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

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Memory search

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

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)
  • Lines are parallel

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
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 (160 participants)
    - Yes
    - No

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, 68 milliseconds)
- 2) is exhaustive
  - search always goes through all items

Search of memory

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

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>Pointing</th>
<th>Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagrams</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.