



Norms for the Reading Span Test: English Version

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AUD RESEARCH PROJECT

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Background

- ▶ Working memory plays a role in speech perception^{1, 3, 4, 5, 6, 7, 8, 10, 11}
- ▶ May be a predictor of success with hearing aids^{3, 4, 5, 6, 8, 9, 10, 11}
- ▶ Might eventually be better predictor of success with sound processing strategies than the degree of the patient's hearing loss
- ▶ The Reading Span Test (RST) is the most appropriate and effective test for assessing working memory^{1, 2, 3, 9}
- ▶ Most highly predictive of speech perception abilities, especially when speech is degraded^{1, 2, 3, 9}

Purpose

- ▶ To establish normative data for the English version of the RST
- ▶ Having the appropriate normative data will potentially:
 1. Allow clinicians to determine whether the working memory abilities of their hearing impaired clients fall within normal limits
 2. Serve as a tool to aid researchers and clinicians in determining whether there are clear groups that will perform better or worse with particular hearing aid signal processing strategies
 3. Provide norms for working memory research using the RST in other disciplines outside of Audiology

Methods: Subjects

- ▶ 60 native English speakers ages 18-30¹² with normal hearing and typical cognitive function
- ▶ Balanced for gender (30 males, 30 females)
- ▶ Balanced for education
 1. High School Degree/GED (20 subjects, 10 males, 10 females)
 2. Some College/Associate's Degree (20 subjects, 10 males, 10 females)
 3. Bachelor's/Master's/Doctoral Degree (20 subjects, 10 males, 10 females)
- ▶ Age groups
 1. 18-21 (11 subjects)
 2. 22-25 (38 subjects)
 3. 26-30 (11 subjects)

Methods: Stimuli

- ▶ The Reading Span Test
 - ▶ Ronnberg et al (1989) version
 - ▶ Working memory test designed to tax both storage and processing functions of working memory
 - ▶ Involves sentence comprehension, the ability to maintain and retrieve the first or final word from each sentence, and the ability to make a judgement about each sentence
 - ▶ Consists of 57 sentences (noun, verb, object)
 - ▶ Three groups of 3, 4, 5, and 6 sentences
 - ▶ Becomes more difficult as the test goes on

Methods: Procedure

- ▶ Subject seated in quiet room with limited distractions, facing researcher's personal laptop computer
 - ▶ Option of where to participate
 - ▶ No compensation
- ▶ Test protocol completed in 3 steps:
 1. Read and sign consent form
 2. Complete 8-item questionnaire
 3. Complete the Reading Span Test
- ▶ Verbal and written instructions provided prior to beginning the test

Instructions to the Reading Span test

This is a difficult test but try to do your best.

You will be shown a number of short sentences on the screen.

The words in the sentences will be shown by one or two words at a time.

Some of the sentences will be strange and will not make sense. For example: *The train sang a song.*

Other sentences will be normal and will make sense. For example: *The girl sang a song.*

After each sentence there will be a brief pause.

Read each sentence out loud. When you have read the sentence your job is to answer "YES" if the sentence made sense, and "NO" if the sentence did NOT make sense.

After a number of sentences have been presented, the screen will display the word "RECALL".

You will then be asked to repeat the first or the last word in each sentence. I will tell you whether it is the first or the last word in each sentence that you are supposed to repeat.

In addition, your task is to try to repeat the words in the correct order.

The number of sentences is going to increase as the test goes on, which will make it more and more difficult. Just try to do your very best!

Keep in mind that this test will move rapidly. The sentences are presented quickly, and cannot be restarted. Make sure that you pay attention to the sentences, and save any comments or questions for breaks in the test. I will let you know when these breaks occur.

So, your jobs are to:

- Read each sentence out loud. Answer "YES" or "NO" after each sentence depending on whether the sentence made sense or not.
- When the word "RECALL" is shown, I will say "first" or "last" and you will repeat the first or the last word of each sentence in the correct order.

Do you have any questions?

Reading span test

START

PAUSE

CANCEL

THE FISH

PLAY

CANCEL

DROVE

PAUSE

CANCEL

A CAR



PLAY

CANCEL

CHARLES

PAUSE

CANCEL

DRANK

PAUSE

CANCEL

GRASS

PAUSE

CANCEL

PLAY

CANCEL

THE BALL



BOUNCED

PAUSE

CANCEL



Document1 - Microsof...

Reading span english

stimulering engelska.vi



12:34 AM

AWAY

PAUSE

CANCEL



Document1 - Microsof...

Reading span english

stimulering engelska.vi



12:35 AM

PLAY

CANCEL

Recall

CONTINUE

CANCEL

PAUSE

CANCEL

Methods: Scoring

- ▶ Each correct word was recorded and yes/no response was recorded
- ▶ There are two primary methods of scoring
 - ▶ Total correct
 - ▶ Total in correct serial order
- ▶ Confusion regarding the correct serial order method
- ▶ The developer was contacted for clarification and reported to use the total correct method
- ▶ Total correct method seemed most appropriate and appears to be the most commonly used

Three sentences

<u>Sense?</u>	<i>Response</i>	<i>First/Last</i>
<u>Y</u> N THE HORSE - NICELY	<input type="checkbox"/>	-----
<u>Y</u> N THE BOY - FAR	<input type="checkbox"/> # correct <input type="checkbox"/>	
Y <u>N</u> THE BIRCH - LOUDLY	<input type="checkbox"/> # in correct serial order <input type="checkbox"/>	

<u>Sense?</u>	<i>Response</i>	<i>First/Last</i>
Y <u>N</u> THE FISH - CAR	<input checked="" type="checkbox"/>	<u>F</u>
Y <u>N</u> CHARLES - GRASS	<input checked="" type="checkbox"/> # correct <input checked="" type="checkbox"/>	
<u>Y</u> N THE BALL - AWAY	<input checked="" type="checkbox"/> # in correct serial order <input type="checkbox"/>	

<u>Sense?</u>	<i>Response</i>	<i>First/Last</i>
<u>Y</u> N THE PRIEST - BIBLE	<input type="checkbox"/>	-----
Y <u>N</u> THE FARMER - HOUSES	<input type="checkbox"/> # correct <input type="checkbox"/>	
<u>Y</u> N THE CAR - FAST	<input type="checkbox"/> # in correct serial order <input type="checkbox"/>	

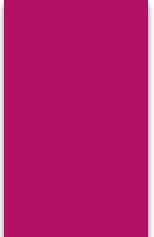
Data Analysis

- ▶ Goal: to develop normative data
- ▶ But, are there any gender, education, or age effects?
- ▶ Analyzed data using SPSS
- ▶ Generated descriptive statistics
- ▶ Performed One Way ANOVA for each factor

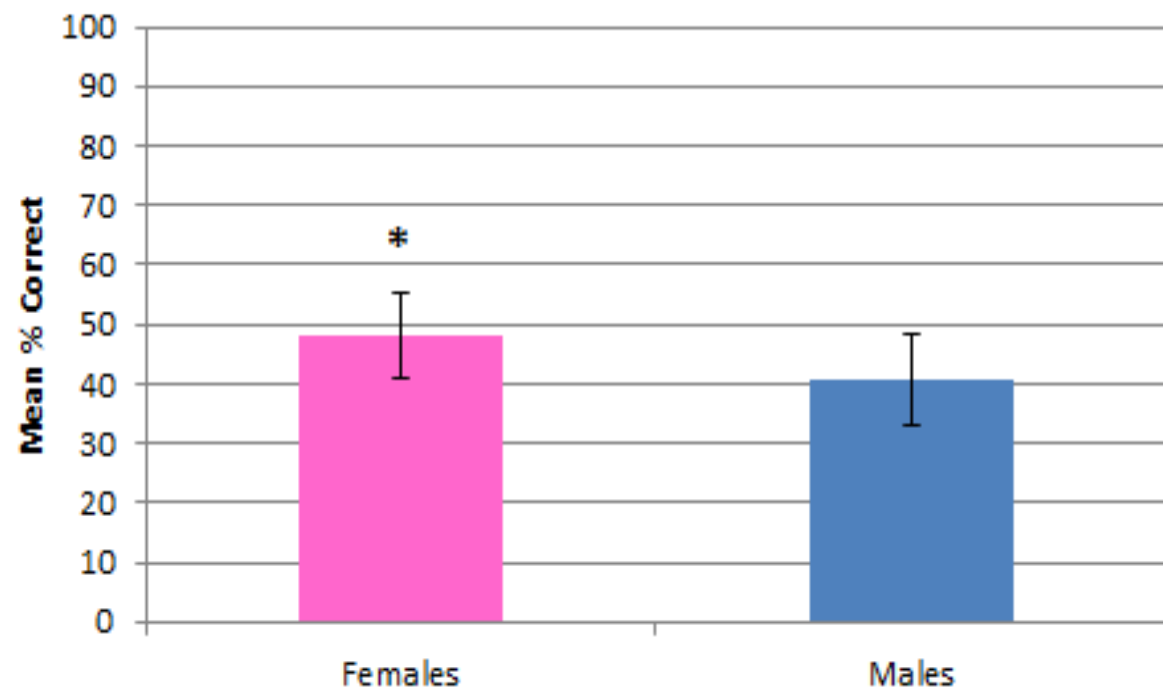
Results

Descriptive Data

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
% Correct	All	60	44.41	8.34	42.26	46.57	29.63	61.11
	Female	30	48.09	7.29	45.37	50.81	35.19	61.11
	Male	30	40.74	7.78	37.84	43.65	29.63	55.56
	High School/GED	20	42.96	8.49	38.99	46.94	29.63	55.56
	Associate's/Some College	20	42.78	6.85	39.57	45.98	29.63	61.11
	BA/MA/Doc	20	47.50	9.06	43.26	51.74	31.48	59.26
Y/N Errors	All	60	4.38	2.75	3.67	5.09	.00	12.00
	Female	30	3.77	2.76	2.74	4.80	.00	11.00
	Male	30	5.00	2.64	4.01	5.99	.00	12.00
	High School/GED	20	5.40	2.64	4.16	6.64	1.00	12.00
	Associate's/Some College	20	4.70	2.49	3.53	5.87	1.00	11.00
	BA/MA/Doc	20	3.05	2.68	1.79	4.31	.00	9.00



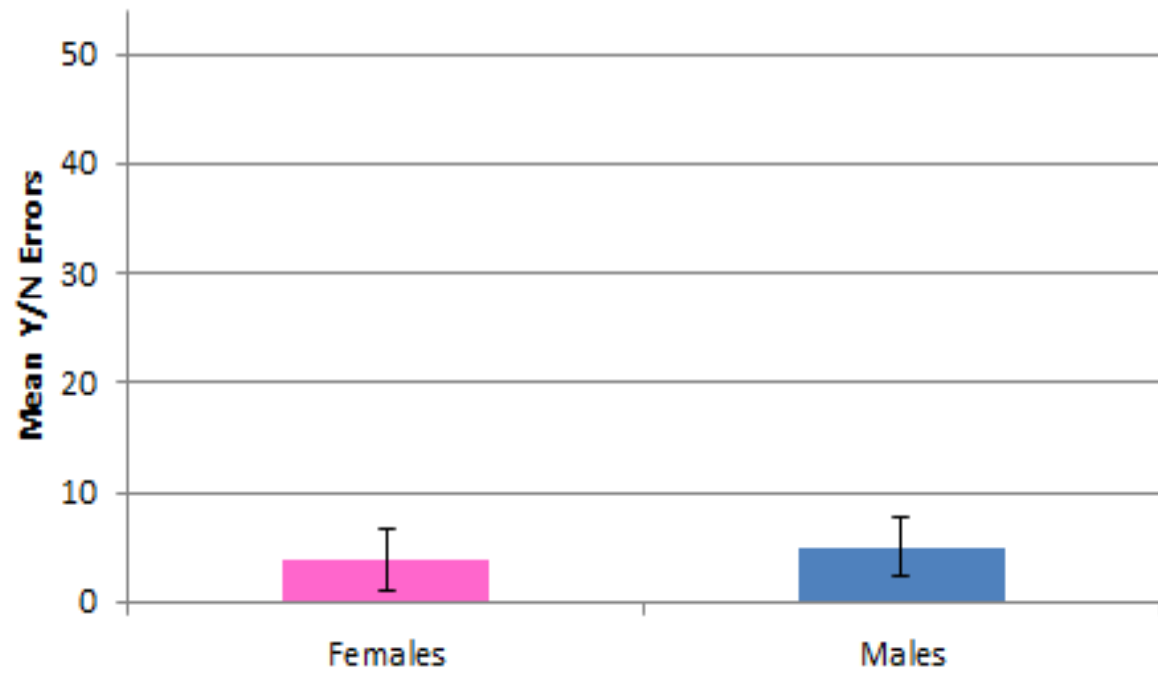
Gender



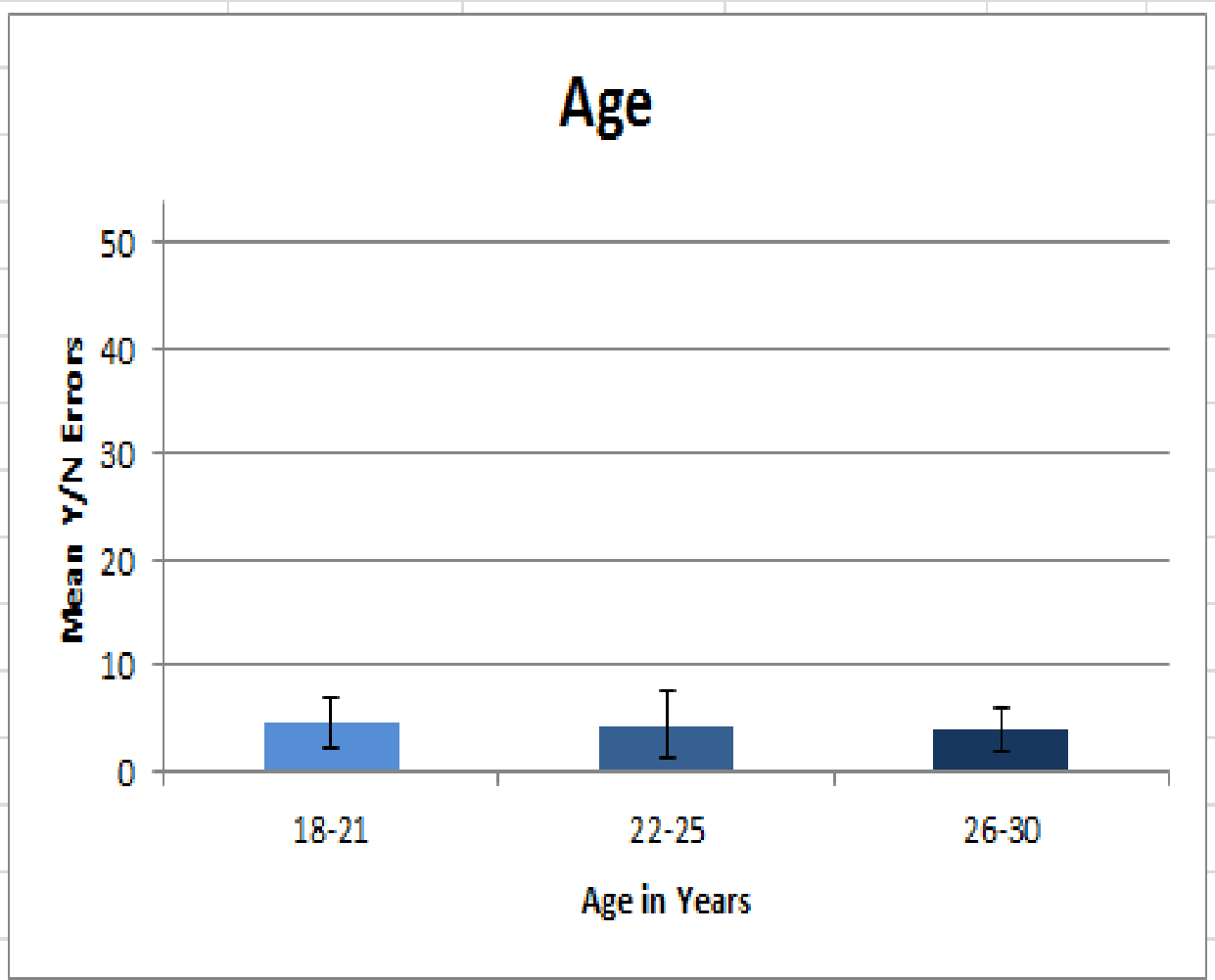
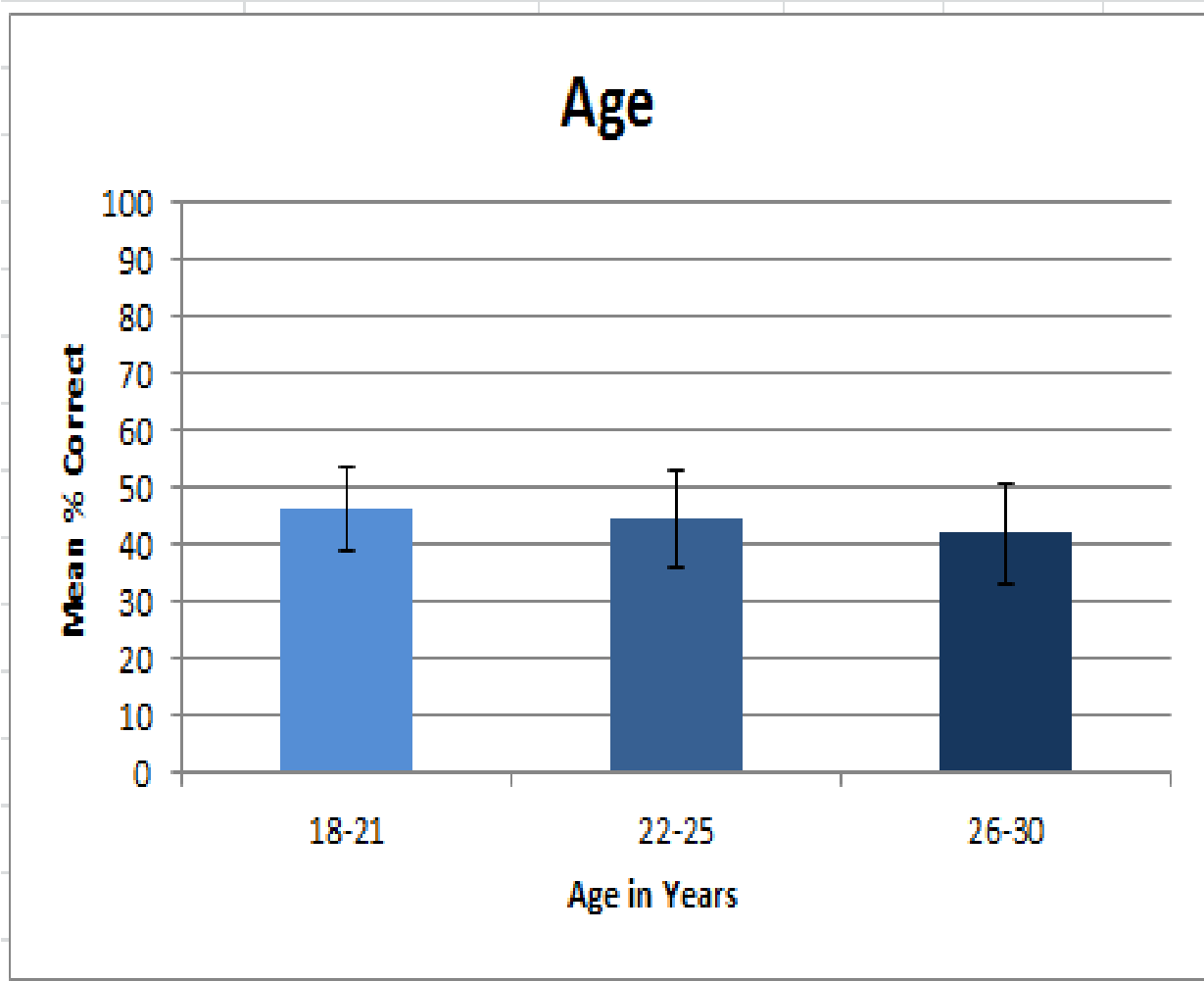
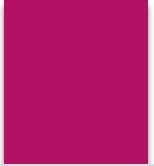
* $p < 0.001$

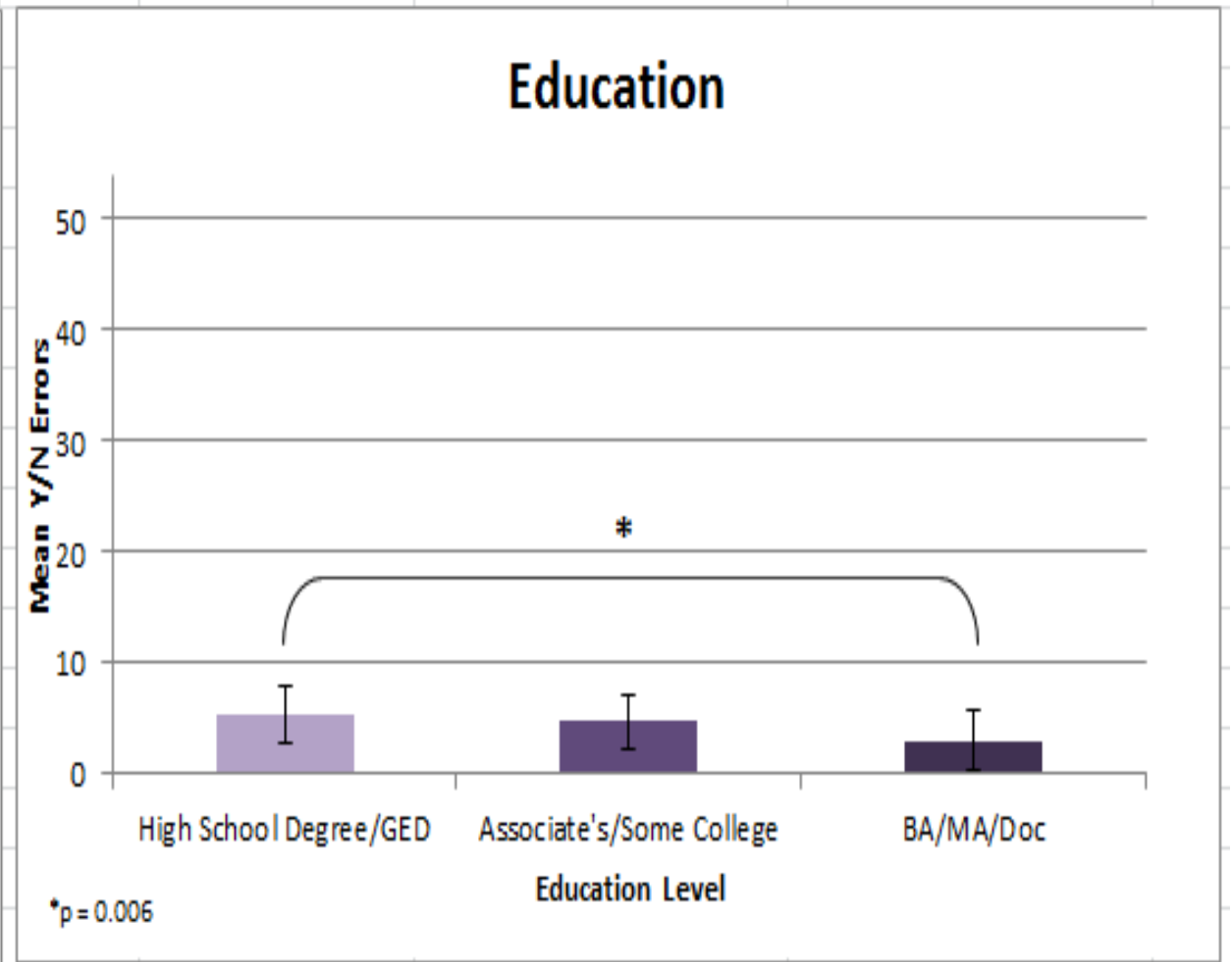
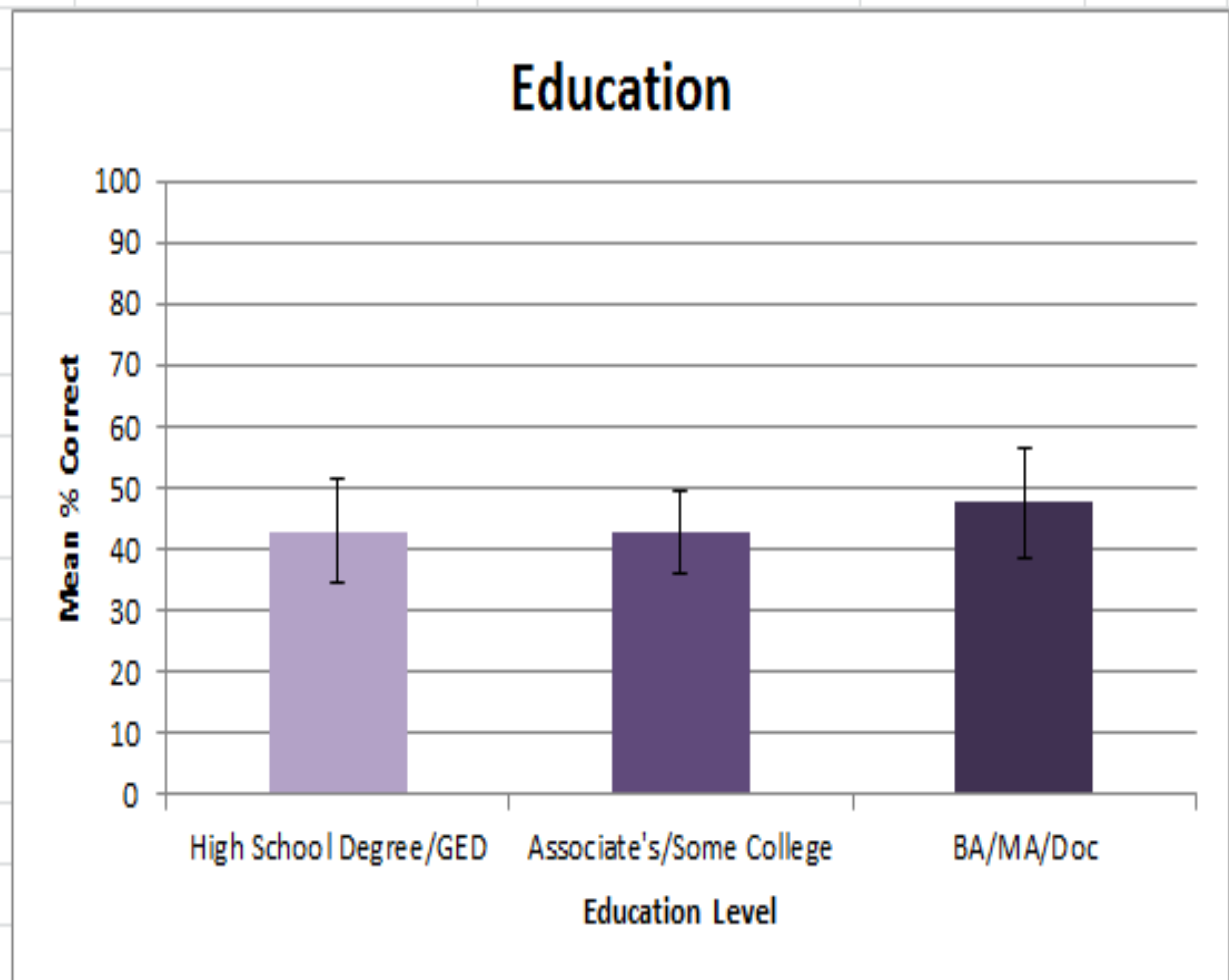
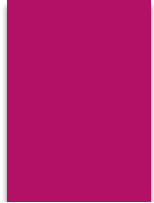
Gender

Gender



Gender





Discussion

- ▶ Primary Aim
 - ▶ Obtain normative data for the English version of the RST
- ▶ Findings
 - ▶ % Correct
 - ▶ Average score across all subjects was 44.41% with a standard deviation of 8.34%
 - ▶ Range of scores between 29.63 and 61.11%
 - ▶ Yes/No Errors
 - ▶ Average errors across all subjects was 4.38 with a standard deviation of 2.75
 - ▶ Range of errors between 0 and 12
- ▶ Implications
 - ▶ Important for determining “normal” range of scores
 - ▶ Age group represents peak performance, and still no greater than 61.11% correct
 - ▶ Norms on additional populations needed

Discussion

- ▶ Secondary Aim
 - ▶ Determine if there are differences in performance as a function of gender, age, and education
- ▶ Findings
 - ▶ Gender Effect: mean % correct score was significantly higher for females compared to males
 - ▶ Age Effect: none
 - ▶ Education Effect: the high school/GED group made significantly more yes/no errors than did the Bachelor's/Master's/Doctoral degree group

Discussion

- ▶ Secondary Aim
 - ▶ Determine if there are differences in performance as a function of gender, age, and education
- ▶ Implications
 - ▶ Females may have better working memory abilities compared to males
 - ▶ Supported by some research¹³
 - ▶ Additional norms may support or refute this finding
 - ▶ Young adults between 18 and 30 years of age tend to have similar working memory abilities
 - ▶ Did not balance for age
 - ▶ Small and limited age range
 - ▶ Educational level may impact one's ability to make judgments about a sentence, but may not necessarily correlate with working memory ability
 - ▶ Likely a function of greater word-familiarity and vocabulary with greater education

Conclusions

- ▶ Normative data for the English version of the Reading Span Test was collected on 60 native English speakers with normal hearing and typical cognitive function.
- ▶ Statistical analysis of the data revealed gender and education effects but no age effects.
- ▶ A gender effect was noted, which may suggest that females have greater working memory abilities compared to males; Additional norms are needed to help support/refute this finding.
- ▶ An education effect was noted and is likely a function of greater word-familiarity and vocabulary with greater education.

Conclusions & Future Directions

- ▶ Norms for the English version of the RST ought to be collected on other populations, such as older/elderly normal hearers, young hearing-impaired, and older/elderly hearing-impaired in order to establish differences between and among groups.
- ▶ Establishment of further norms may show evidence of clear group differences in working memory ability.
- ▶ Research has shown that working memory and cognition correlate more highly with speech perception test benefit, satisfaction, and reported intelligibility when fast signal processing is employed over the degree of hearing loss itself².
- ▶ Thus, establishing a normative database to help clinicians determine where their patients fall relative to normal may aid in the appropriate selection and fitting of amplification, which may result in greater patient benefit and successful hearing aid adoption.

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