Working Memory Deficits in Individuals with Aphasia

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Disclosures

Neither presenter has any disclosures to report.

Learner Objectives

Describe potential working memory deficits in aphasia

Outline ways to assess working memory in individuals with aphasia

Describe implications of discussed research findings to clinical practice
Defining Working Memory

Short-term memory - ability to temporarily hold info in an accessible state

Working memory - info that is temporarily held in short-term memory is monitored and manipulated to plan and carry out behavior
  Retaining partial results while “working on” another aspect of info

MODELS OF WORKING MEMORY

Models of Working Memory
  Baddeley & Hitch (1974)
  Cowan (1988)
  Others
Baddeley & Hitch

Subsystems of working memory:

- **Central executive control system**
  - Attentional control of WM
- **Phonological loop**
  - Verbal and acoustic info
- **Visuospatial sketchpad**
  - Visual info
- **Episodic buffer**
  - "chunka" info from subsystems with info from long-term memory (i.e. central storage system)

Cowan

Embedded Processes Model - hierarchically organized

- **Short-term memory** = a temporarily activated subset of info from long-term memory.
- **Focus of attention** = a portion of activated short-term memory (controlled by a central executive process for attentional control)
- **Working memory** = focus of attention within activated short-term memory as well as central executive process to control attention and manipulate the stored info
WORKING MEMORY IN INDIVIDUALS WITH APHASIA

Cognitive difficulties in Individuals with Aphasia
Problems with:
- Verbal WM
- Nonverbal WM
- Attention
- Executive function
Verbal Working Memory Deficits in Individuals with Aphasia

Digit span
Picture span (Dede et al., 2014)
Synonymy judgements
Rhyming judgements
Others?

Nonverbal Working Memory Deficits in Individuals with Aphasia

Spatial span tasks
• Corsi block-tapping task
• Spatial span subtest of the Wechsler Memory Scale (Wechsler, 1997)
• Figure recognition paradigms (Kalbe et al., 2005)
Others?

TASK ANALYSIS OF SPATIAL SPAN
Task analysis - SS forward

Spatial Span Forward - nonverbal
• See examiner touch series of blocks
• Hold the sequence in nonverbal short-term memory or WM via the visuospatial sketchpad
• Reproduce the sequence
• (Possibly inhibitory processes related to attention to suppress previously activated sequences)

Task analysis - SS backward

Spatial Span backward - nonverbal
• Relies more heavily on WM
• See examiner touch series of blocks
• Hold the sequence in the visuospatial sketchpad while manipulating it
• Produced the manipulated sequence by touching the blocks in the reverse order.
• (Possibly inhibitory processes related to attention to suppress previously activated sequences)

Differences between Digit Span and Spatial Span

Digit span
  Forward
  • Relies on the phonological loop
  Backward
  • Relies on the phonological loop and central executive

Spatial span
  Forward
  • Relies on the visuospatial sketchpad
  Backward
  • Relies on the visuospatial sketchpad

(Smyth & Scholey, 1992)

There are alternate views as well.
Differences between Digit Span and Spatial Span

- Discrepancy between degree of input of attentional control in WM tasks in verbal and visuospatial domains
- Verbal (i.e., phonological) info is highly practiced and automatized to a greater degree than visuospatial info
- Therefore visuospatial input may require a greater reliance on executive control mechanisms
- Is this true for individuals with aphasia?

Differences between Digit Span and Spatial Span

For individuals with aphasia
- Phonological coding that occurs for verbal input may be less automatized than in healthy individuals
- May consequently rely more heavily on the central executive system for attentional control related to maintaining a phonological representation

Baddeley (2003)

Harnish et al. (2015)
Relationship between memory and language

Dell, 1986
Connection strength among linguistic nodes and decay rate of activated linguistic nodes work temporally to keep targeted nodes activated to threshold above competitor nodes.

If lexical retrieval is impaired (e.g., decay rate increased, or connection strength decreased), then the person may rely more heavily on attentional control to attempt to ignore noise in the system and maintain activation of a lexical node.
Relationship between memory and language

Martin et al. (1996) hypothesized that language impairment that disrupts the ability to maintain active lexical nodes would also impact auditory verbal short-term memory. 

Memory storage and processing are part of the cognitive system underlying language processing, and may account for deficits that appear to be linguistic in nature, such as the ability of nodes to persist in an activated state (Hula & McNeil, 2008, Martin et al., 1996)
Why do we care?

1. Theoretical significance
   If visuospatial abilities are predictive of anomia treatment response, then perhaps in individuals with aphasia there is more central processing of both nonverbal and verbal info.
   Evolution of WM theories focusing more on central executive mechanisms versus separate verbal and nonverbal modules

Why do we care?

2. Clinical significance
   Prognostic value in predicting those individuals who may respond best to a particular type of treatment, or who may benefit from WM training prior to beginning anomia treatment.

Verbal Memory Task for Individuals with Aphasia

Why would we need to adapt this type of a task?
   If they can’t say the names back, is it because they don’t remember?

   Or because they have receptive difficulties (during the initial naming phase)?

   Or because they have expressive difficulties?
Forward versus Backward
Which did you find more challenging?

Why?

Even though this task is adapted, it is still tapping into language … Why?

Nonverbal Memory Task
Which task did you find most challenging?
Why?

Overview of Our Study

Research question: Does nonverbal working memory ability help to predict response to anomia treatment in persons with chronic aphasia?

(Harnish & Lundine, 2015)
Working Memory + Anomia Treatment
Outcome → Effect size of naming treatment

![Graph showing effect size (d) = 11.75.](image)

Effect Size (d) = 11.75
Large effect

(Cuen Picture Naming Treatment)

Independent Variable/Predictor → scores on a test of working memory
Spatial Span Task

(Wechsler, 1997)

(Harnish, Morgan, Lundine et al., 2014)
Working Memory + Anomia Treatment

Stepwise Multiple Regression

Designed to find the factors (predictors) that are most effective in predicting the dependent variable (Effect Size)

Predictors will not be added to the regression equation unless they make a statistically significant addition to the analysis.

Entered forward and backward initial scores on the Spatial Span task into the regression model

Backward Spatial span accounted for 72% of the variance in Step 1 ($p = .008$)

Forward Spatial span did not enter into the equation ($p = .519$)

What does this all mean?

** People who had poorer performance on nonverbal WM tasks were more likely to have smaller effect sizes in treatment **

** Nonverbal WM was highly predictive of anomia treatment effect size **
WHO CARES?

Theoretical Significance
Validates memory models with a central processing (executive) mechanism that supports both nonverbal and verbal abilities

Other variables did not show a relationship with effect size (initial baseline naming abilities on BNT OR overall aphasia severity)

Clinical Significance
Nonverbal WM may be a valuable prognostic indicator for anomia treatment

To identify who may respond best to a treatment program like CPNT

To identify who may benefit from initial cognitive training in order to maximize language gains
Conclusions

• Visuospatial WM abilities were highly predictive of anomia treatment response in a small sample of individuals with aphasia.
• The data support an account of memory that includes a central processing mechanism, one that may be taxed to a greater degree for auditory-verbal information in individuals with aphasia due to the decreased automaticity of the phonological code.

Future Directions

• Replicate current study with a larger sample.
• Use a larger battery of nonverbal WM assessments instead of a single measure.

Future Directions

• Does training visuospatial memory or organizational strategies prior to beginning anomia treatment provide a stronger WM foundation?
• Do verbal WM abilities or other cognitive factors predict treatment response?
Future Directions

- Is recall of material significantly influenced by the quality of the organizational strategies used during initial encoding?
- If so, it may be worthwhile to train organizational strategies concurrently with treatment for anomia.

QUESTIONS? COMMENTS? DISCUSSION?

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References


