Basic Processes in Working Memory and Their Role In Language Comprehension

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WM and Sentence Comprehension

The toy from Allison arrived today.

Subject?
The toy from Allison arrived today.

STM buffer –
Phonological codes
Order information
(Baddeley, 1986; N.Martin &
Gupta, 2004)
Preserved Sentence Comprehension with Poor Phonological STM

Butterworth, Campbell, & Howard (1986)
Caplan, Waters, & Hildebrandt (1991)
Martin (1993), Martin & Romani (1994)

No Correlation between STM Span and Degree of Sentence Comprehension Deficit

Caplan & Hildebrandt (1988), Martin (1987)
Multiple Capacities Model of STM
(Martin, Lesch, Bartha, 1999)

- Dissociable phonological & semantic components of STM

(N. Martin & Saffran, 1997; Martin & Romani, 1994; Martin & He, 2004; Wong & Law, 2008; Hoffman et al., 2009)

Patients with spans of 1-3 words, despite good single word processing

**Semantic STM deficit**
- Show standard phonological effects
  - Auditory > Visual
  - No advantage of words over non-words
  - Rhyme probe > category probe

**Phonological STM deficit**
- Fail to show standard phonological effects
  - Visual > auditory
  - Advantage of words over non-words
  - Category probe > rhyme probe
Knowledge Representation

Semantic Features

Lexical Nodes

Input phonological segments

Output phonological segments

Martin, Lesch & Bartha (1999)
Relation to Sentence Comprehension

- Semantic STM Deficit
  - Poor sentence comprehension for sentences with delayed integration
  - “rusty old red swimsuit”
  - “rugs, vases, and mirrors cracked”

Limitations of Multiple Capacity Approach

- Susceptibility to interference for patients with semantic STM deficits (prior list intrusions)

- Extension to other sentence structures?
ML: Semantic STM Deficit

Etiology: Left CVA, frontal-parietal damage

Clinical description: non-fluent speech, word-finding difficulties, good comprehension

Age: 62

Memory span: 2.5 items auditory, 1.5 items visual

Single word processing: picture naming and word comprehension at a normal level
Recent Negatives Task
(Hamilton & Martin, 2005)

- **Recent Probe**
  - **List**
    - K L M P
    - T V R X
  - **Probe**
    - List → B → “No”
    - List → P → “No”

- **Non-recent Probe**
  - **List**
    - K V R X
    - G L D P
    - W M S Z
    - B D F C
  - **Probe**
    - List → T → “No”
    - List → J → “No”
    - List → F → “No”
    - List → X → “No”
Recent Negatives Task - Patient ML (recent negatives-nonrecent negatives)
Recent Negatives Task
(recent negatives-nonrecent negatives)
Re-thinking Approach to Working Memory

Focus of attention: very restricted capacity (1-4 chunks)

Activated but not in focus

Emphasis on cue-based retrieval, interference

Long Term Memory

Unsworth & Engle, Cowan, Oberauer, Verhaeghen, McElree
Related Approach to Role of WM in Sentence Processing

Cue-based parsing (Lewis, Vasishth, Van Dyke, 2006; McElree et al., 2003)

1. Limited focus of attention in Working Memory
   Two-chunk capacity needed for integrating different parts of sentence

2. Information outside focus must be retrieved for integration

3. Retrieval through cue-based parallel access to item information *but not serial order* information

4. Similarity-based interference due to partial matches with cues
The toy from Allison arrived.
The toy

Encoding into Memory

Syntax:
Subj NP: the toy
Number: Singular
Predict Sentence
Predict Verb Slot

Semantics:
Object for play
Definite

Memory Representation

In focus of attention

Based on Lewis et al., 2006
The toy from Allison

Encoding into Memory

Process Intervening

In Focus

Syntax:
- Predict Sentence
- Subj NP: the toy
- Number: Singular
- Predict Verb Slot

Semantics:
- Object for play
- Definite

Memory Representation

Out of Focus of Attention
The toy from Allison arrived.

Encoding into Memory

Syntax: Predict Sentence
Subj NP: the toy
Number: Singular
Predict Verb Slot

Semantics: Object for play
Definite

Cue Generation

Syntax
Sentence
Verb slot: open
Number: singular/pl
Subject: NP

Semantics:
NP: person/object that can arrive

Memory Representation

Out of Focus of Attention

Retrieval Cues

In focus
Retrieval Interference: Semantic
(e.g., Van Dyke, 2007)

- The toy from **Allison** arrived today.
- The toy from **Boston** arrived today.

**Allison** more plausible subject of “arrived”
Causes greater interference
Retrieval Interference: Syntactic

(e.g., Van Dyke & Lewis, 2003; Van Dyke, 2007)

- The toy that the company manufactured last year arrived today.
- The toy that bankrupted the company last year arrived today.

Another subject, more interference
Semantic STM Deficit & Interference in Sentence Comprehension

• Overly sensitive to semantic interference?
• Any effect of syntactic interference?
Patient ML: Preliminary Data on Interference in Comprehension (in collaboration with Julie Van Dyke)

Note: Good syntactic processing
Grammaticality judgments: 97% correct
Passive sentence comprehension 100%
Semantic and Syntactic Interference

- Based on Van Dyke (2007) (simpler sentences) Proactive Interference. Spoken sentences.

HiSyHiSem
The reporter stated that the witness at the hearing was shouting.

HiSyLoSem
The newspaper stated that the witness at the hearing was shouting.

LoSyHiSem
According to the reporter, the witness at the hearing was shouting.

LoSyLoSem
According to the newspaper, the witness at the hearing was shouting.

Who was shouting?
Predictions:
Backward serial search, no effect of interfering
Rapid decay, no effect of interfering
Retrieval interference - effects of both?

- HsynHsem The reporter stated that the witness at the hearing was shouting.
- HsynLsem The newspaper stated that the witness at the hearing was shouting.
- LsynHsem According to the reporter, the witness at the hearing was shouting.
- LsynLsem According to the newspaper, the witness at the hearing was shouting.
ML Semantic/Syntactic Interference Percent Errors

- Low Syntactic
- High Syntactic
Conclusions

- Phonological buffer maintaining ordered representations not critical for comprehension
- Access to item information (i.e., semantic/syntactic) critical
- Cue-based parsing provides a means of linking WM and sentence processing emphasizing retrieval and interference
- Relation between WM in list recall and sentence comprehension may be revealed by focusing on retrieval interference
  - Preliminary data: Patient showing poor item retrieval and high interference has difficulty with (semantic) interference in sentence comprehension.
Thanks.

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