Working Memory and Language An Overview

Alan Baddeley

Zijian Lu (Fabio)

Memory: A two-component model

• The most influential model by Atkinson and Shiffrin (1968)

- Long-term Memory (LTM)
- Short-term Memory (STM)



- Working memory: a workplace
 - structures and processes used for temporary <u>storage</u> and <u>manipulation</u> of information
- Short-term memory: short-term storage of information

Memory: A two-component model

Evidence from neuropsychology

- Damage to the medial temporal lobe
 - Impaired capacity for new learning
 - Performance on STM tasks unaffected
- Conduction aphasia patients -> a specific deficit in STM



• A Paradox



Working Memory: A three component model

• To tackle this paradox ...

• Divide the unitary WM into three separable components



The Visuospatial Sketchpad

- A visual subsystem of working memory
 - Function:



• Less relevant to language disorders

The Visuospatial Sketchpad

• An unexpected role in comprehension

- Grammatical capacity of people with Williams syndrome
 - Preserved verbal skills
 - Impaired visuospatial processing
 - Subjects: 3 groups
 - WS: Williams Syndrome
 - TD: typically developing children
 - MLD: Minimal Learning Disability
 - Procedure: present sentences
 - with/without spatial term
 - Task: find the corresponding picture from 4



The Central Executive

• The attentional control of working memory

• Effect on language processing



The Phonological Loop

Two subcomponents



Hold memory traces over seconds, decay unless refreshed by ...

Maintain information & Register visual information (item can be named)

Evidence for subvocal

- Subvocal -> Retention depend on <u>acoustic phonological characteristics</u>
 - Easy: B, W, Y, K, R, X
 - Hard: T, C, V, D, B, G
 - Easy: pit, day, cow, sup, pen
 - Hard: man, cat, map, cab, can

The Phonological Loop

• Evidence for rehearsal <- <u>the Word Length effect</u>

- Present 5-word sequences
- Require immediate serial recall
 - Number of syllable ↑, Performance ↓
 - Less rehearsal
- Wiped out by utterance of a sequence of irrelevant sounds
 - Output delay held consistent
 - Retention through <u>rehearsal</u> blocked

The Phonological Loop Neuroanatomical basis

- Evidence for separable storage and rehearsal systems
 - Lesions and neuroimaging Studies
 - Brodmann area 44: storage
 - Broca's area (Brodmann area 6 and 40): subvocal rehearsal
 - Activation principally in the left hemisphere



The Phonological Loop Functional significance

• What biological function is served by the system?

- STM deficits -> few problems in daily life
- Hypothesis: facilitate the acquisition of language
 - Subject: patient with pure phonological STM deficit
 - Task:
 - (1) acquisition of the vocabulary of an <u>unfamiliar foreign</u> language
 - 8 items of Russian vocabulary (e.g., rose svieti)
 - (2) learning to associate pairs of unrelated words in <u>native</u> language
 - e.g., horse castle
 - Result: normal in (2), but completely failed in (1)
 - Conclusion: A useful aid in learning new words

The Phonological Loop Functional significance

• What biological function is served by the system?

- STM deficits -> few problems in daily life
- Hypothesis: facilitate the acquisition of language
 - Extend the findings:



- Confined to second language learning
 - Acquisition of native language?

• The phonological loop and native language acquisition

• Follow-up: tests of verbal memory

A group of children with a <u>specific language impairment</u> (SLI)

- Mean age: 8 years
- Nonverbal intelligence: normal
- Language development: delay of 2 years
- A particular deficit in sound mimicry
 - the capacity to hear and repeat <u>nonwords</u>

• The phonological loop and native language acquisition

• Follow-up: a developed nonword repetition test

A group of normal children

- Mean age: 8 years
- Nonverbal intelligence: matched
- Language development: normal

A group of children with a <u>specific language impairment</u> (SLI)

- Mean age: 8 years
- Nonverbal intelligence: normal
- Language development: delay of 2 years

A group of younger children

- Mean age: 6 years
- Nonverbal intelligence: normal
- Language development: matched
- SLI group: 4 years behind the age & 2 years behind the language development
 - Deficit <- impairment in the <u>phonological storage</u> component

Investigation within normal children

- Groups of 4 year olds & 5 year olds
 - Measuring ...
 - Nonword repetition
 - Nonverbal intelligence
 - Vocabulary
 - Clear association between <u>nonword repetition</u> and <u>vocabulary</u>
 - Phonological loop facilitates native language acquisition
- Correlation ≠ Causation
 - Rich vocabulary facilitates acquisition of new words?

• Investigation within normal children

- Evidence for the primacy of phonological storage
 - Cross-lagged correlation
 - Relate vocabulary and nonword repetition between 4 and 5



An alternative view

- Phonological storage
 - merely a reflection of deeper phonological processing problems



• Evidence for the alternative view

- An important study by Gathercole (1995)
 - For any nonword, some sequences are harder than others
 - Easier: resemble English words (e.g., stirple, blonterstaping)
 - Harder: unfamiliar phoneme sequences (e.g., kipser, perplisteronk)

• Follow-up study



Influence of <u>existing language habits</u> on current nonword repetition performance

• One way of explaining this pattern of results ...

- Phonological loop
 - divided into separate <u>storage</u> and <u>articulatory</u> components
- Highly appropriate in retrospect
 - If storage dominated by habits ...
 - new items swamped by old items -> new learning hindered by habits
- Articulatory output impacted by habits
 - enhance repetition of familiar phoneme sequences



• Evidence for the explanation

- A series of studies by Gathercole et al.
 - Subjects: children who might have articulatory difficulties
 - Procedure: children hear <u>2 sequences</u> of words or nonwords
 - E.g., dog, pen, hat, tip -- dog, hat, pen, tip
 - Task: identical or changed





- Result: the lexicality effect disappeared
 - Familiarity of phoneme sequences -
- Conclusion: Existing language habits -- impact on output and rehearsal

Conclusion

- Working Memory ...
 - A temporary storage system
 - Implications for language processing
 - Disorders impact on language processes
 - Deficits within the phonological loop or other aspects
 - Serious impair language processing
 - The interface between working memory and language
 - Continue to be fruitful

Questions

• Word length effect?



- Long words takes longer to recall?
- How is the phonological information stored?
- What's the unit of phonological information?
- How is the written language processed in working memory exactly?
 - How is the visual information registered by the subvocal rehearsal system utilized?
 - How is stored visual information integrated with phonological information?
 - How does the visuospatial sketchpad integrate with phonological loop?