Declarative Memory Consolidation and Sleep

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Cognitive Psychology
Psych 200
January 13, 2011

Longterm Memory

- Declarative Memory: Memory for facts, information, and events
- Procedural Memory: Memory for skills, habits, and conditioning

Traditional Memory Models

- Short Term Store
- Long Term Store

Current Memory Models

- Short Term Store
- Consolidation
- Long Term Store

After initial acquisition, memory remains in a weak or malleable state, susceptible to loss due to interference or decay

Consolidation: the process by which memories are strengthened and stabilized, increasing resistance to interference and decay

Why Sleep?

Absence of Sleep
- Impaired working memory
- Decreased arousal
- Increased RT to stimuli
- Real-world consequences
  - Car accidents
  - Comair Flight 5191 crash
  - Exxon Valdez oil spill

Absence of Sleep
Why Sleep?

- Proposed mechanism of consolidation: Offline processing
  - Your brain “works on” information without any effort by you
- Sleep provides a physiological state during which offline processing can occur

Consolidation of declarative memory during sleep

Procedure: Paired Associates Task

- Participants studied 40 word pairs
- Cued Recall Test – 40 word pairs
  Feedback given on every trial
  Error
  Correct response
- Trained to criterion: 60% correct
- Delayed cued recall test – 12 hours after training

Design

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>9:00</td>
</tr>
<tr>
<td>Wake</td>
<td>Sleep</td>
</tr>
<tr>
<td>Study Test I</td>
<td>Study Test I</td>
</tr>
<tr>
<td>Wake to Criterion</td>
<td>Wake to Criterion</td>
</tr>
<tr>
<td>21:00</td>
<td>9:00</td>
</tr>
<tr>
<td>Test II</td>
<td>Test II</td>
</tr>
</tbody>
</table>

Recall Performance

- No Evidence of Circadian or Diurnal differences in performance

- Recall of information is **better** after sleep than it was prior to sleeping
- This effect is specific for an interval that includes sleep
- No improvement is seen after waking
A Memory Test....

Declarative Memory and Sleep

- Sleep improves recall of paired associates
- This effect is specific for an interval that includes sleep
  - No improvement is seen after waking
- Does sleep simply strengthen a memory trace?
- Can sleep change the way that a memory is stored or the ability to use a memory?

Recall...

Did you see the word snooze?

Did you see the word dream?
Did you see the word lamp?

Did you see the word sleep?

The List

- Bed
- Rest
- Awake
- Tired
- Dream
- Wake
- Snooze
- Blanket
- Doze
- Slumber
- Snore
- Nap
- Peace
- Yawn
- Drowsy

If you remembered seeing the word Sleep then you experienced a false memory

Does sleep affect the formation of false or illusory memory?

False Memory and Sleep

- Sleep may promote associative generalization
  - Increased false memory
- Sleep may consolidate or strengthen true memory or prune false memory
  - Reduced false memory

3 Studies with sleep manipulation

- DRM lists presented either Visually or Auditorally
- Visual recognition test
  - Studied items
  - Critical Lures
  - Unrelated Lures
- Correct memory
  - Critical Lure
  - Studied items
  - Critical Lures
  - Unrelated Lures

SLEEP

- Bed
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- Tired
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- Peace
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Correct memory

(Studied items)
False Memory and Sleep in the DRM Paradigm

- Sleep reduces false memory without corresponding reduction in correct memory
- Sleep may be enhancing memory for the source of the information

Misinformation Effect

**Procedure**

I. Study
Ss watch film of two-car accident.

II. Misinformation
Ss estimate speed of cars when the cars ...

a) “smashed into each other” or
b) “hit each other”

1 week later: “Did you see broken glass?”

<table>
<thead>
<tr>
<th>“smashed” Ss</th>
<th>“hit” Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>% yes (incorrect)</td>
<td>32%</td>
</tr>
</tbody>
</table>

(Loftus & Palmer, 1974)
Misinformation and Sleep

- Procedure
  1. Video of robbery
  2. Misleading information
  3. Recognition test
     - Appeared in the film
     - Appeared only in questions (suggested memory)
     - Unrelated lures

- Two factors
  - Retention interval
  - Timing of misinformation

Two factors
- Retention interval
- Timing of misinformation

Misinformation and Sleep

- Sleep can have both positive and negative effects on memory
- Sleep can protect memory from reconstruction
  - When misinformation occurs after sleep, participants are better able to identify studied information and reject suggested information
- Sleep may increase false memory and increase memory reconstruction
  - When misinformation occurs prior to sleep, false information may get consolidated with veridical memory

If sleep can increase resistance to misleading information, will sleep deprivation decrease resistance?
Sleep Deprivation

- Reduces working memory capacity
- Reduces frontal lobe function
- May reduce ability to acquire information

Memory Susceptibility and Sleep Deprivation

- Procedure
  1. View pictures that depict a story
  2. Misleading information
     - Read sentences that tell the same story, with false information
  3. Multiple choice test
  4. Source test

- Independent Variable
  Sleep vs. Sleep deprivation

Source Test

- I saw it in the pictures only
- I saw it in the narrations only
- I saw it in both and they were the same
- I saw it in both and they conflicted with each other
- I guessed

Correct memory for story elements

False memory for suggested information
“Robust” False Memory

- I saw it in the pictures only
- I saw it in the narrations only
- I saw it in both and they were the same
- I saw it in both and they conflicted with each other
- I guessed

Memory performance is worse after sleep deprivation
Correct memory for studied information is lower than after a full night of sleep
Sleep deprivation increases susceptibility to misleading information

Overall: Sleep and Memory

- Sleep can improve declarative memory for studied information
- In some cases, sleep may also decrease false memory or increase resistance to misleading information
- Sleep deprivation decreases memory performance for studied information
- Sleep deprivation increases susceptibility to misleading information

Sleep is important. Study early. Do NOT pull an all-nighter before an exam! You will perform worse.

Memory Susceptibility and Sleep Deprivation

- Memory performance is worse after sleep deprivation
- Correct memory for studied information is lower than after a full night of sleep
- Sleep deprivation increases susceptibility to misleading information

Thank you