

Development of a New Auditory Working Memory Measure: Preliminary Results

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Working Memory

- mechanism involved with combining temporary storage of information and maintenance/processing of that information to perform a cognitive task at hand
 - Visuospatial processing
 - Reading comprehension
 - Speech understanding

Baddeley & Hitch, 1974; 2010; Daneman & Carpenter, 1980; Shah & Miyake, 1999.



Working Memory

- capacity-limited
- a finite quantity of working memory resources available for a given person to store and process information
 - inter-individual differences in capacity
 - varies from person to person
 - intra-individual differences in capacity
 - resources allocated to storage and/or processing within an individual's given capacity for a given task

Just & Carpenter, 1992; Pichora-Fuller, 2006a



Working Memory and Speech Understanding

- listeners must interpret the meaning of running speech as it unfolds
- more mental energy is used during effortful listening (e.g., hearing loss, noise)
- errors, slower processing, or forgetting occurs when there is an insufficient working memory capacity for a given task, such as speech understanding in noise

e.g., Pichora-Fuller, 2006a



Working Memory and Speech Understanding



Adapted from Pichora-Fuller, 2006, p. 7., with permission.

Working Memory as a Clinical Tool

- Speech in noise performance (e.g., Akeroyd, 2008)
- Help identify individuals who may benefit from fast acting compression hearing aids (e.g., Gatehouse et al., 2006)



Purpose

- To develop a clinically-feasible auditory working memory measure for speech
 - quantify inter-individual and
 - intra-individual differences in working memory for speech in listeners with hearing loss



Prior Measures

- Daneman and Carpenter's (1980) reading span measure
- Pichora-Fuller and colleagues (1995) listening span measure using R-SPIN sentences
 - R-SPIN sentences were arranged in block sizes of 2, 3, 4, 5, and 6
 - Each block size had 5 sets each
 - Totalling 100 sentences (50 LP, 50 HP)



Our Word Span Measure

Randomization Two			
2 block			
Word	Recognition	Judgment	Recall
RICE	✓	✓	Rice, ✓
FIST	X, Fish	✓	Fish, ✓
RISK	✓	✓	Risk, ✓
GRACE	✓	✓	Grace, ✓
BAR	X, Car	X	Card, X
SHOVE	✓	X	Shove, ✓
WHAT	✓	✓	What, ✓
MOON	✓	✓	Moon, ✓
CALF	✓	✓	Rice, ✓
THAT	✓	✓	That, ✓

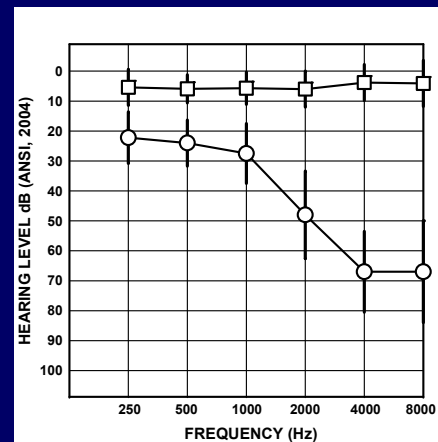
Span Scores

Block Size				
2 ✓	3 ✓	4 X	5 X	6 X
4/5	3/5	2/5	1/5	0/5

3.67

Participants

- 42 younger listeners with normal hearing
 - Mean age = 23.1 years ($SD = 2.6$)
- 59 older listeners with hearing loss
 - Mean age = 70.6 years ($SD = 6.1$)
- All passed MMSE



Processing Task

- 3 types of processing tasks were selected to induce different levels of processing (Craik & Lockhart, 1972)
 - None: no extra processing task
 - (i.e., storage only)
 - Alphabet: first (A-M) or second (N-Z) part of alphabet
 - Object: Yes or No



Methods/Procedures

- Battery of measures were administered in two visits:
 - Our word span (3)
 - WAIS-IV digit span
 - Words-In-Noise Test
 - Auditory Free Recall
 - Visual Free Recall
 - Montreal Cognitive Assessment
 - Vocabulary (WAIS-IV)

-Modified versions
-Same speaker
-Under earphones
-CD administration

-Power point



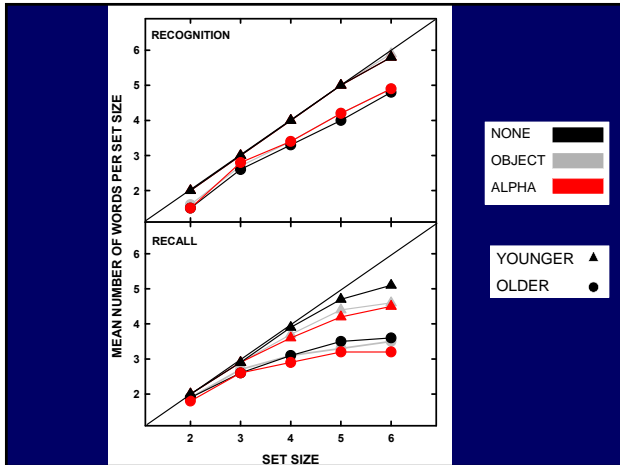
Methods/Procedures

- Battery of measures were administered in two visits:
 - Unaided Abbreviated Profile of Hearing Aid Benefit*
 - Speech Spatial and Qualities Hearing Scale*
 - Listening Self-Efficacy Questionnaire*
- for older participants only*
- and only n = 44 thus far*



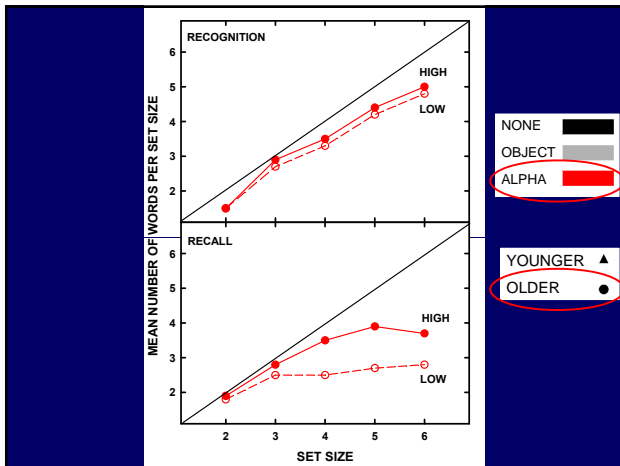
What are the recognition and recall performances for the word span measure for each processing task?





Low versus High Span

- Separated listeners into two groups based on median span score (3.33)
 - 3.33 and less → Low Span Group
 - 3.67 and higher → High Span Group



Correlations for OHL

	Recognition	Span
Recognition	-	ns
Span	ns	-

Auditory Measures	Recognition	Span
PTA or HFPTA	$r = .70-.77$ ($p = .000$)	ns
WIN 50% Point	$r = -.82$ ($p = .000$)	ns

Memory Measures	Recognition	Span
Digit Span-Forward	ns	ns
Digit Span-Backward	ns	$r = .28$ ($p = .03$)
Digit Span-Sequencing	ns	$r = .34$ ($p = .009$)
Auditory Free Recall	$r = .31$ ($p = .007$)	$r = .35$ ($p = .007$)
Visual Free Recall	ns	$r = .42$ ($p = .001$)
MoCA (total)	ns	$r = .37$ ($p = .004$)

- Word span (alphabet) and unaided APHAB**

- ease of communication subscale
 - 6 items related to communicating in quiet environments or 1:1 listening situations
 - $r = -.36$, $p = .02$, $n = 44$
- so, listeners with higher word span scores report fewer problems with ease of communication

- Recognition in quiet and unaided APHAB (or any questionnaire)**

- no significant correlation with ease of communication



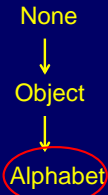
Preliminary Conclusions: Recognition Performances

- Younger listeners with normal hearing thresholds perform nearly ceiling
- Older listeners have good recognition performances (~ 80%), but poorer than younger listeners
- Fairly similar performances across processing tasks and set sizes



Preliminary Conclusions: Recall (Span) Performances

- Younger listeners outperform older listeners with hearing loss on all tasks
- Working memory is taxed more by higher memory load (i.e., higher set-sizes)
- Processing tasks:



Preliminary Conclusions: Correlations

1. Word span adds new information beyond auditory measures
 - No correlations among word span and auditory measures for either listener group
2. Word span is related to a relevant factor
 - Older listeners with better word span reported fewer problems on the ease of communication subscale (APHAB)
3. Inter-individual differences in memory for speech can be measured easily with well-known audiology test materials



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