Cognitive Principles of Learning and Memory

Lise Abrams, Ph.D.
Professor & Chair
Department of Psychology
abrams@ufl.edu

Goals of this Workshop

- To help students learn more effectively in class
- To help students study what they have learned more effectively

Why Learning Can Be Difficult

- PROBLEM:
  - “When I'm listening in class, it all makes sense (so I don't need to write anything down)”
  - Why this is a problem:
    - Long-term memory is good at retaining the gist, not the details
- SOLUTION:
  - Encourage students to take good, comprehensive notes, which become the basis for their subsequent studying

How to Encourage Good Notetaking

- Get students to actively participate
  - Ask questions, do demos, have them read before class
    - Get them to critically analyze the information you are covering
- Notetaking strategies
  - Have them take notes in their own words, rather than just regurgitating yours from short-term memory
  - Incorporate notes from the book into lecture notes
  - Taking notes by hand vs. on a laptop (Mueller & Oppenheimer, 2014)

Why Studying Can Be Difficult

- “There is too much material, so I can't possibly study everything.”
- “When I’m studying, I feel like I know the material.”
- “I studied SO MUCH, but I still didn't do well on the exam.”
How to Study More Effectively

- What to do:
  - Elaborate
  - Test
  - Organize
  - Take breaks
  - Use variable encoding

Get Students to Elaborate

- Elaborate
  - Associate what they are learning with other things they have stored in memory
    - Levels of processing theory
      - The depth at which we process information during encoding determines how well we recall it (Craik & Lockhart, 1972)
        - Shallow vs. deep processing

Levels of Processing Theory

- Craik & Tulving (1975)
  - Presented nouns one at a time, and one of three types of questions:
    - Shallow processing: Is the word in capital letters?
    - Less shallow processing: Does the word rhyme with _____?
    - Deep processing: Does the word fit in the sentence...?

In our demo:

- Shallow (features):
  - book, snow, flower, tree, fox
- Less shallow (sounds)
  - safe, weight, color, hall, day
- Deep (meaning)
  - duck, house, student, robin, textbook

Recall all the words that you saw earlier (the ones paired with the different questions)

Results:

- More likely to recall words judged on meaning
- Least likely to recall words judged on appearance

Conclusion:

- Better memory for words processed more deeply
Deep Processing

- In what other ways can people process information deeply?
  - Self-reference
  - Imagery
  - Generation

Generation Effect

- Slamecka & Graf (1978)
  - Manipulated whether pairs of related words were read or generated
    - Read: sea-ocean
    - Generate: sea-oc_____
  - Also manipulated depth of processing
    - Deep: words related in meaning, e.g., sea-ocean
    - Shallow: words related in sound (rhymes)
      e.g., save-cave
  - Then gave a recognition test:
    - diamond ocean light

Self-Reference Effect

- Rogers, Kuiper, & Kirker (1977)
  - Encoding with respect to oneself increases memory: self-reference effect

Imagery

- Create images that link things, and visualize them interacting with each other

Real-World Examples of Generation

- Students can...
  - Talk out loud when studying
  - Explain the material to someone else
Roediger & Karpicke (2006)

Repeated testing is better for long-term retention than repeated study, even with reading the passage much less!

Get Students to Test Themselves

- **Self-test** by asking themselves questions
  - “Test Yourself” & “Think About It” questions
  - Create their own questions
- Complement individual studying with a study group
- Make sure they generate answers!

Get Students to Organize

- **Organize**
  - They should go through their lecture notes and organize them that same day
    - “Should I rewrite my notes?”
      - If so, use different words this time
  - Make their own study guides for exams
Get Students to Take Breaks

- Take breaks
  - Study in a number of shorter study sessions rather than trying to learn everything at once
    - Spacing effect

Spacing Effect

- Smith & Rothkopf (1984)
  - Gave an 8-hour statistics course, 4 lessons presented in one day (massed instruction) or four days (spaced instruction)

<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massed instruction</td>
<td>Lesson 1</td>
<td>Lesson 2</td>
<td>Lesson 3</td>
<td>Lesson 4</td>
</tr>
<tr>
<td>Spaced instruction</td>
<td>Lesson 1</td>
<td>Lesson 2</td>
<td>Lesson 3</td>
<td>Lesson 4</td>
</tr>
</tbody>
</table>

- Spacing Effect
  - Smith, Glenberg, & Bjork (1978)
    - Studied lists twice, either in same or different contexts:

<table>
<thead>
<tr>
<th></th>
<th>Study</th>
<th>Study</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studied in <strong>same</strong> context:</td>
<td>Room A</td>
<td>Room A</td>
<td>Test C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Recall = 40%)</td>
</tr>
<tr>
<td>Studied in <strong>different</strong> contexts:</td>
<td>Room A</td>
<td>Room B</td>
<td>Test C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Recall = 61%)</td>
</tr>
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</table>

- How to Study More Effectively
  - What students should NOT do:
    - Simply memorize their notes
    - Create illusions of learning
    - Rely on metacognition

- What NOT to Do
  - They should not memorize their notes
    - Instead, apply what they have learned
    - Come up their own examples
What NOT to Do

- They should not create “illusions of learning”
  - Rereading
    - Leads to greater fluency, not better memory
  - Highlighting
    - Seems elaborative, but often becomes automatic

What NOT to Do

- Do not rely on metacognitive indicators
  - Our knowledge about our own memory is not always accurate
  - Encourage students to review their exams

Abrams metacognition demo

- What measures from BEFORE the exam correlate with actual exam score?

<table>
<thead>
<tr>
<th></th>
<th>Above</th>
<th>Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>I felt prepared:</td>
<td>$r = 0.21$</td>
<td>$r = 0.22$</td>
</tr>
<tr>
<td>I studied:</td>
<td>$r = 0.26$</td>
<td>$r = 0.03$</td>
</tr>
<tr>
<td>Hours studied:</td>
<td>$r = 0.34^*$</td>
<td>$r = -0.06$</td>
</tr>
<tr>
<td>My score will be:</td>
<td>$r = 0.25$</td>
<td>$r = 0.08$</td>
</tr>
</tbody>
</table>

Some Helpful Videos

- [http://www.samford.edu/how-to-study/](http://www.samford.edu/how-to-study/)