Working memory
PSY 200
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Lecture 15

Why there is a gate at the first floor stairway in the Psych building.

Modal Model of Memory
- Atkinson & Shiffrin (1968)
- Today we focus on the Short-term store (Short term memory)

Search of memory
- How is memory searched?
  + Sternberg hypothesized three types of searches
  + Explore by varying the number of items in memory set (similar to visual search experiments)
  + measure reaction time
  + Sternberg (1969)

Types of searches
- (1) parallel: target item is compared to all the items in memory at the same time
  + the answer (yes or no) is returned after all items have been checked

Memory search
- If parallel search
  + number of items does not matter
  + Yes and No responses are both flat

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PSY 200: Intro. to Cognitive Psychology
Types of searches

- **(2) serial terminating:** target item is compared to each item one after the other
  - the answer (yes or no) is returned after the target is found or all items are searched

  ![Diagram of serial terminating search](image)

  Reaction time is faster for a yes response.

If self-terminating search

- Go through items one-by-one until find target
- RT increases with set size
  - YES RT’s shorter than NO RT’s
- Lines have different slopes

![Diagram of self-terminating search](image)

Types of searches

- **(3) serial exhaustive:** target item is compared to each item one after the other
  - the answer (yes or no) is returned after all items are searched (regardless of whether target is found or not)

  ![Diagram of exhaustive search](image)

If exhaustive search

- Go through every item and then report answer
  - RT’s increases with set size
  - YES RT increases the same as NO RT’s
- Lines are parallel

![Diagram of exhaustive search](image)
Hypothetical searches

- So, we have three hypothetical ways of searching STM
  - They predict very different patterns of reaction time as a function of memory set size
- Sternberg runs the experiment to see how the data comes out
  - You ran a version of the experiment in CogLab

Search of memory

- Sternberg’s data support exhaustive search
- Here’s the CogLab data (93 participants)

Implications: Search of STM

1) is serial, one item at a time
   - and checking each item takes approximately the same length of time
   - Approximately 40 milliseconds (CogLab data is a bit slower, 46 milliseconds)
2) is exhaustive
   - search always goes through all items

These results were a bombshell in 1969

- finer analysis of cognition than anyone expected was possible
- used a thought experiment about different types of searches to generate precise testable predictions about cognition
  - subsequent research found that there were other types of searches that complicate the conclusions
  - counter-intuitive finding
    - why should search be exhaustive?
    - seems inefficient!

Interpretation

- Exhaustive search makes sense if search of STM is done by some process that is
  - very efficient (can search very quickly)
  - dumb (doesn’t bother to stop itself)
  - initiated by some other system (a controller)

Controller

- Controlling attentional system
  - supervises
  - coordinates
  - starts and stops relatively independent processes
- e.g.
  - Search short term memory
  - Search long term memory
  - walking down stairs
  - gate in psychological sciences building
  - Doors
Other aspects of STM
- At about the same time, another study indicated important characteristics of phonological and visuo-spatial systems
- Brooks (1968)
  - two types of tasks (visuo-spatial and phonological)
  - two types of responses (visuo-spatial and phonological)
- Identifies two types of systems that are relatively separate

Separate systems
- A complicated experiment
  - Part 1: spatial mental task (diagrams)
    - visual imagery
    - classify corners (top or bottom corner?)
    - "yes" if top or bottom
    - "no" if not top or bottom

Separate systems
- Part 2: verbal mental task
  - read sentence
  - categorize words (noun or not?)

Two response types
- Either
  - verbally
  - spatially

Results
- Measure time to finish mental task for each response type
  - diagrams -- pointing
  - sentence -- pointing
  - diagrams -- verbal
  - sentence -- verbal

Results
- when you have to respond by pointing, it is easier to work with sentence information than diagram information
- when you have to respond verbally, it is easier to work with diagram information than sentence information

<table>
<thead>
<tr>
<th>Mental task</th>
<th>Diagrams</th>
<th>Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointing</td>
<td>28.2s</td>
<td>9.8s</td>
</tr>
<tr>
<td>Verbal</td>
<td>11.3s</td>
<td>13.8s</td>
</tr>
</tbody>
</table>
Significance
- The results suggest that there are two relatively separate systems
  - one deals with visuo-spatial information and must do the pointing response and mental diagram task
  - one deals with verbal information and must do the spoken response and the sentence task

Interference
- These systems have only limited resources and capabilities
  - Asking a system to do two things at once (e.g., pointing and mental diagram) slows down the system
  - Splitting responsibilities across the systems (e.g., spoken response and mental diagram) can be done quickly

All together now
- Sternberg’s study suggests the existence of a “controller” that tells other systems what to do
- Brook’s study suggests separate systems that deal specifically with visuo-spatial and verbal information, respectively
- Baddley (1986) put these ideas together into a model of working memory

Working memory
- Current thought, awareness
  - extension of short-term memory
  - small capacity
  - rapid forgetting
- Processor of information
  - not a storage device
  - hypothesizes mechanisms that lead to memory properties

Conclusions
- Sternberg’s study
  - controller system
- Brook’s study
  - separate visual and verbal systems
- Baddley’s working memory model
  - Central executive
  - Visuo-spatial sketchpad
  - Phonological loop

Next time
- Properties of phonological loop
- Data
  - phonological similarity effect
  - articulatory suppression
  - word length effect
  - irrelevant speech effect
- CogLabs on Memory span and Phonological similarity due!
- A problem with IQ tests.