Phonological Loop, Visuospatial Sketchpad & Articulatory Suppression

Psychology 355: Cognitive Psychology
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This Powerpoint presentation may contain macros that were used to create the slides. The macros aren’t needed to view the slides. If necessary, you can disable the macros without any change to the presentation.
• Working Memory (WM) Model is a multi-component model of STM.

• Phonological Loop (PL):
  ♦ Phonological similarity effect
  ♦ Word length effect
  ♦ Articulatory suppression reduces phonological similarity effect and word length effect.

• Visuospatial Sketchpad (VSP)
  ♦ Mental subtraction of images
  ♦ Brooks’ experiment with pointing and verbal responses
1. **Phonological Loop (PL)**
   - Storage of sounds
   - Rehearsal
   - Manipulation of verbal information

2. **Visuospatial Sketch Pad (VSP)**
   - Storage & manipulation of visual images and spatial information.

3. **Central Executive (CE)**
   - Directs activity within the PL or VSP.
   - Coordinates activity between PL, VSP, and LTM.
Baddeley-Hitch Working Memory (WM) Model

This Lecture:

• What evidence shows that WM has multiple components?

• Specifically, what is the evidence for PL and VSP?
  PL = phonological loop
  VSP = visuospatial sketch pad
Summary of Evidence for PL (Phonological Loop)

- **Phonological similarity effect:** Memory span is smaller for lists of similar-sounding words than for lists of dissimilar-sounding words.
  - Example 1: Remember the list, D B C T P G (harder)
  - Example 2: Remember the list, K F Y L R Q (easier)

- **Word length effect:** Memory span is greater for lists of short words than for lists of long words.

- **Articulatory suppression experiments**

- **Neuropsychological evidence** (later - not in this lecture)
The Phonological Similarity Effect: Memory span is smaller for similar-sounding words than for dissimilar sounding words.

What does this show about working memory?

- Basic Assumption of PL: One way people maintain information in STM is by *rehearsing the sound of words*.

- Similar-sounding words are more confusable in a sound-based rehearsal. Memory span for similar-sounding words should be smaller if retention is based on rehearsal in the PL.

- The predicted smaller memory span for lists of similar-sounding words is confirmed (*even if the stimuli are presented visually!*).
Interpretation of Phonological Similarity Effect

• **Phonological similarity effect:** Memory span is smaller for similar-sounding words than for dissimilar sounding words.

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• **Basic Assumption of PL:** One way that people maintain information in STM is by *rehearsing the sound of words.*

• Similar-sounding words are more confusable in a sound-based rehearsal. Memory span for similar-sounding words should be smaller if retention is based on rehearsal in the PL.

• The predicted smaller memory span for lists of similar-sounding words is confirmed (*even if the stimuli are presented visually!*).
Next: Demo of Word Length Effect

- We already did some trials with short words.
- Next: Memory span trial with long words.
Note to Self: The following slides advance automatically on a timer, i.e., don't advance the slides manually.
HABITUALLY
NEUROTOXIN
ANTICIPATION
DECIDUOUS
SAXOPHONE
What Were the Words?

• Correct Answer:
  HABITUALLY, NEUROTOXIN, ANTICIPATION, DECIDUOUS, SAXOPHONE

• Which word list was harder to remember?
  ♦ First list: Short dissimilar sounding words
  ♦ Third list: Long dissimilar sounding words
Word length effect: Memory span is smaller for long words than for short words.

What does this show about working memory?

• Basic Assumption of PL: One way that people maintain information in STM is by rehearsing the sound of words.

• Longer words take longer to rehearse than shorter words. It takes longer to rehearse a list of long words than a list of short words.

• In a list of long words, words that are early in the list are more likely to be lost from STM while we are finishing the rehearsal of other words.

• Thus, memory span should be smaller for longer words.
• Digits take longer to pronounce in English than in Chinese. Digits take longer to pronounce in Welsh than in English;

• Digit span is greater for Chinese speakers than for English speakers. Digit span is greater for English speakers than for Welsh speakers.

• Interpretation:
  ♦ Everybody has the same basic STM capacity.
  ♦ Chinese speakers can rehearse digits faster than English speakers. Therefore they can retain more digits on the average in a Digit Span task.
  ♦ English speakers can rehearse digits faster than Welsh speakers. Therefore they can retain more digits on the average in a Digit Span task.
What Is Articulatory Suppression?

• Articulatory Suppression: Subjects are told to speak an irrelevant sound, e.g., "the, the, the, the, ....", while performing a memory task.

• Purpose of Articulatory Suppression: Prevent use of PL while performing the memory task. The conflicting task ("the, the, the, ...") prevents use of PL.

• Prediction: Articulatory suppression should reduce or eliminate the phonological similarity effect and the word length effect because ....

  a) articulatory suppression prevents use of PL while performing the memory task, and ...

  b) these effects result from phonological representations whose use is blocked by articulatory suppression.
Word Length Effect & Articulatory Suppression

List 1: (long words)
- helicopter, transformation, synergy, counterpoint, ....

List 2: (short words)
- ant, top, ear, dog, red, ..... 

• Condition 1A: Subjects read List 1, then try to remember it.
• Condition 2A: Subjects read List 2, then try to remember it.
• Condition 1B: Subjects read List 1 while saying "the, the, the, the, ...." Then they try to remember it.
• Condition 2B: Subjects read List 2 while saying "the, the, the, the, the, ...." Then they try to remember it.
Results for Conditions 1A and 2A were not shown graphically in the Goldstein textbook. Results for Conditions 1B and 2B are shown in Figure 5.13.

- **Conditions 1A and 2A**: Normal word length effect was found.

- **Conditions 2A and 2B** (with articulatory suppression):
  Lists of short or long words remembered about equally.
  Difference was not significant.

**Interpretation of This Result**
• Articulatory suppression prevents rehearsal of word sounds (probably the subject rehearses the word images). So word length no longer has as much effect.
Articulatory Suppression & the Phonological Similarity Effect

- Articulatory suppression also reduces the phonological similarity effect. (Results not shown here.)

Three Results that Support Existence of PL

- Phonological similarity effect
- Word length effect
- … and both effects are reduced with articulatory suppression

These results are predicted by the assumptions that:

- … retention in STM is based in part on verbal rehearsal;
- … articulatory suppression prevents verbal rehearsal.
Summary re Phonological Loop (PL)

Basic Assumption of PL: One way that people maintain information in a short-term memory store by *rehearsing the sound of words*.

This assumption predicts that ...

- ... similar sounding words should be more easily confused in PL (phonological similarity effect)
- ... longer words should be harder to maintain in PL (word length effect).
- ... preventing people from verbal rehearsal should reduce these effects (articulatory suppression).
1. Phonological Loop (PL)
   - Short-term storage
   - Rehearsal
   - Manipulation of verbal information

2. Visuospatial Sketch Pad (VSP)
   - Short-term storage of visual & spatial information
   - Manipulation of visual images and spatial information.

3. Central Executive
   - Directs activity within the PL or VSP.
   - Coordinates activity between PL or VSP, and between these components and long-term memory (LTM).
Sample stimuli, A and A'

- First, the subject sees A.
- Next A disappears and the subject sees A'.

Mental Subtraction Task: “Mentally subtract" the second stimulus from the first; then name the object that remains.
Sample stimuli, A and A'

♦ First, the subject sees A.
♦ Next A disappears and the subject sees A'.

Mental Subtraction Task: The subject must mentally "subtract" the second stimulus from the first, and name the object that remains.

Remainder  =  ice cream cones.

Sample Experiment: Mental Subtraction

• Next you will see an image.

• After this image is removed, you will see a second image.

• Mentally subtract the second image from the first image, and name the image that remains after the subtraction.
Example: Memorize This Image

Image B
Subtract This Image from the Preceding Image

Image B'

Name the Image that Results from Subtraction
• Name the image that results from mentally subtracting Image B’ from Image B.
Name the Image that Results From Subtracting Image B' from Image B?

Result of Subtracting Image B' from Image B
(This image would not be shown to a subject)

- Possible answer: A fish
Subtraction Task: The subject must mentally "subtract" the second stimulus from the first, and name the object that remains.

- Possible answer for A and A' on Left: Ice cream cones.
- Possible answer for B and B' on Right: Fish

• Important to note that if the subject names the first image, then it is harder to access a name for the image that remains after subtracting the second image.
Condition 1: Subject does the mental subtraction task.

Condition 2: Subject says "la, la, la, la, ...." while doing the mental subtraction task.

Finding: Subjects perform BETTER in Condition 2 than in Condition 1. Why?
Monday, April 27, 2015: The Lecture Ended Here
Interpretation of Mental Subtraction Experiment

- The stimuli were designed so that subjects could name the object before "subtracting" the second image.
  - E.g., with stimulus 1, a subject might think "headphones".
- If a subject silently says "headphones" while looking at the left part of stimulus 1, it is harder to see ice cream cones after subtracting the right part of the stimulus.
- Saying "la, la, la, la, ...." suppressed the tendency to name the left part of the stimulus, so the subject relies only on the visual image in VSP. This makes the subtraction task easier.
Assumption: People can maintain a visual/spatial representation of information by actively processing it in VSP.

Hypothesis: Suppression of PL can improve processing on tasks if ...

1) ... people are in the habit of naming the image (recoding initial image into the PL), but ..... 

2) .... the task is actually performed more easily in VSP.

Result: Articulatory suppression does improve performance on the mental subtraction task. 

♦ This result is hard to explain if STM is a single storage area without separate PL & VSP.