Relationships between Working Memory Capacity and Listening/Reading Sentence Comprehension in Aphasia

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Introduction

- **Definition of Working Memory (Baddeley, 1986, e.g.)**
  Working Memory (WM) is a cognitive construct that involves both maintenance and computation components, which is used to perform sentence comprehension.
- **WM Capacity Theory (Just & Carpenter, 1992, e.g.)**
  - WM capacity is the maximum amount of activation available in WM to support either storage or processing components.
  - WM capacity effects emerge only when the capacity available either for storage or processing is exceeded.
- **Manipulations of WM Demands**
  Concurrent memory load, syntactic complexity, extra verbal material such as padding adjectives…
- **WM and sentence comprehension**
  A series of studies has found that WM span measures are correlated with reading and auditory comprehension tasks in normal adults (e.g., Daneman & Merikle, 1996) as well as in persons with aphasia (PWA) (e.g., Caspari Parkinson, LaPointe, & Katz, 1998).

Research Questions

Q1: To examine which of the following factors significantly predict performance on listening and reading comprehension on the *Computerized Revised Token Test* (*CRTT*) in PWA:

a) WM, as assessed by a listening WM span task (Tompkins, Bloise, Timko, & Baumgaertner, 1994)

b) Overall aphasia severity, as measured by *Porch Index of Communicative Ability* (*PICA*) (Porch, 1981)

c) Overall reading ability, as measured by *Reading Comprehension Battery for Aphasia* (*RCBA*) (LaPointe & Horner, 1979)

Q2: To investigate whether WM-group differences between low and high span groups emerge more clearly on longer and syntactically more complex subtests of the *CRTT* than for less complex subtests.

Predictions

P1: WM will significantly predict performance on CRTT testing conditions in which greater memory demands are imposed.

P2: WM capacity effects will be manifested in individuals with lower WM capacity, especially in more complex CRTT subtests

Methods

1.Participants: 20 individuals with aphasia (M=10/F=10)

- **Descriptive Information**
  - **Age** (mean=62.85, SD=12.31)
  - **Months of Post Onset** (M=155.25, SD=175.87)
- **Screening Measures**
  - **Hearing/Vision Screening**
  - **Language Tests:** *PICA*, *RCBA*
  - **Memory Screening:** *Assessment Battery of Communication in Dementia* (Bayles & Tomoeda, 1993)
  - **Working Memory Task:** a listening version of a sentence span task (Tompkins et al., 1994)

2. Materials (*CRTT* testing conditions)

- **Listening Comprehension: Auditory version of the *CRTT***
- **Reading Comprehension**
  1) full-sentence presentation (***CRTT-R-FS***)
  2) self-paced word-by-word moving window reading with cumulative presentation ***(word constant; CRTT-R-WC)***
  3) self-paced word-by-word moving window presentation, with each previous word disappearing ***(word fade; CRTT-R-WF)***

CRTT-auditory and **CRTT-R-WF** testing conditions are **more memory demanding**, since linguistic stimulus is only temporarily available to participants.

3. *CRTT*

- **The *CRTT* matrix**

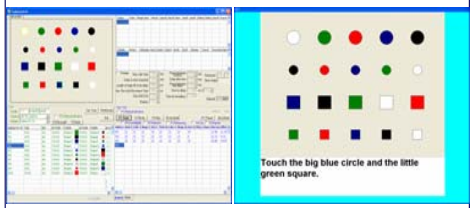
	Subtest									
	I	II	III	IV	V	VI	VII	VIII	XI	X
Nr.	3	4	6	8	6	8	6	8	4	5
ST	SI	CI	SI	CI	GSP	GSP	DP	DP	AD	AD

Nr=number of linguistic elements to be scored
ST=sentence type
SI=simple imperative; CI=compound imperative; GSP= imperative prepositional phrases with general spatial prepositions; DP= imperative prepositional phrases with directional prepositions; AD= adverbial clauses

Higher subtests (e.g., subtests 6, 9) are **more memory demanding**, since they involve greater syntactic complexity and more verbal material (such as padding adjectives)

- **Window Interface of the *CRTT-R***

Examiner's Screen **Participant's Screen**



Results

1. Stepwise multiple regression analysis

- WM significantly predicted performance on *CRTT-auditory* and *CRTT-R-WF*

	Stepwise Multiple Regression		
CRTT conditions	Significant Predictor	R-square	P-values
CRTT-Auditory	**WM**	**0.357****	**0.005**
CRTT-R-FS	RCBA	0.325*	0.011
CRTT-R-WC	PICA	0.412**	0.002
CRTT-R-WF	**WM**	**0.361****	**0.006**

2. Correlation coefficients among the predictors and *CRTT* and *CRTT-R* conditions

	WM	PICA	RCBA	*CRTT-A*	*CRTT-R-FS*	*CRTT-R-WC*	*CRTT-R-WF*
WM	**1.00**						
PICA	0.70**	**1.00**					
RCBA	0.69**	0.54*	**1.00**				
CRTT-Auditory	0.60*	0.35	0.55*	**1.00**			
CRTT-R-FS	0.45*	0.36	0.57**	0.65**	**1.00**		
CRTT-R-WC	0.58**	0.64**	0.51*	0.67**	0.65**	**1.00**	
CRTT-R-WF	0.60**	0.53*	0.52*	0.66**	0.70**	0.88**	**1.00**

3. Classification of participants into two WM groups based on a median split

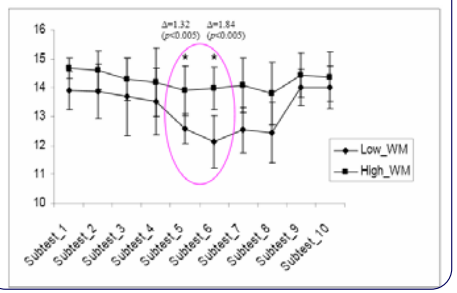
- Since the distribution was bimodal, 20 PWA were classified into low and high WM groups based on a median split only for the two conditions which WM significantly predicted

	Descriptive Data per each WM group in the two conditions	
WM group	***CRTT-Auditory***	***CRTT-R-WF***
Low WM group	13.27 (0.23)	12.79 (0.32)
High WM group	14.23 (0.23)	13.78 (0.30)
Both groups	13.64 (0.75)	13.26 (0.97)

4. Two-way mixed ANOVAs (WM group x Subtest)

1) *CRTT-Auditory* condition

- Significant main effects for WM group, subtest, two-way interaction (p<.05)
- Bonferroni-corrected Post-hoc analysis was performed (p<.005)

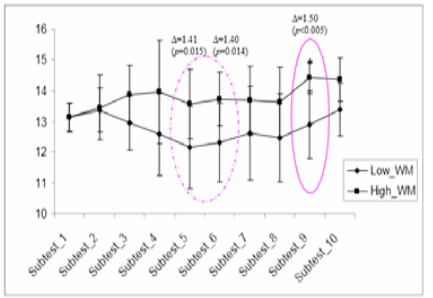


Results (Cont'd)

4. Two-way mixed ANOVAs (WM group x Subtest) (Cont'd)

2) *CRTT-R-WF* condition

- Significant main effects for WM group and subtest (p<.05)
- Significant interaction between WM group and subtest (p<.05)
- Bonferroni-corrected Post-hoc analysis was performed (p<.005)



Discussion

1. Effects of WM on listening/reading sentence comprehension

- A listening WM span task significantly predicted overall CRTT performance for memory-demanding conditions
  - Predicted performance on both auditory and some reading conditions (specifically, *CRTT-R-WF* condition).
  - Despite using different modalities, these conditions are similar in making information only temporarily available and therefore require greater WM involvement.
- Overall reading ability and aphasic severity better predicted performance on less memory-demanding conditions
  - RCBA and PICA scores better predicted performance on *CRTT-R-FS* and *CRTT-R-WC* conditions than WM did.
  - These conditions are closer to naturalistic reading and less memory demanding than the *CRTT-R-WF* or auditory *CRTT* because people can go back and re-read sentences as needed.

2. Differential WM group effect

- Significant interaction between WM-group and *CRTT*-subtest
  Consistent with WM capacity theory (Just & Carpenter, 1992), which predicts that WM effects appear when WM capacity is taxed.

These findings are consistent with the broad class of WM theories (e.g., Baddeley, 1986), which argue that WM underlies the ability to maintain and process temporarily available information.

Selected References

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