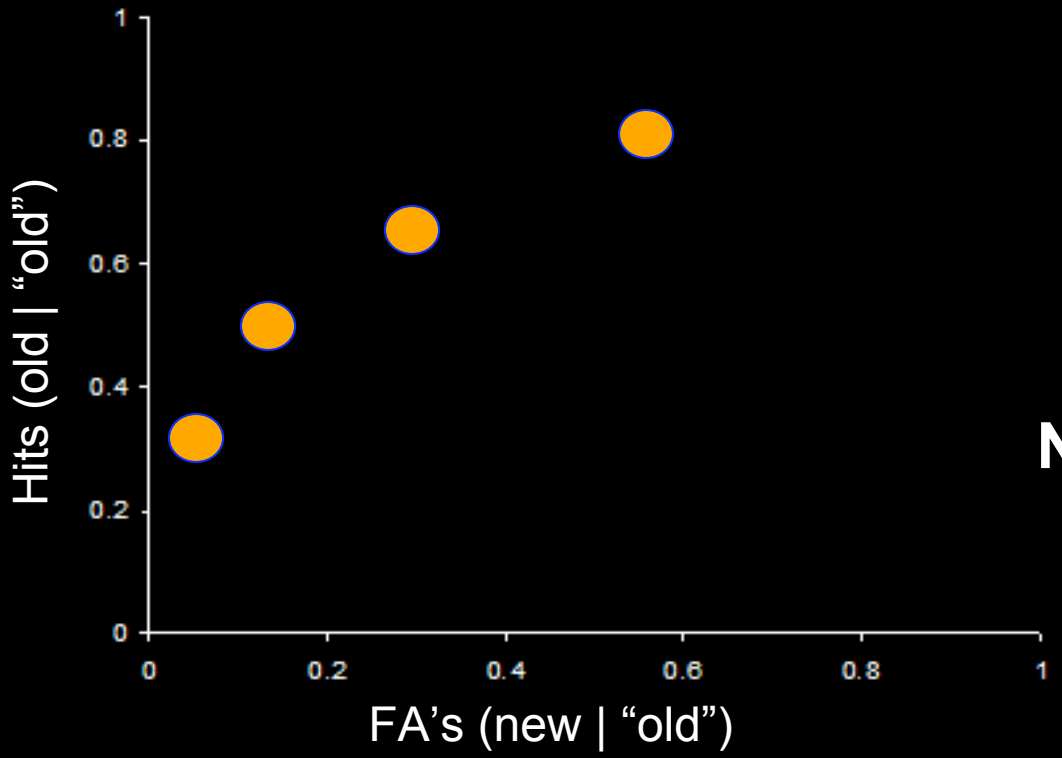
ROCs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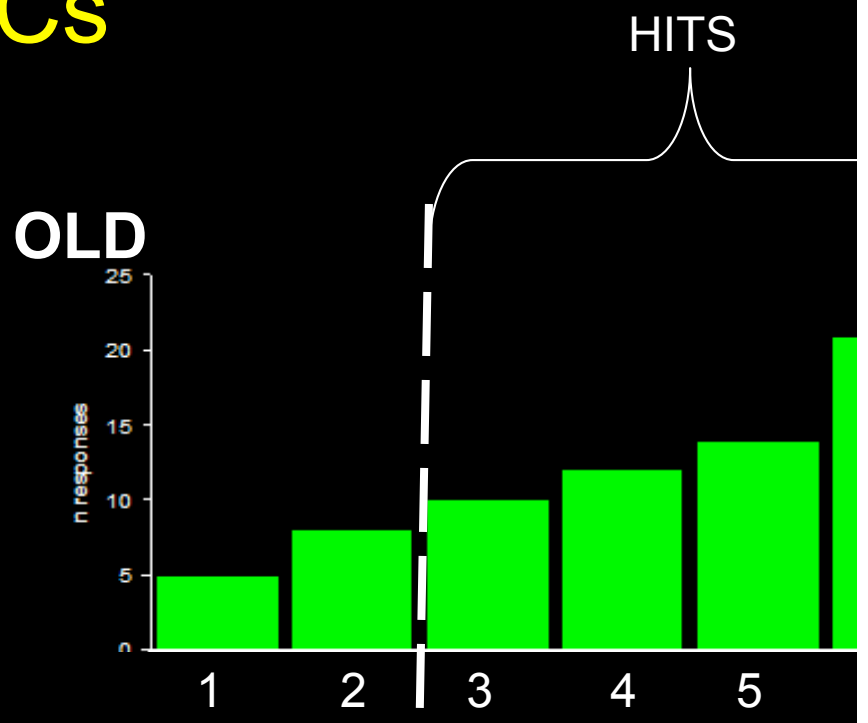
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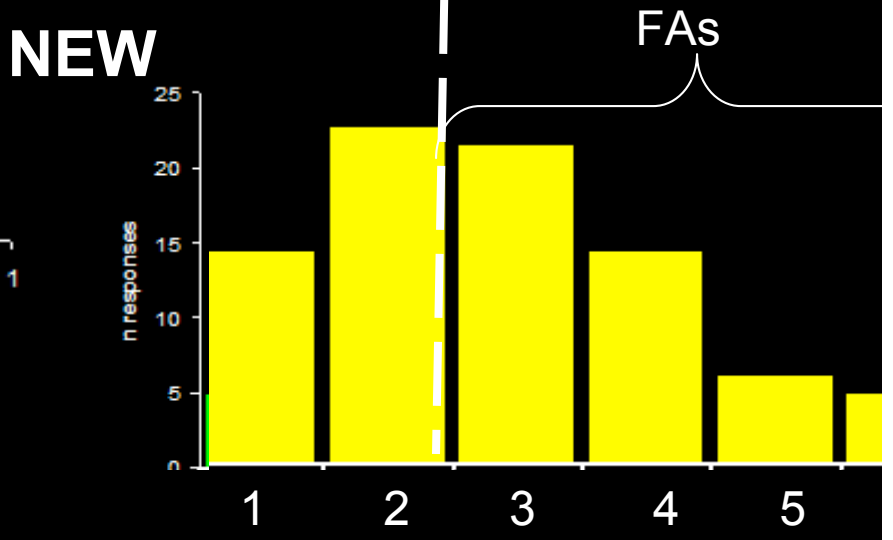
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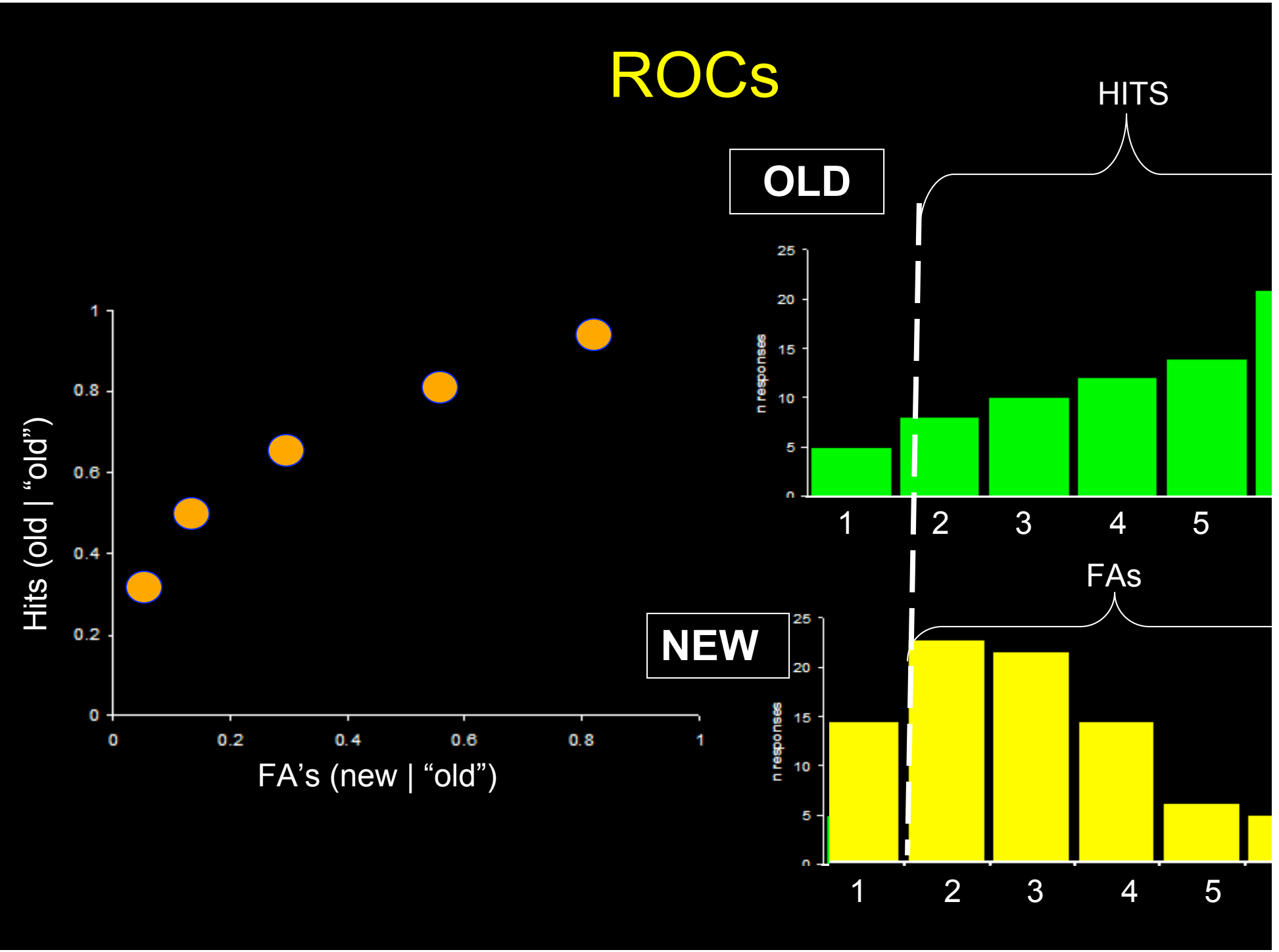
ROCs
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Hits (old | “old”)
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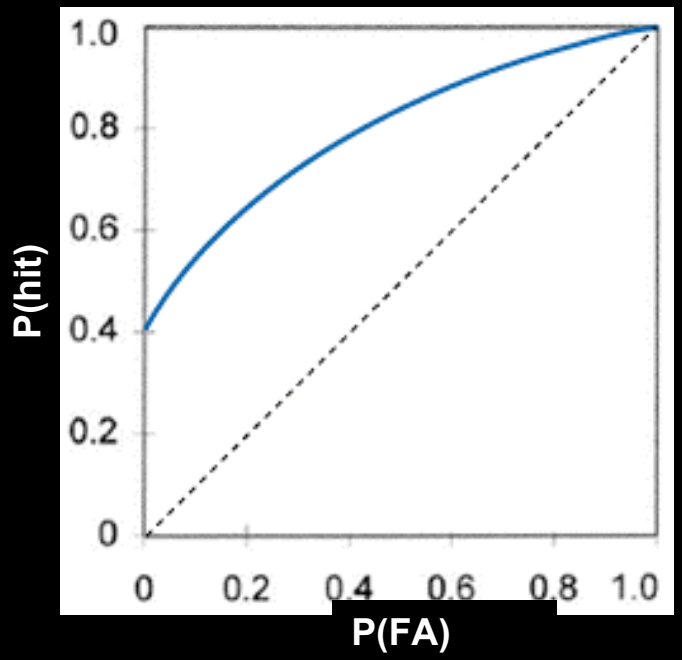
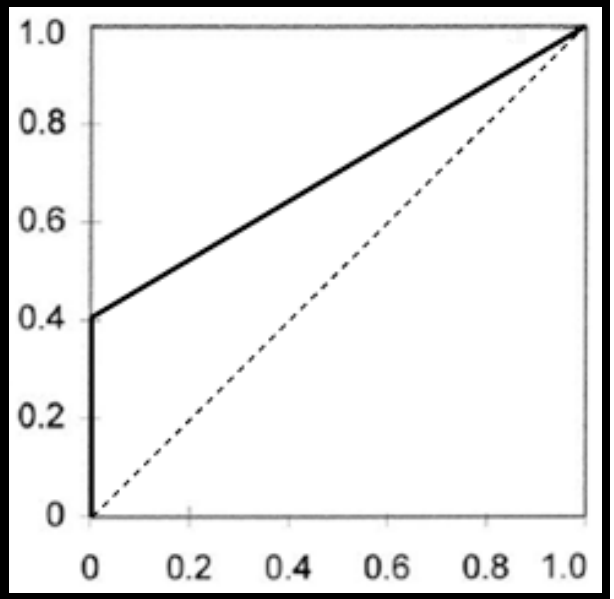
FA’s (new | “old”)

ROC Analysis of recognition memory data

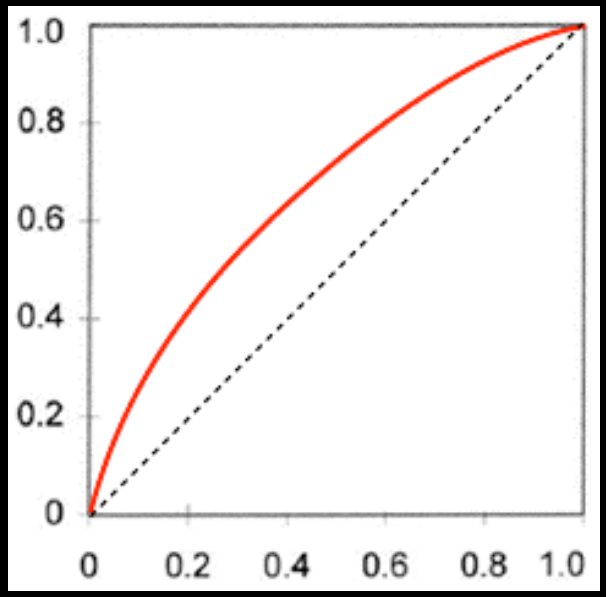
Overall Performance



Threshold Recollection



Continuous Familiarity

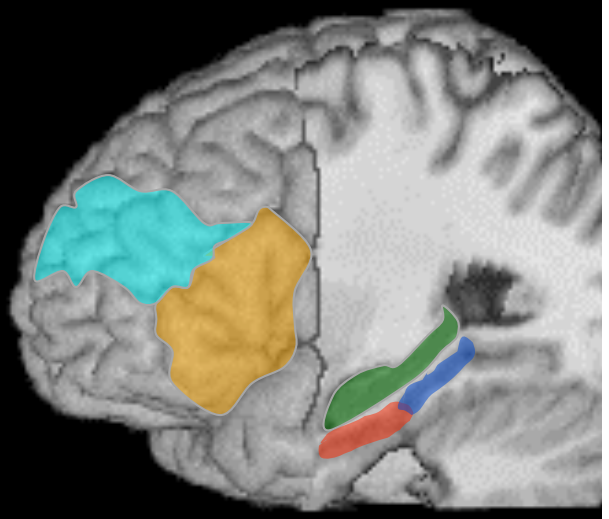


- Can also be derived by varying response criterion
- Familiarity and recollection components can be independently manipulated

Yonelinas (2001) *Phil Trans Roy Soc Lond* 3

Neural circuit: Medial temporal lobes

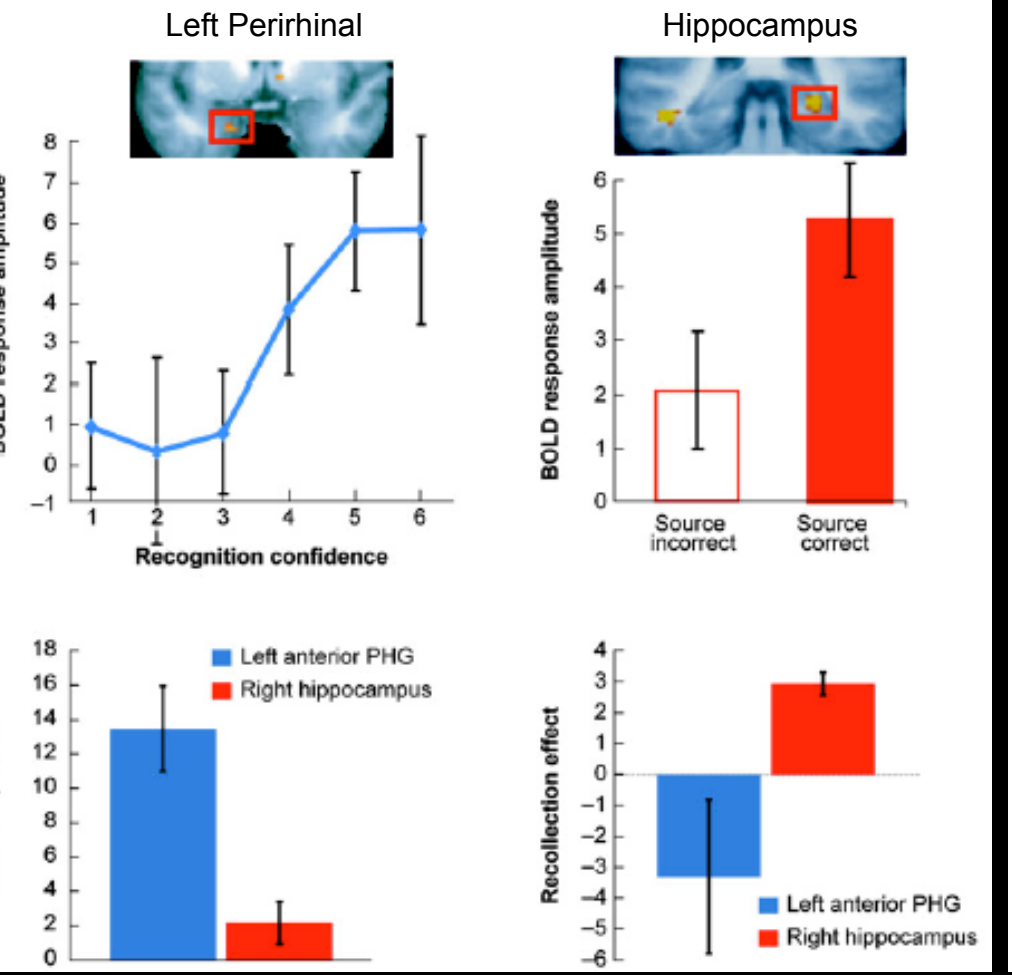
- Hippocampus linked to recollection/relational memory
- Perirhinal cortex linked to item familiarity

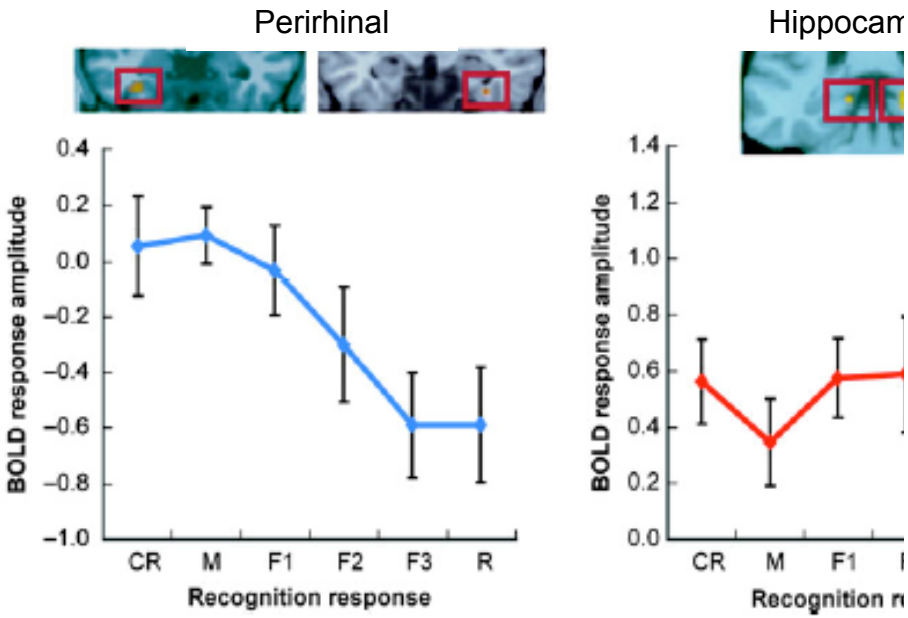


Double dissociations between recollection and familiarity

Encoding

Retrieval





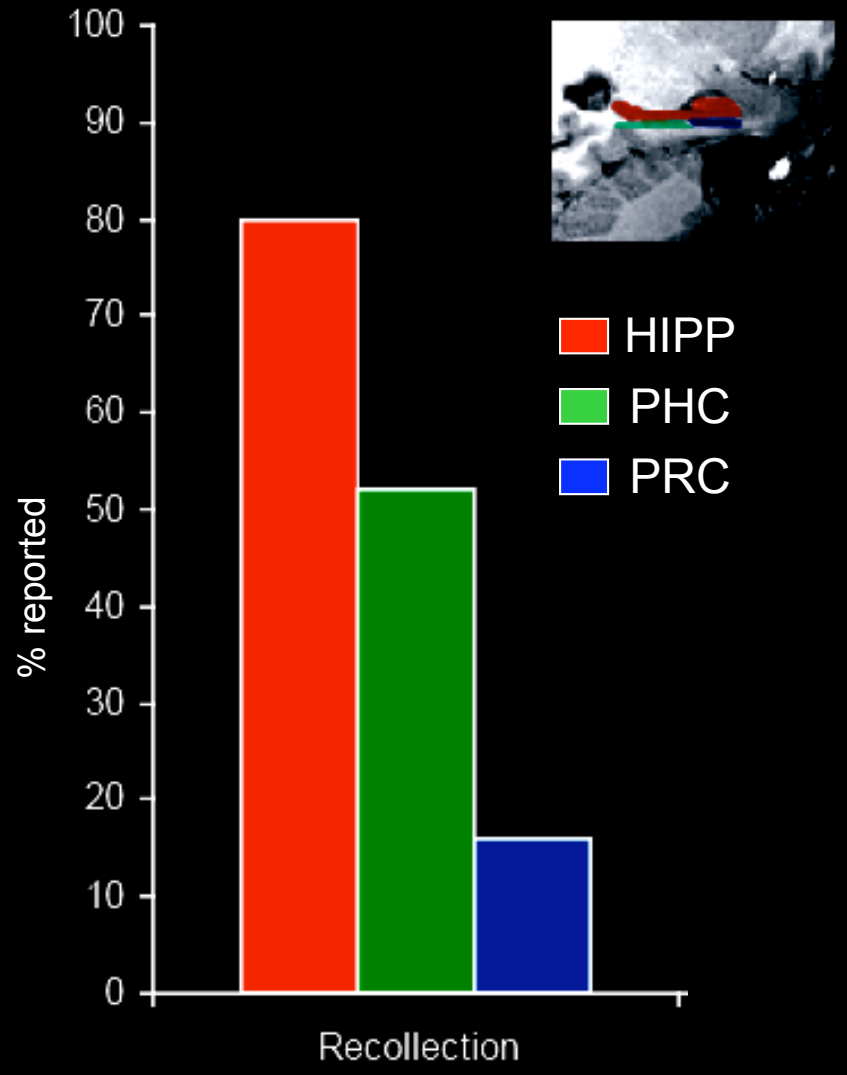
Ranganath et al., 2003

Montaldi et al., 2006

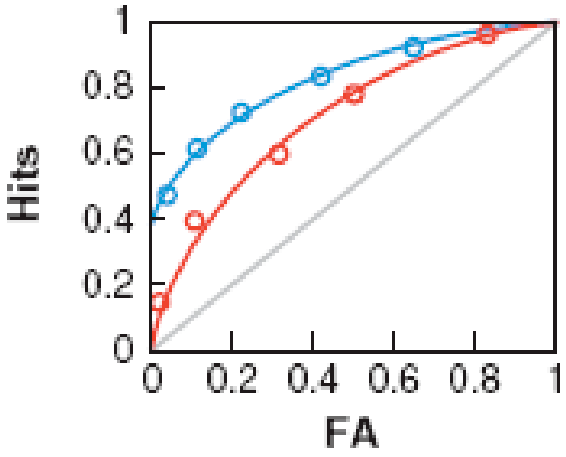
Dissociations between recollection and familiarity in the MTL

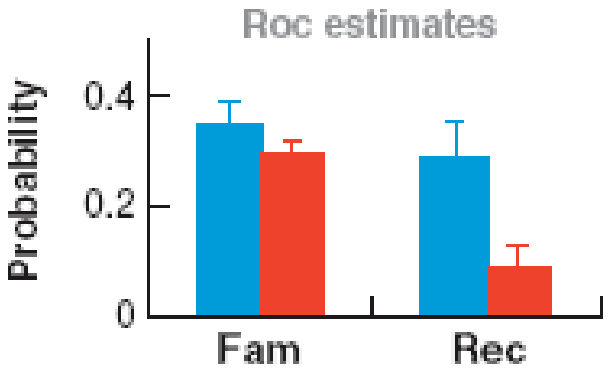
Diana, Yonelinas, & Ranganath,
Trends in Cognitive Sciences (2007)

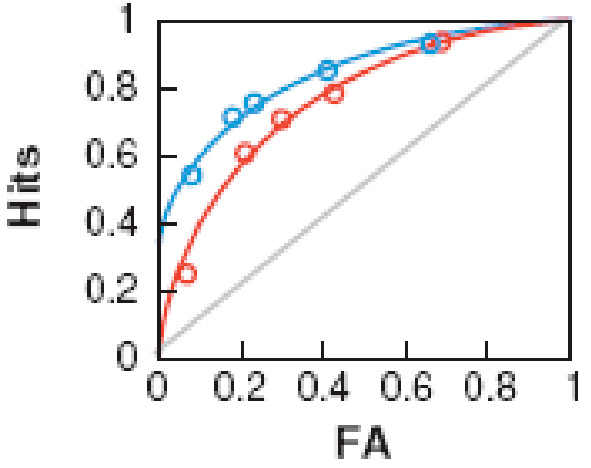
- Review of >20 FMRI studies examining neural correlates of recollection and familiarity

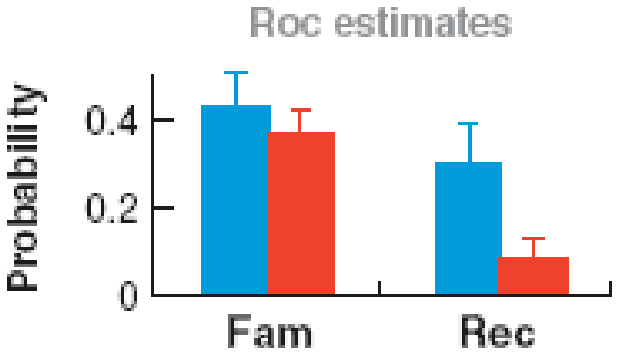


Convergence between human and animal models







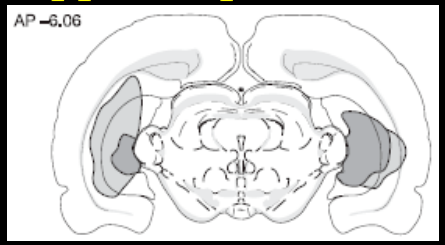


Yonelinas et al. (2002)
Nature Neuroscience

Patients with presume
hippocampal damage
due to hypoxia

Fortin et al. (2004)
Nature

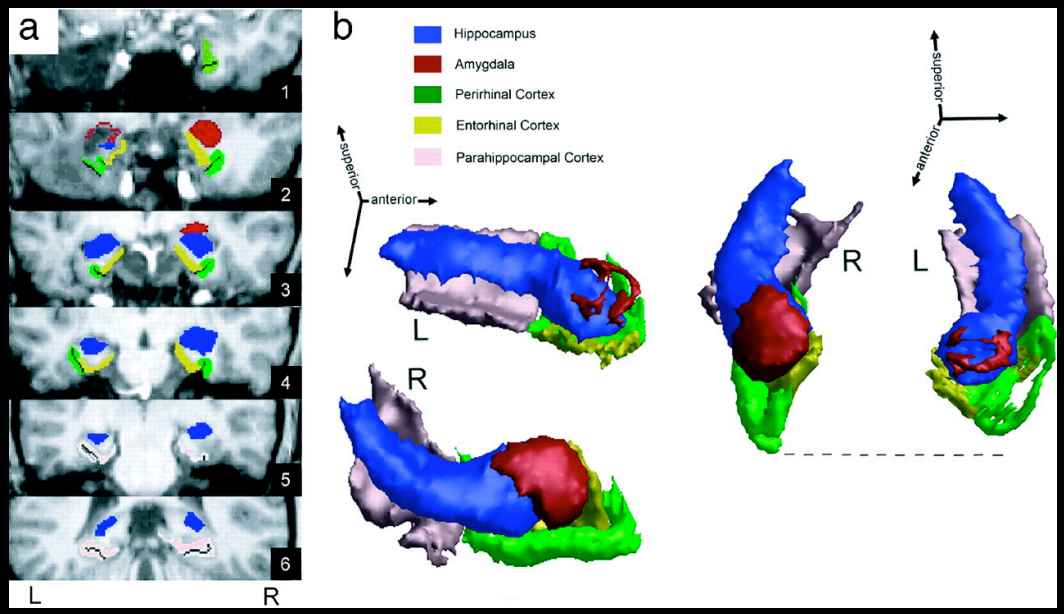
Rats with focal
hippocampal lesions

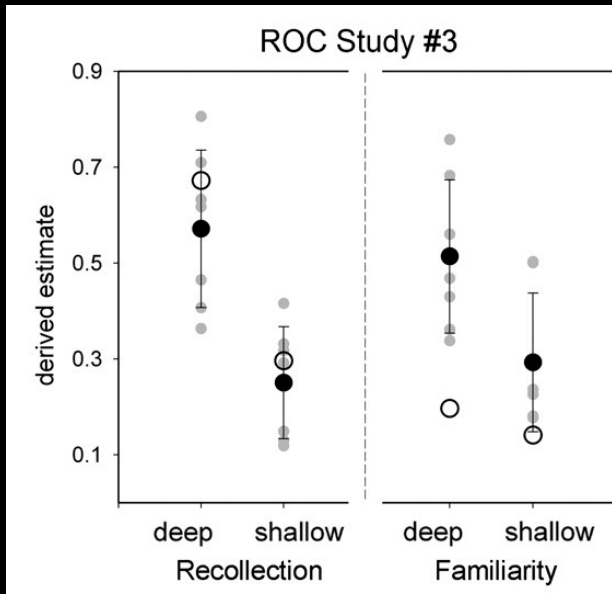


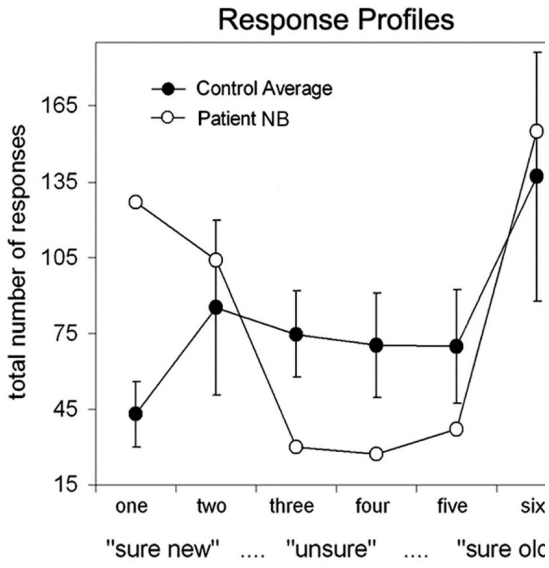
Perirhinal damage impairs familiarity discrimination but spares recollection

Bowles et al. PNAS (2007)

- Patient with left perirhinal lesion and intact hippocampus

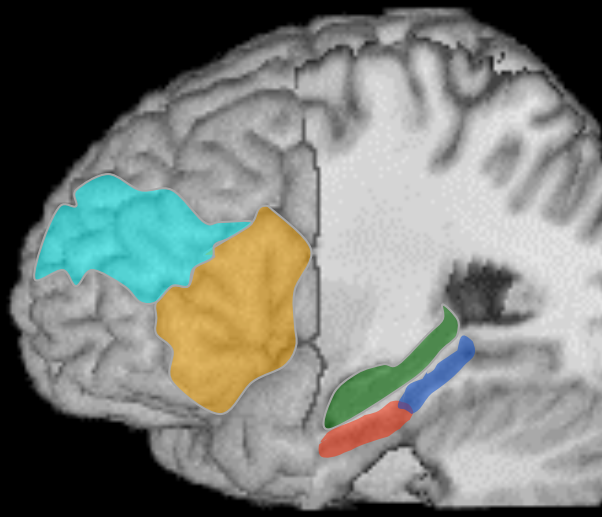






Neural circuit: Lateral Prefrontal Cortex

- Dorsolateral (DLPFC) linked to control processes that facilitate memory for relationships b/w items
- Ventrolateral (VLPFC) linked to processes that facilitate memory for item-specific and relational information

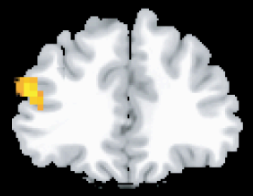


DLPFC activity predicts successful associative memory

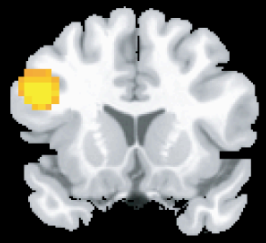
Murray & Ranganath (2007) J. Neuroscience

- Scanning during encoding of word pairs
- Activity averaged as a function of subsequent memory for association or items in each pair

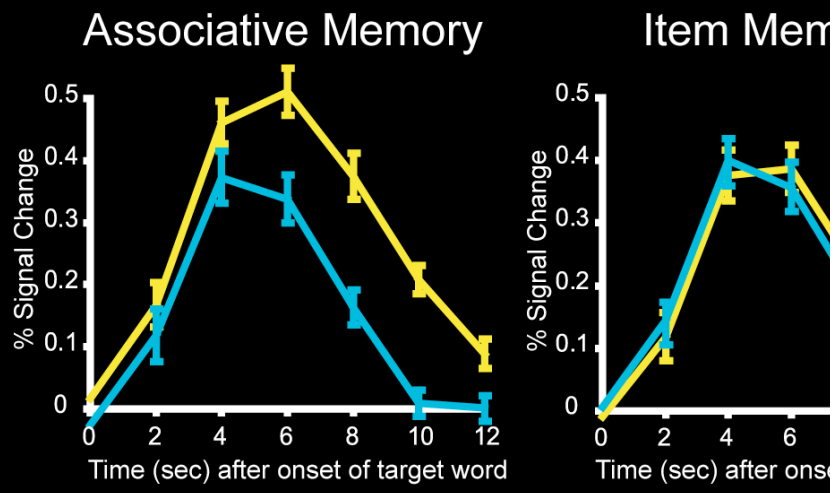
Linda Murray

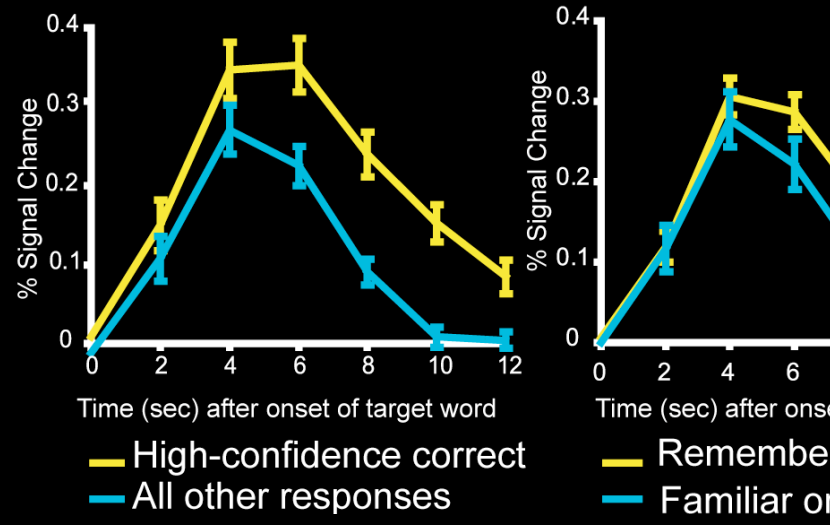


DLPFC
BA 46



VLPFC
BA 45/47





Connections to schizophrenia

- Item memory may be relatively preserved if patients are provided with an item-specific strategy during encoding.
  - Evidence for relative sparing of VLPFC functioning
- Relational memory may be disproportionately impaired in schizophrenia
  - Evidence for relatively impaired recruitment of hippocampus & DLPFC

Reinforcement Learning

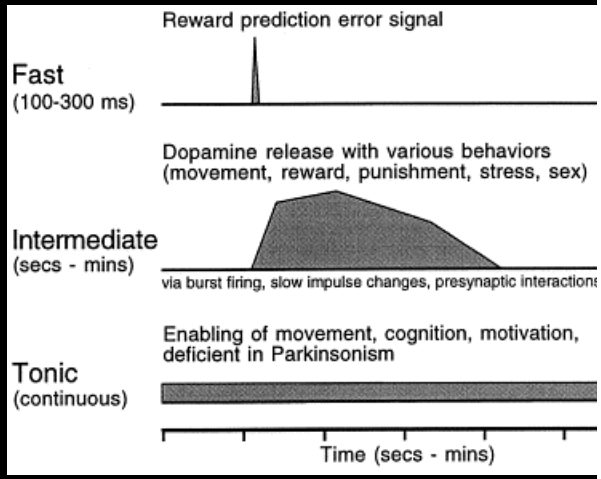
- Acquired behavior as a function of both positive and negative reinforcers, including the ability to:
  - Associate previously neutral stimuli with value
  - Rapidly modify behavior as a function of changing reinforcement contingencies
  - Slowly integrate over multiple reinforcement experiences to determine probabilistically optimal behaviors in the long run

Examples

- Associate previously neutral stimuli with value
  - Pavlovian conditioning
- Rapidly modify behavior as a function of changing reinforcement contingencies
  - Wisconsin Card Sorting Test
  - Reversal learning
- Integration over multiple reinforcement experiences
  - Effects of varying payoffs on response biases
  - Weather prediction task

Neural circuit

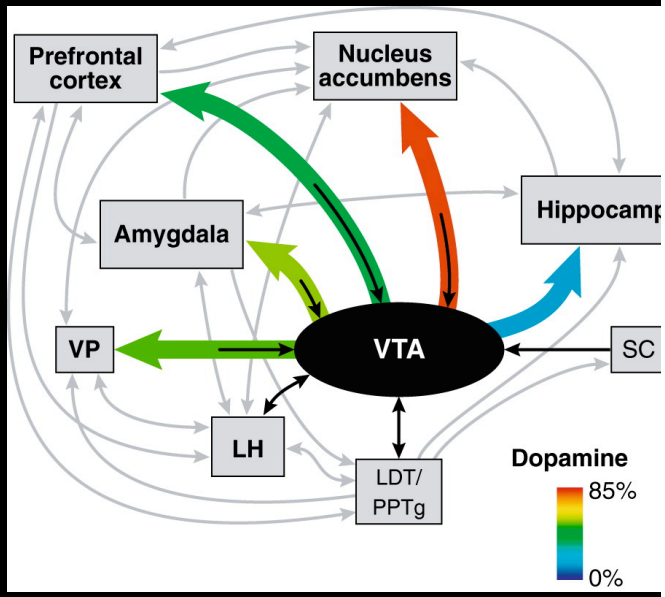
- Reward processing linked to dopamine (SN/VTA)
  - Reward value, likelihood
  - Reward Prediction Errors



Schultz (2002)

Neural circuit

- Reward processing linked to dopamine (SN/VTA)
  - Reward value, likelihood
- Other regions:
  - Ventral Striatum
  - Orbitofrontal cortex
  - Amygdala



Fields et al. (2007)

Summary

- Item and Relational memory
  - Easily measured in humans + animal models
  - Functionally and neurally dissociable
    - Item memory: Perirhinal Cortex
    - Relational memory: Hippocampus + DLPFC
  - Relational memory may be area of differential deficit
- Reinforcement learning
  - Easily measured in humans + animal models
  - Dependent on dopamine and on ventral striatum, orbitofrontal cortex, and amygdala