# Midterm 3 Review Session

Ava Momeni, Brandon Forys

PSYC 365

# Do you want to gain research experience?

The Motivated Cognition Lab is looking for motivated undergraduates who:

- are interested in emotions, attention, and coordination
- are curious about how we make sense of each other's experiences
- can volunteer up to 10 hrs/week

RAs will assist in collecting behavioural and physiological data, video coding/pose estimating, and data analysis. Prior experience is appreciated, but not required.

**To apply, please email a brief statement of interest, your resume and unofficial transcript to mmanaligod@psych.ubc.ca. Please include whether you are interested in data collection, video coding and/or data analysis. Interviews will take place on an ongoing basis. Applications will close on April 4.**

# Midterm 3: the material

- Anderson paper (for short answer)
  - Focus on what's said in class, tips document
- Classes 18-21 (for **40** multiple choice questions)
  - Reward and Attention
  - The Hippocampus
  - Episodic Memory
  - Rehearsing and Retrieving Memory
  - + Passingham Chapter 4

## Short answer questions

- Great job, keep it up!
- Keep using point form
- Study strategically, focus on what's covered in tips and in lecture

Anderson et al.

# Dopamine (DA)

- Produced by DA neurons in substantia nigra and ventral tegmental area
- Two forms of DA release:
  1. **Tonic:**
     - Wanting/seeking
  2. **Phasic:**
     - Prediction error
     - Expectation of reward
     - Incentive salience = when a cue acquires association with reward and triggers a feeling of wanting or craving

Tonic = slow and sustained DA release
Phasic = quick burst of DA release

## Anderson et al., 2016

- Value Driven Attention Capture
- Big Picture Question
  - What is the role of dopamine in attentional biases for reward (incentive salience)?
- Specific Question
  - What is the role of dopamine in maintaining attentional capture by reward cues even when they no longer predict reward?

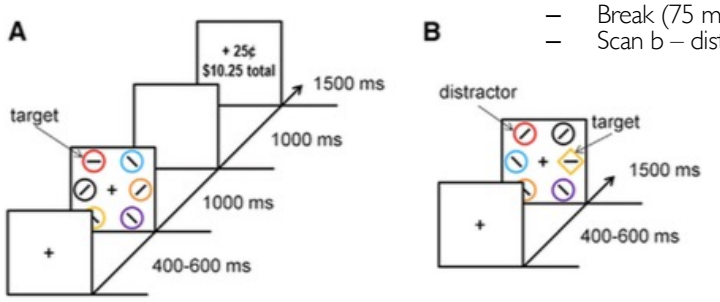
Article title: “the Role of dopamine in Value-based Attentional Orienting”

# Methods: Building an Attention Bias

- Participants
  - 20 healthy young adults
- Day 1: Training: Creates *incentive salience for certain colours*
  - Report orientation of bar in red or green circle
  - Specific colour predicts probability of either a high or a low reward

Day 2: Test Attention bias

- Inject with tracer
- Put in PET scanner
- Task: Report orientation in unique shape
  - Scan a – distractors present (60 min)
  - Break (75 min)
  - Scan b – distractors absent (60 min)

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On day 1, during the training phase:

- Participants were placed in the PET scanner, but no data was recorded. The researchers did this to match the context of the training day.
- Participants were asked to complete a **visual search task** in which they had to look for the target shape (i.e., a circle that was either red or green) and report the orientation of the bar inside the circle.
- The colour of the target circle predicted the probability of reward associated with it. One colour predicted a high probability of getting a high reward, and the other colour predicted a high probability of

getting a low reward.

On day 2, during the test phase [click]:

- Participants underwent PET scanning as they completed two versions of the visual search task, each in a separate scan session. In both versions, participants were told to look for a unique shape (i.e., the target) in a display of similar shapes (like a diamond among circles) and indicate the orientation of the bar inside the unique shape.
- **In the distractor present condition**, one of the shapes that was not the target had the same colour as what the participants have associated with either high-value or low-value reward (the distractors). However, in this task, the participants would not get any reward.
- **In the distractor absent condition,** no salient distractors were present.
- The researchers then used PET data to examine the participants' DA levels in the distractor present condition compared to the distractor absent condition.

## Anderson et al.

- Independent Variables
  - Training?
  - Test?
- Dependent Variables

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You should be able to come up with them as practice for the exam!

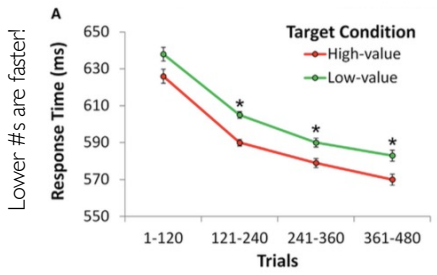
**Independent variables:**
Training phase: different levels of reward associated with specific colours
Testing phase: the two scan conditions

- Distractor present
  - High reward distractor
  - Low reward distractor
  - No distractor present
- No distractor present

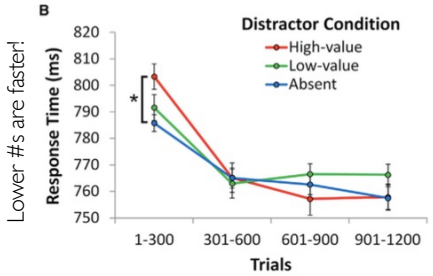
**Dependent variables:**
RTs, and DA availability (measured via Raclopride concentrations)

# Behavioural Results: Value Driven Attentional Capture (VDAC)

Training




Test




*Training: Faster RTS for high value targets with learning*
*Test: High value distractor RT > No distractor RT = VDAC*
*Result: Greater attentional capture (at first) by high value distractors*

Anderson et al., 2016

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[click]
During the training phase, participants were faster at identifying the orientation of the bar in the high-value targets compared to low-value targets, which is an index of appetitive conditioning. Note that in the training phase, participants were directly earning reward.

In the TEST phase, in the first 300 trials before they learned that there was no reward related to the distractors (extinction), they were SLOWER to find the target when there was a high value distractor compared to when there was no distractor (no effect of low value).

[click]
This indicates that there **was greater attentional capture (at first) by high-value distractors** which acquired INCENTIVE SALIENCE.

# Value-Driven Attentional Capture (VDAC)

Previously Rewarded Colour (Distractor)


You


*If you're more distracted by the previously rewarded colour, you will be slower to report the orientation of the bar in the target shape*

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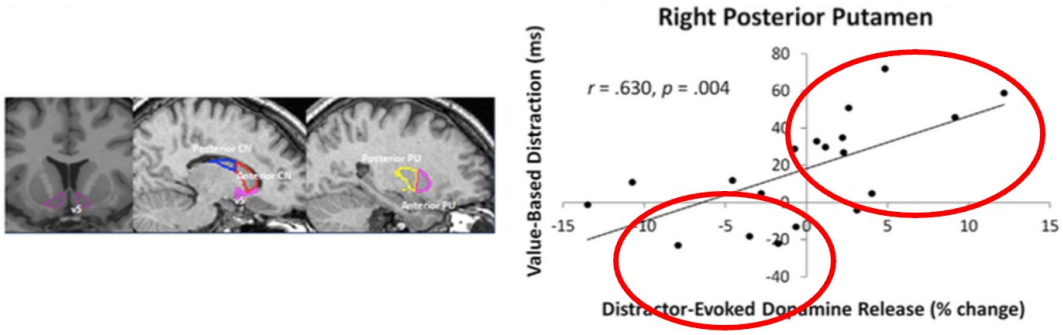
VDAC is a form of reward-biased attention. It is a measure of incentive salience. You can't help but pay attention to the cue that you've learned to associate with reward (just like bottom up attn). It's attentional capture because is NOT relevant to your task goals (tell the orientation of the bar in the unique shape**),** yet you can't help but pay attention to it**.**

## Individual Differences in DA release




*Group 1: More VDAC & more DA release in scan with distractors,*
*Group 2: No or negative VDAC & less DA release in scan with distractors*

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Y-axis = difference in response times in the distractor-present trials compared to distractor-absent trials.

- Positive values indicate slower response times for high-value distractor-present trials.
- Negative values indicate slower response times for distractor-absent trials.

X-axis = difference in DA release in distractor-present trials compared to distractor-absent trials.

- Positive values indicate more DA release in distractor-present trials.
- Negative values indicate more DA release in distractor-absent trials.

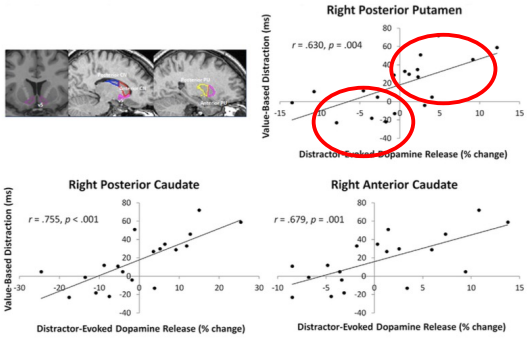
Researchers found that for some participants, there was more DA release in the distractor-present trials, and for others, there was more DA release in the distractor-absent trials. They examined this finding by splitting participants into 2 groups.

[Click]
In the high bias group, participants showed more DA release and slower RTs in the distractor-present trials, indicating more attentional capture.

In the low-bias group, participants showed less DA release and faster RTs in the distractor-present trials, indicating less attentional capture.

This suggests a dissociation between groups: strong value-driven attentional capture is associated with elevated levels of  DA release, whereas the ability to *ignore* previously reward-associated stimuli is associated with less DA release.

# Individual Differences in DA release

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AND this pattern was seen in 3 regions in the right posterior caudate and right anterior caudate:

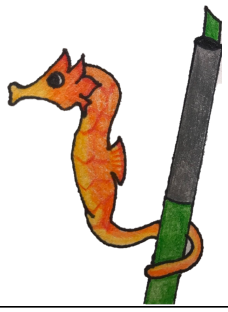
These regions are linked to voluntary motor behavior, habits (learning and using) and motivation related to getting good things.

Caudate tail projects to visual cortex and modulates activation to prioritize attention to rewarding cues.

# Anderson Summary

- Attention is captured by objects that previously predicted reward, even when they no longer do
- People who are more captured by cues of past reward show more DA in the dorsal striatum in the presence of reward cues
- Those who are not captured show less DA in the presence of reward cues:  Maybe they suppress?
- DA signaling in dorsal striatum is important for involuntary motivated attention linked to addictive behaviour.

# Class 19 Highlights



# Memory Systems

**Implicit (Unconscious)**

- Procedural Memory
  - Performance of skilled action
- Conditioning
  - Automatic, emotional responses cued by environmental stimuli
- Priming
  - Exposure to stimuli biases future behaviour

**Explicit (Conscious)**

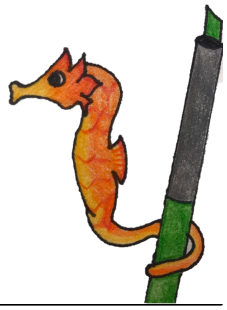
- Semantic
  - Accessible facts
- Episodic
  - Experiential, temporal recollection of events
- Autobiographical
  - Recollection of events that occur in one's own life
- Prospective
  - Related to future performance or actions

# Hippocampus (HPC) Deep Dive

- HPC is vital for episodic memory
- Generates cognitive representations, recollection, and imagination
- Connections to the entorhinal cortex (EC) and Visual Cortex (VC)

## Cognitive Maps and Schemas

- **Cognitive Map Hypothesis:** the idea that the brain builds a representation, or mental map, of the spatial environment to support memory and guide future action
  - Cognitive maps often focus on relevant details
  - Generated based on required information and attentional filtering
- **Schema:** a mental script based on previous experiences that helps filter new stimuli and process expectations



The hippocampus plays a key role in creating **mental maps**.

# Examining Humans

- HM demonstrated the importance of the HPC in episodic memory
- Cognitive maps have been observed in human navigational patterns
  - Use of landmarks allows humans to relate internal maps to sensory info
- Taxi drivers have been the focus on navigational studies
  - Shown to have increased grey matter in the posterior HPC

Landmarks are key in determining where you are within your cognitive map and your relationship with other areas.

Landmark integration is facilitated by the PPA, which helps with scene analysis.

To become a licensed London taxi driver, candidates must pass an intensive test called **"The Knowledge,"** which requires memorizing thousands of streets, landmarks, and potential routes across London. This process can take several years of training and practice.

PPA = parahippocampal gyrus

## Spiers & Maguire, 2006

2 RQs

- When is the HPC most relevant or active?
- What specific processes is the HPC primarily involved in?

Methods

- fMRI was performed on taxi drivers while they navigated a VR landscape in response to customer prompts.
- Results were measured in blocks: initial navigation, coasting, and destination change.
- Post scanning, drivers reported their thoughts at every point of the journey.

## Results

- HPC activation during initial route planning, and customer switch
  - Largest increase was shown for initial planning
  - Activation was not related to landmarks or spontaneous changes to the route
- HPC deactivation during irrelevant comments.

# Fernandez-Velasco and Spiers - Wayfinding

- Diverse forms of navigation systems exist, based on. features of nature
  - Beyond maps and beyond WEIRD populations!
- Information could be coded in relation to the first-person perspective

| Technique | Example populations |
|---|---|
| **Environmental Cues** | |
| Stars | Gwich'in |
| Waves, Ocean Swell | Marshall Islanders |
| Landmarks, Street names | Londoners |
| **Systematized Knowledge** | |
| Inland stellar wayfinding | Gwich'in |
| Landscape directionals | Inuit |
| The Knowledge | London taxi drivers |
| **Visualization Techniques** | |
| Projecting Constellations | Gwich'in |
| Imaginary Landmarks | Micronesian navigation |
| Birds eye view, in-street view | London taxi drivers |
| **Cognitive Artifacts** | |
| Stick charts | Marshall Islands |
| Tactile maps | Inuit |
| London A-Z (street maps) | Londoners |

Studies of navigation in traditional cultures were reviewed.

# Takeaways

- London taxi study: the HPC is most relevant in navigational planning, compared to changing routes or coasting
- Wayfinding: Traditional cognitive science has overlooked:
  - Non-visual senses
  - Visualization techniques
  - The role of language and naming
  - The role of navigation tools/artifacts
  - The role of culture and local knowledge

# Tips!

- Don’t forget to go through Passingham Chapter 4
  - Check out information on scene processing, the taxi driving studies and neuroanatomy
- Try walking through your short answer with another being
  - When explaining studies, focus on creating a full story
  - How easily would this person (or pet) be able to walk someone else through the study?

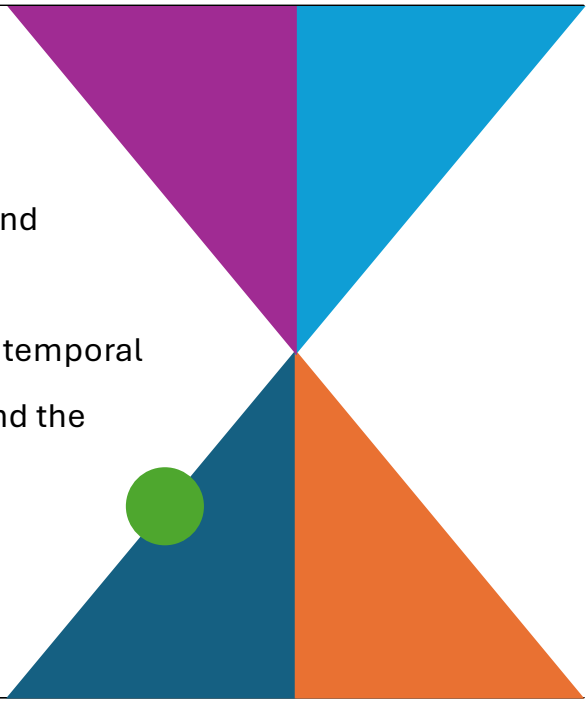
# Questions for Thought

- Can you give an example of each type of implicit and explicit memory?
- What role does each process play in creating a cognitive map?
- How does route planning play into the abilities of the HPC?
- In the London taxi driver study, what is the HPC responsible and not responsible for?

Clive Wearing,
Amnesia, episodic
memory and the self

## Learning objectives

- Give examples of both retrograde and anterograde amnesia
- Evaluate effects of extreme medial temporal lobe damage on episodic memory and the sense of having a self



## Amnesia

- Retrograde amnesia: patients cannot recall events in their lives that occurred prior to some critical event that affected their brain
- Anterograde amnesia: a failure to form new memories after the critical event.

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## Stages of memory

1. Encoding: Initial perception of event (attention, perception)
2. Consolidation: Strengthening memory over time (synaptic ->hours and systems level -> months, years)
3. Retrieval: Calling the memory back up later
4. Reconsolidation: Changing the memory once it's retrieved. Allows us to update our memories and create false ones.

# Affected brair

**HIPPOCAMPUS**

Important for both the space

**TEMPORAL LOBES**

Contains grid cells for

## Summary

**Retrograde amnesia**

- No episodic recall
- Some semantic recall
- Procedural memory intact

**Anterograde amnesia**

- No episodic encoding
- Some semantic encoding
- Some procedural encoding

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# Overarching messages

1. The case of Wearing is an argument for **different memory systems**.
2. He has retrograde and anterograde amnesia for episodic memory. This is highly disruptive on his sense of self.
3. His acquired implicit procedural knowledge is intact, he can also learn some new skills.
4. His semantic knowledge is somewhat intact, especially the ones with a lot of emotional associations.

Loss of significant brain regions due to encephalitis

Bird et al.

# Bird et al.: Memory Reinstatement

- Is the role of reinstatement in memory consolidation just passive?
- Or does active rehearsal help?

# Memory Consolidation: Passive vs. Active

- Big Picture Question: What roles do active rehearsal and prior knowledge (schemas) play in episodic memory consolidation?
- Research Questions
  1. Does active rehearsal influence memory durability?
  2. Do stronger patterns of neural similarity between encoding and rehearsal – reinstatement - in episodic memory nodes lead to more detailed memory?

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Again, this is a paper where they have research questions rather than directional hypotheses.
RQ1. Does actively recalling a memory over and over influence how long/well a memory lasts.
RQ2. If reinstatement, or the pattern of brain activity during rehearsal of memories is more like it was during encoding, will this lead to more detailed memory later on?

# Two experiments

**Goal of Experiment 1 (Behavioural)**

- Investigate effect of active rehearsal on durability of memories

**Goal of Experiment 2 (fMRI)**

1. Identify whether they see reinstatement of BOLD activity when remembering unique videos.
2. Does the strength of this reinstatement when the memories are being actively rehearsed predict how well the video will be remembered later

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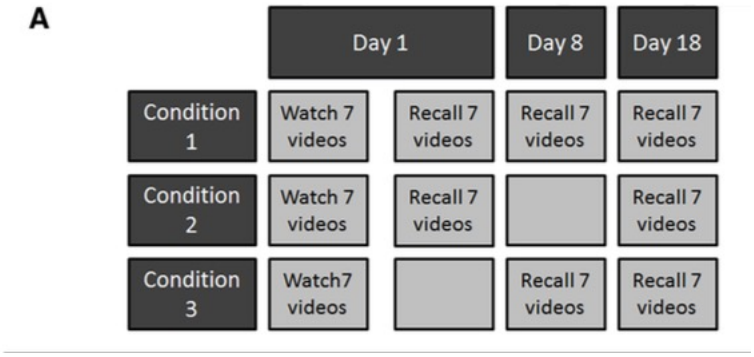
1. **Durability**: How well they hold up over time. 2. **Trial unique** – it means they saw a different video in each trial of the task. Now we're going to try an exercise to illustrate how the authors addressed their research questions. So please roughly organize yourselves into pairs and have some way of jotting down information handy.

# Experiment 1

Investigate effect of active rehearsal on memory "durability"

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This was a within subject design, so every participant saw 7 videos in each of the 3 conditions on the first day and had to recall different combinations of videos on a second and third testing day.

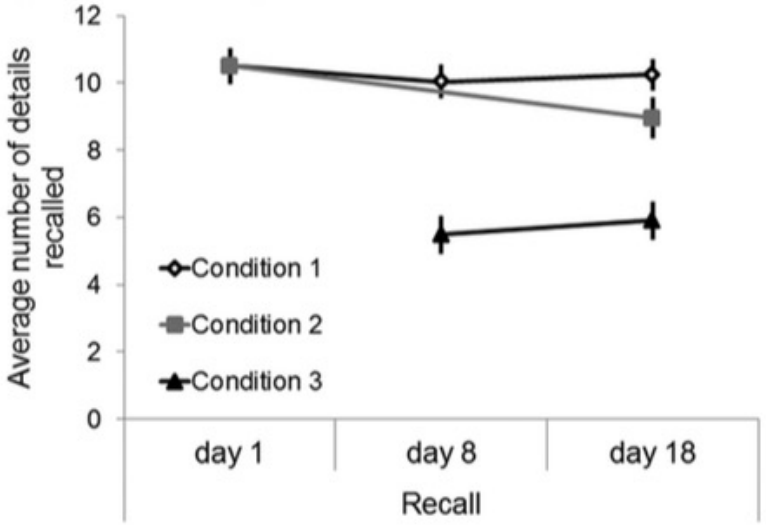
- On day 1, after ~5 min, they recalled the videos in conditions 1 and 2.
- On day 8, participants recalled the videos in conditions 1 and 3.
- On day 18, they recalled the videos in all the 3.

**How was memory recall measured?**

- Participants were shown the title of the video and asked to verbally describe the video in as much detail as possible.

•First, the researchers identified a number of details that were consistently recalled for each video and used them to create a checklist to help them score.
•Participants were scored on the number of correctly recalled details.

## Experiment 1 Results




*2x as many details remembered for details rehearsed on day 1 than not rehearsed!*

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•On day 1, the number of details recalled for the videos in conditions 1 and 2 was identical.
•On day 8, the number of details recalled was higher for the videos watched in condition 1 than in condition 3.
•On day 18, the number of details recalled was the highest for the videos watched in conditions 1 (rehearsed on days 1, 8, and 18). It was a little bit better for the videos watched condition 2 (rehearsed on days 1 and 18). It was the worst for the videos watched in condition 3 (rehearsed on days 8 and 18) - they are doing half as well. [click]

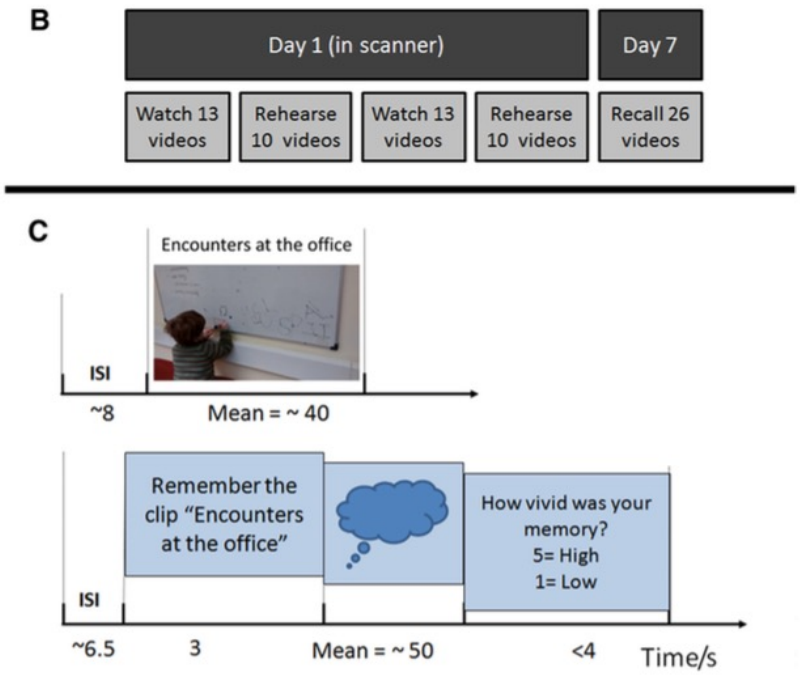
•So rehearse it right away or lose it!

They also looked at the degree to which the details recalled by each participant were similar across sessions relative to the details recalled between different participants. They found that for each participant, details across sessions were highly consistent (r = .79), whereas details between participants were much less so (r = .27). This was not only the case for correctly recalled information but also for incorrect details.

The authors wondered if that was an example of semanticization. For example, one participant falsely recalled a kiss between two characters when tested on day 1, and then repeated this on day 8.

Semanticization is when general knowledge is pulled out of repeatedly rehearsed events (stored separately) - resulting in semantic knowledge that is independent of the knowledge of how it was learned (episodic knowledge).

# Experiment 2

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On day 1, 26 videos were watched, and 20 of these were silently rehearsed in an MRI scanner. The watching and rehearsal phases were divided into two runs.

The rehearsal phase used a cued recall paradigm, with the video title serving as the rehearsal cue. Participants were instructed to spend approx the same amount of time rehearsing the video as the video had originally lasted. After rehearsal, participants pressed a button to indicate end of rehearsal. Then, they rated how vividly they could remember the video on a visual analog scale from 1 to 5.

A week later, all 26 videos were recalled without scanning, and participants' correctly recalled details were scored.

- Participants?
- Independent variables?
- Dependent variables?

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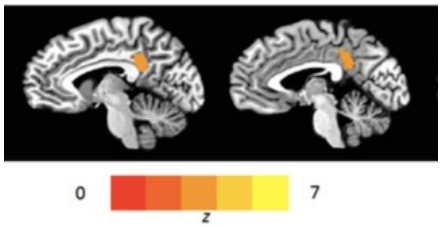
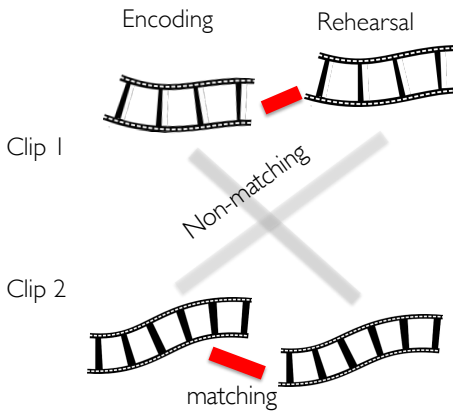
**Talk to your neighbor.**
- Independent variables: how many videos to recall when
- Dependent variables: degree of BOLD reinstatement

# Posterior cingulate: Fleshing out memory detail




*Strength of the correlation between voxels between encoding and rehearsal for each video clip predicted memory detail1 week later as well as in-scanner vividness*




Bird et al, 2015

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FOR each Video, the more correlation between PCC activity at encoding and rehearsal was for a particular video, the more vivid the rehearsal was rated and the better the memory was recalled one week later.

In RSA, the researchers do a decoding of the brain activity by looking at patterns of activation across voxels in a region of interest to discover how similar the patterns of activations are in one condition versus another. Then, they read out the distance in representational space.

## Summary

- Successful consolidation of video content depended on rehearsal shortly after encoding
- Reinstatement of BOLD patterns in episodic memory nodes was associated with active rehearsal
- Rehearsal: Does it speed up semanticization process?
- Posterior Cingulate Cortex: Crucial role in active memory consolidation
  - Integrates semantic and episodic information into a schema

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**2.** Reinstatement of BOLD patterns in episodic memory nodes (i.e., HPC, PCC, retrosplenial cortex, precuneus) was associated with active rehearsal. This suggests that rehearsal strengthens episodic processes alongside semanticization.

**3.** Evidence for **semanticization:** participants' descriptions of each video were similar across recollections, suggesting that perhaps rehearsal speeds up the semanticization process.

**4.** The researchers found that the PCC is crucial in active memory consolidation via interrogating semantic and episodic information into a schema.

- So, the videos depicted an unfolding sequence of actions that must be interpreted with reference to prior knowledge or "schemas" to create a coherent representation of the whole event.
- Support for this conclusion was the descriptions of the videos frequently

referred to external information (for example, one video was described as being “like the film ‘Twilight,’” and in another, a character was described to have acted “like James Bond”).

# Take-Homes

- Memory reinstatement – passive and active – is a key component of memory consolidation.
- Memory rehearsal allows reinstatement of representations to contribute to memory detail in wakefulness as well as sleep
- This involves reactivating patterns of activity in brain regions, including hippocampus/MTL/PCC, that were active during encoding
- The PCC plays a key role in reinstatement of memory vividness & detail


1. And that's for complex events unfolding in time, not just static images.

Best of luck on the midterm!