

Working memory

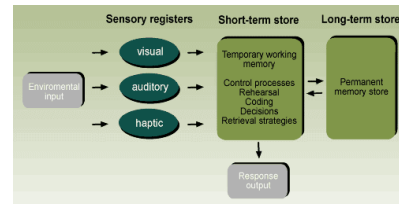
PSY 200
Greg Francis
Lecture 15

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



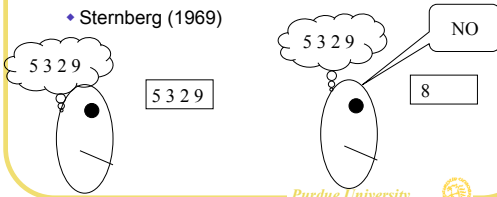
Modal Model of Memory

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



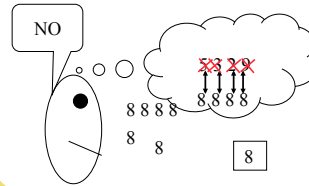
Search of memory

- 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)



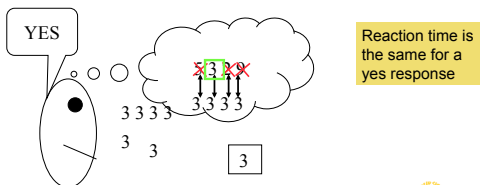
Types of searches

- (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



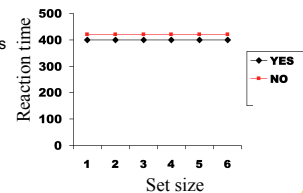
Types of searches

- (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



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

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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

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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

Set size	YES RT (ms)	NO RT (ms)
1	400	400
2	450	450
3	500	500
4	550	550
5	600	600
6	650	650

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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)

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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)

Reaction time is the same for a yes response as for a no response

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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

Set size	YES RT (ms)	NO RT (ms)
1	300	400
2	350	450
3	400	500
4	450	550
5	500	600
6	550	650

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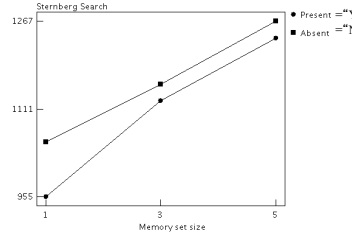
Hypothetical searches

- 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


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Search of memory

- Sternberg's data support *exhaustive search*
- Here's the CogLab data (160 participants)




Memory set size	Present RT (ms)	Absent RT (ms)
1	955	955
3	1111	1040
5	1267	1175

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Search of memory

- 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

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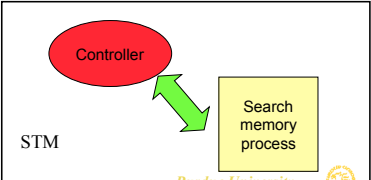
Search of memory


- 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!

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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)



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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

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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

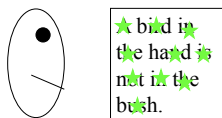
- A complicated experiment
- Part 1: spatial mental task (diagrams)
 - visual imagery
 - classify corners (top or bottom corner?)
 - “yes” if top or bottom
 - “no” if not top or bottom



Separate systems

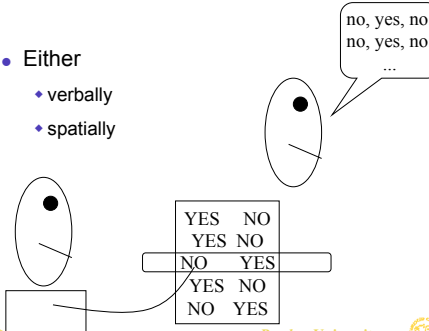
- Part 2: verbal mental task

- 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

- 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

		Mental task	
		Diagrams	Sentences
Response task	Pointing	28.2s	9.8s
	Verbal	11.3s	13.8s

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

Diagrams
Pointing

Visuo-spatial
information

Verbal
information

Sentences
Verbal

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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

Diagrams
Pointing

Visuo-spatial
information

Verbal
information

Sentences
Verbal

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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*

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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

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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

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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.

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