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Attention and memory in young and middle-aged adults

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ATTENTION AND MEMORY

IN YOUNG AND MIDDLE-AGED ADULTS

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INTRODUCTION

Within the field of communication sciences and disorders, studies concerning performance on cognitive tests tend to focus on the differences between young and old-age groups. The geriatric population has significantly increased over the years and will continue to rise in the coming decades. This rise in the number of older adults has resulted in research that is directed towards investigating the decline in cognitive ability in the aging population.

Unfortunately, little research has been conducted on the cognitive-linguistic performance in middle-aged adults. Without such information, health-care professionals will not have a way to know if middle-aged patients are exhibiting impaired cognitive skills or are in fact, demonstrating age-appropriate cognitive abilities.

This research provides necessary information for speech-language pathologists to design and conduct therapy with the highest benefit to the clients of representing various age ranges. Speech and language are complex cognitive abilities and their degree of functionality depends greatly on the affects from other cognitive functions acting upon it.

LITERATURE REVIEW

Research has shown that memory decline can appear in at least 40% of adults older than 60 years of age (Small, 2001). Small's work investigates the connection between a decline in memory and aging and has conclusively linked the affects of age on memory skills on a gross anatomical level, particularly concerning the effects of an aging hippocampus (2001).

Memory is essential to language performance as it aids comprehension, conversation and word retrieval (Au and Bowles, 1991). Language assessments usually require functional memory processing abilities to ensure success in areas of language. The decline in ability to complete

memory tasks can be directly affected by aging, even among healthy individuals. Yet it works in the other direction as memory can be aided by the successful use of language (Au & Bowles, 1991). Language and memory are two cognitive skills that are heavily interconnected and the study of memory in terms of communication disorders can give insight into language therapy strategies for the aging populations.

Short-term memory keeps information for only a few seconds if it is not actively practiced or repeated. Information is then re-located to long-term memory or forgotten (Connor, 2001). Little research on memory has been gathered on the middle-aged population and short-term memory. Davis, Small, Sterm, Mayeux, Felsdstein and Keller (2003) examined verbal memory recall (i.e. repetition) across the life span using 136 participants were divided into four age groups: 30-45, 46-60, 61-75, ad 76-90 years of age. Participants were given a series of verbal recall tests and had to recall this information following a 20 minute delay and a one day delay. The rate of acquisition was similar for all of the groups, but the level of acquisition and recall was poorer in the two older groups and scores declined as more time passed. Participants aged 46-60 performed better than the two older groups, but not as well as the youngest group. Findings demonstrated that cognitive memory delays could be distinguished by age 40.

Memory is not the only important cognitive ability involved in communication. Hooker and Shifren (1995) found the components involved in older adults' communication include attention and memory. Their research has shown that the older population demonstrates a decline in attention as complexity increases. Irrelevant information is also difficult for the older population to sort. This results in unfocused attention causing difficulty when completing memory performance tasks (Hooker & Shifren, 1995).

Attention is a critical factor in cognition. Without attention, information cannot be correctly processed (Lemme, 1999). A decline in the ability to attend for a long period of time can begin as early as 30-40 years of age as reported by Yakhno, Zakharow and Lokshina (2007). Operative memory was also seen to decrease in accordance with age. The young adult population serves as the comparison baseline for determining the success of middle-age and older adult populations' performance in tasks concerning cognitive ability. (Yakhno, Zakharow, & Lokshina, 2007)

Some research has been conducted in middle-aged adults' attentional abilities. Some researchers have found that middle-aged adults do as well as young adults on familiar visual search activities measuring selective attention (Clancy & Hoyer, 1994). On the other hand, Parasuraman and Giambara (1991) found that middle-aged participants had poorer outcomes than young adults on vigilance tasks.

Other research on attention has only compared young and older adults. Castel and Craik (2003) looked specifically at divided attention. Younger adults (mean age 21) were given both divided and full-attention tasks, while older adults (mean age 70) were given full-attention tasks. Full attention tasks were measured by signaling recognition of previously encoded word pairs, while divided attention tasks looked at previously encoded word pairs in addition to encoded number pairs. All participants were given 130 unrelated word pairs which were comprised of 260 two-syllable concrete nouns that were randomly paired to form 130 pairs. They then had to recognize the first word when given the second word in the pair (item recognition). Associative information was measured by recognition of the complete pair. The older adults who participated in the full attention tasks and the younger adults who were given the divided-attention tasks did

not perform as well as young adults who were given the full-attention tasks. These support age-related decreases in the attentional abilities of adults as they age.

While preliminary research has been conducted on the attention and memory changes in the middle-age, studies have traditionally compared the results of cognitive tests between young and older adults. It is the comparison between young and middle-aged adults that is lacking. The following study is a step in the right direction to remedy this situation.

A pilot study conducted by Johnson, Young, Burda, and Hageman (2006) reported that middle-aged adults evidenced statistically significant declines in attention compared to young adults. Yet there was no difference in performance between the age groups on memory tasks. Also, the middle-aged adults had higher recall scores than their younger counterparts, contradictory to previous research studies on memory decline outlined earlier (Davis, et al., 2003).

PURPOSE

This study was designed to investigate the effect of age on the cognitive abilities of attention and memory. Studies have traditionally focused on the differences between young and older adults, so this study will focus on the middle-age population. By focusing on attention and memory of the middle-age population, the missing information can lead to a better understand of how cognitive functions, particularly attention and memory, evolve throughout an individual's lifetime. Attention and memory are two vital cognitive functions that directly affect comprehension and production of speech and language. By studying the evolution of these functions, a clearer understanding of communication can be established concerning the middle-age adult population. Studies continuing this investigation can lead to more effective

rehabilitation and innovative prevention techniques. This in turn will facilitate therapy goals and strategies for those facing communication difficulties that place them in the care of speech-language pathologists. The purpose of this study is to investigate whether or not a significant difference exists in performance on cognitive tests, specifically in areas of attention and memory, between young and middle-aged adult groups.

HYPOTHESIS

The results of this study are expected to mimic the result of the pilot study conducted by Johnson et al. (2006). The middle-aged adults will score lower in areas of attention when compared to young adults, and when comparing the subgroups within the middle-aged adult group, scores will show a decline between 40-49 years to 50-59 years of age. In terms of memory, scores similar to the Johnson et al. (2006) study will result, showing no significant differences between the groups. A decline in scores may be seen in the 50-59 years of age middle-age adult subgroup. This is expected as studies have found the older adult populations have lower performance on memory tests when compared to the young and middle-age adult populations.

RESEARCH METHODS

Cognitive assessments were administered to young and middle-aged adults. Fifty-four native English speaking adults with at least a high school education participated in this study. They were divided into two groups of young adults, 20-39 years of age, and middle-aged adults, 40-59 years of age (see Table 1). The participants came to the Roy Eblen Speech and Hearing Clinic at the University of Northern Iowa for testing. When unable to do so, testing occurred in a private, quiet setting within the home. Only one session was necessary per participant. Testing

sessions lasted approximately 90 minutes. Participants were approached to participate in the study in the Roy Eblen Speech and Hearing Clinic or contacted by phone. If interested, the participant was given information provided in the consent form and provided information regarding how to contact the researcher and when the session would occur.

Table 1

Participants

	Mean	*SD*
Young Adults (20-39 yrs)	26.35	5.79
Middle-age Adults (40-49 yrs)	45.40	3.50
Middle-age Adults (50-59 yrs)	52.94	2.44

Participants were asked to sign a consent form before any testing began as specified in the IRB approved protocol. The form facilitated informed consent from the participant before the examinations began. It thoroughly explained the format of the testing session, specifically, the requirements that the participant needed to pass a screening of speech, language, cognition and hearing abilities before four tests of cognition were administered. The consent form alerted the participant audio recordings would be used to record speech samples that would be scored after the completion of the test. The minimal risks were outlined stating discomfort is a possibility if some test questions were found challenging. And finally, confidentiality of all test materials and score results were assured, and the participant's right to withdraw from the study at any time was defined.

After consent was granted, the participant had to pass a hearing screening to ensure the participant's hearing ability would not affect their performance results. The participant had to have normal hearing in both ears for frequencies 250, 500, 1000, 2000, and 4000 Hz to pass. The

screen was administered by the researcher with an audiometer in a therapy room at the Roy Eblen Speech and Hearing Clinic or the quiet setting within the home.

The participants also completed a biography questionnaire at this time. The questionnaire began with the participant's name, age, gender and level of education completed. The options regarding educational level included: high school, two year degree (associate's degree), some college but never completed a degree, professional/technical degree, bachelor's degree, master's degree, and Ph.D. At least a high school degree was required for the participant to be considered for the study. The questionnaire continued with questions concerning the individual's health status that required self-reported statements regarding existence of any neurological problems and evaluation of general health overall, as well as their health on the day of the assessment. If there was a concern with the health of the participant and that their potential health concerns would interfere with the individual's performance on the cognitive assessments, then the participant was pulled from the study. The questionnaire ended with yes and no questions inquiring about the participant's physical exercise routine, social network of friends, regular completion of word or number puzzles, and involvement in volunteer or civic organizations.

The *Mini-Mental State Examination* (*MMSE*) was administered after the hearing screening and biography questionnaire. The *MMSE* is used as a screening measure of variously aged-adults when there is concern regarding a decline in cognitive function that can lead to living in an assisted community, hospital or institution. Poor performance may help health-care professionals make recommendations regarding the living situation of the individual. It is a systematic, routine assessment that can be given repeatedly to assess mental status and to compile data to track the decline of cognitive function in the individual. Mental status is assessed

in terms of cognitive functionality by testing orientation, registration, attention and calculation, recall, and language abilities (Kurlowicz & Wallace, 1999). Participants must pass this 11-part questionnaire with a score of 28 or higher out of 30 total to continue on with this study. The *MMSE* is an ideal choice for the mental status screen as it only takes 5-10 minutes to administer.

The participant continued on with the experimental session after s/he signed the consent form, passed the hearing screening, completed the biographical questionnaire and obtained a score of at least 28 on the *MMSE.* After screening was complete, the participant was administered four tests to assess cognitive skills. The four chosen were *Ross Information Processing Assessment (RIPA-2), Rey Auditory Verbal Learning Test (RAVLT), Wechsler Working Memory* subtest of the *Wechsler Memory Scale (WMS-III)*, and *Cognitive Learning Quick Test (CLQT)*. The tests were presented in counter-balanced order to the participants.

The *RIPA-2* (Ross-Swain, 1996) is a 10 subtest battery that assesses cognitive-linguistic skills. The test is designed to be given by speech-language pathologists or other trained assessment professionals to investigate a patient's cognitive-linguistic skills after a traumatic brain injury (TBI). The subtests cover the skills of immediate memory, recent memory, temporal orientation (recent memory), temporal orientation (remote memory), spatial orientation, orientation to environment, recall of general information, problem solving and abstract reasoning, organization, and auditory processing and retention (Ross-Swain, 1996). Samples of questions asked in Subtest I: Immediate Memory include repeating a series of numbers that were read aloud, up to seven digits, and following three step directions, and samples of questions asked in Subtest II: Recent Memory include inquiries concerning the day of the week and what the participant first did that morning.

The test's author reports that reliability of the *RIPA-2* was measured in terms of content sampling and interscorer reliability. One hundred twenty-six protocols were analyzed to find the degree of homogeneity within each subtest. Using Cronbach's (1951) coefficient alpha for dichotomously scored items, 70% of the subtests had coefficients of .80, considered acceptable reliability. The optimal level, .90, was reached by 20% of the subtests. Strong reliability for the subtests is expressed through the median coefficient alpha of .85. Interscorer reliability is strong in objective tests like the *RIPA-2*. Having three clinicians score the same videotaped assessment, interscorer reliability was calculated at 99.5%. Such a percentage marks an excellent level of reliability (Ross-Swain, 1996).

Validity of the *RIPA-2* was assessed in terms of content validity, criterion-related validity, and construct validity. Content validity was analyzed by each subtest being reviewed by experts in each area assessed. The subtests met the requirements to conclude validity of each section. Criterion-related validity was assessed by Woodcock-Johnson Tests of Cognitive Ability (Woodcock & Johnson, 1989) and all subtests were found to be valid. Construct validity was assessed by multiple methods and results suggest the *RIPA-2* had no weakness in its validity (Ross-Swain, 1996).

The *Rey Auditory Verbal Learning Test (RAVLT)* (Schmidt, 2004) measures verbal learning and memory by presenting tasks for rote memorization without the influence of semantic organization. The assessment take approximately 15 minutes to administer and is appropriate for ages 7 through 89 years. A 15-word list of unrelated nouns is presented and the examinee is asked to recall as many words as possible. The task is repeated five times before a second list of 15 words is presented for recall. Upon completion the participant is asked to recall

words from the first list (Schmidt, 2004). The first list of 15 words includes: drum, curtain, bell, coffee, school, parent, moon, garden, hat, farmer, nose, turkey, color, house, and river.

Data from studies combined from Geffen, Butterworth, and Geffen (1994) and Uchiyama et al. (1995) evidence has supported the *RAVLT's* test-retest reliability. The later trials were found to have stronger reliability than the previous three and the alternate list trial. This is explained by the studies as a result of low variability between the scores of the first few trials. In result, the *RAVLT* has an overall good reliability of scores (Schmidt, 2004).

The *Weschler Working Memory* subtest of the *Weschler Memory Scale III* contains Visual Reproduction, Letter-Number Sequencing, and Spatial Span. Visual Reproduction assessment investigates hippocampal ability, especially in those with traumatic brain injury, and the effects of motor-control on drawing ability and visual-perceptual distortions (*WAIS-III - WMS-III* Technical Manual, 2002). Such abilities can affect the comprehension and production of written language.

Letter-Number Sequencing, similar to the *RAVLT*, is an assessment of auditory working memory (*WAIS-III - WMS-III* Technical Manual, 2002). Neurological disorders can easily affect these results, including a decline in cognitive function, particularly in attention and memory. The participant recalls a series of letters and numbers that were presented by the administrator in a random order, except the participant arranges the numbers in numerical order first, and the letters alphabetically (*WAIS-III - WMS-III* Technical Manual, 2002).

The Spatial Span subtest requires the participant to repeat visual sequences presented by the administrator utilizing a three-dimensional board. The subtest is administered in two parts.

The first, the participant is to repeat the sequence exactly as presented and second, the participant is to repeat the sequence in reverse order. (*WAIS-III - WMS-III* Technical Manual, 2002).

Regarding the reliability of the *Wechsler Memory Scale III*, studies have shown the reliability coefficients for the subtests range from .74 to .93 within the average medians throughout the age scores. The median coefficient being .81 (*WAIS-III - WMS-III* Technical Manual, 2002). These results suggest a strong reliability across the subtests of the *WMS-III*.

Convergent validity of the memory measures within the *Weschler Working Memory Scale* subtest is evidenced by the high correlation with externals measures with visually presented material. High correlations were also found regard with measures of spatial processing within the subtest when compared with external measures (*WAIS-III - WMS-III* Technical Manual, 2002).

The *Cognitive Linguistic Quick Test* (*CLQT*; Helm-Estabrook, 2001) is an assessment of neurological dysfunction. The author reports that this evaluation tool covers the cognitive functions of attention, memory, language, executive functions and visuospatial skills in 15-30 minutes. The test can be administered to adults ages 18-89 years with native languages of either English or Spanish. It has been designed to provide a brief, overall assessment of cognitive abilities to aid in further assessment therapy strategies. The *CLQT* contains 10 tasks; personal facts, symbol cancellation, confrontation naming, clock drawing, story retelling, symbol trails, generative naming, design memory, mazes, and design generation. All subtests, except confrontation naming, evaluate the areas of attention and memory (Helm-Estabook, 2001).

RESEARCH QUESTIONS

This research study is focused on collecting the data concerning attention and memory skills in middle-age adults. In addition, this investigation sought to determine if decline in these

cognitive areas can be found in the middle-aged population. This was determined by comparing middle-age adults' scores to young adults' scores, as the young adult population has historically shown no decline in memory and attention due to aging. By focusing on the middle-age population two research questions have directed the study's focus.

- Is there significant difference in the performance on attention and memory subtests between young adults and middle-aged adults?
- Is there a significant difference in performance on attention and memory subtests between middle-aged adults ages 40-49 years and 50-59 years?

By answering these questions, this study can determine if previous assumptions regarding the beginning of the decline of attention and memory in older adults, at least 60 years old, is no longer accurate, and therapy implications need to be addressed.

RESULTS

Specific subtests of the four assessments that assess attention and memory were chosen for statistical analysis. Participant groups were compared young adults (20-39 yrs.) to middle-age adults (40-59 yrs.) and then the subgroups within the middle-age adult group, 40-49 year old adults to 50-59 year old adults. Statistically significant performance differences were found in only one subtest comparing young to middle-age adults. No statistically significant performance differences were found comparing middle-age adult subgroups.

Within the *RIPA-2*, the first two subtests, Immediate Memory and Recent Memory, were chosen. On the *RIPA 2*, Subtest 1, there were no statistically significant differences between the young and middle-age groups for Subtest I $F(2, 54) = 1.93$, $p < .17$ and Subtest II $F(2, 54) = .01$, $p < .92$ (see Table 2). No statistically significant differences between middle-age subgroups

were found for Subtest I F (2,28) = 1.71, p < .20 and Subtest II F (2, 28) = .60, p < .44 (see Table 3).

Table 2

RIPA-2 F-Table for Adults Aged 20-39 and 40-59

Subtests		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Subtest I	Between Groups	12.11	1	12.11	1.93	0.171
	Within Groups	327.22	52	6.29		
	Total	339.33	53			
Subtest II	Between Groups	.01	1	.01	0.01	0.92
	Within Groups	37.99	52	.73		
	Total	38.00	23			

Table 3

RIPA-2 F-Table for Adults Aged 40-49 and 50-59

Subtests		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Subtest I	Between Groups	12.01	1	12.01	1.71	0.20
	Within Groups	182.10	26	7.01		
	Total	194.11	27			
Subtest II	Between Groups	.23	1	.23	0.60	0.44
	Within Groups	9.88	26	.38		
	Total	10.12	27			

For the *RAVLT*, on Trial I, no statistically significant difference between the young and middle-age groups F (2,54) = .661, p < .70. There were statistically significant differences on Trial VI F (2, 54) = 2.45, p < .04 (see Table 4). No statistically significant differences between middle-age subgroups were found for Trial I F (2,28) = 1.71, p < .20 and Subtest II F (2, 28) = . 60, p < .44 (see Table 5).

Table 4

RAVLT F-Table for Adults Aged 20-39 and 40-59

Subtests	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
	10.39a	34	.31	1.88	.07
	70.02	1	70.02	429.84	.00
Trial I	.75	7	.11	.66	.70
Trial VI	4.38	11	.40	2.45	.04
	4.55	16	.28	1.74	.12
	3.10	19	.16		
	138.00	54			
	13.48	53			

a. R Squared = .74 (Adjusted R Squared = .21)

Table 5

RAVLT F-Table for Adults Aged 40-49 and 50-59

Subtests	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
	4.73a	18	.26	1.39	.31
	124.33	1	124.33	658.24	.00
Trial I	1.04	6	.17	.91	.53
Trial VI	3.34	9	.37	1.97	.16
	.01	2	.00	.01	.99
	1.70	9	.19		
	202.00	28			
	6.43	27			

a. R Squared = .74 (Adjusted R Squared = .21)

For the *WMS-III*, there were no statistically significant difference between the young and middle-age groups for Spatial Span Forward $F(2, 54) = 1.11$, $p < .40$ and Spatial Span Backward $F(2,54) = 1.62$, $p < .18$ (see Table 6). No statistically significant difference between middle-age subgroups were found for Spatial Span Forward $F(2, 54) = .68$, $p < .65$ and Spatial Span Backward $F(2, 54) = .73$, $p < .64$ (see Table 7).

Table 6

WMS-III F-Table for Adults Aged 20-39 and 40-59

Subtests	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
	29.23a	31	.94	1.53	.15
	75.75	1	75.75	122.68	.00
SS Forward	6.17	9	.685	1.11	.40
SS Backward	6.99	7	1.00	1.62	.18
	10.75	14	1.62	1.24	.31
	13.58	22	1.24		
	228.00	54			
	42.82	53			

a. R Squared = .64 (Adjusted R Squared = .02)

Table 7

WMS-III F-Table for Adults Aged 40-49 and 50-59

Subtests	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
	4.10a	17	.24	1.03	.50
	121.87	1	121.87	522.30	.00
SS Forward	.80	5	.16	.68	.68
SS Backward	1.02	6	.17	.73	.64
	1.16	5	.23	1.00	.47
	2.33	10	.23		
	202.00	28			
	6.43	27			

a. R Squared = .64 (Adjusted R Squared = .02)

For CLQT, the cognitive domain of Attention had no statistically significant difference between the young and middle-age groups $F(2, 54) = 2.27$, $p < .19$ and the cognitive domain of Memory $F(2, 54) = 2.06$, $p < .22$ (see Table 8). Statistical results for Attention and Memory for middle-age subgroups were inconclusive.

Table 8

CLQT F-Table for Adults Aged 20-39 and 40-59

Subtests	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
	40.82a	48	.85	2.13	.20
	146.26	1	146.26	365.66	.00
Attention	14.52	16	.91	2.27	.19
Memory	16.46	20	.82	2.06	.22
	6.16	4	1.54	3.85	.09
	2.00	5	.40		
	228.00	54			
	42.82	53			

a. R Squared = ..95 (Adjusted R Squared = .51)

RECOMMENDATIONS

Few studies are completed in an entirely optimal manner. As such, there are recommendations that can be taken to further improve any future studies. The participants for this study were acquaintances of the clinicians. Participants chosen for the study should be asked to participate from a random selection of the community's population. The total number of participants should be increased to strengthen the generalization of the implications. Those interpreting the assessments results can insure consistency in the scoring by utilizing the same scorer for each test, opposed to the three administrators working independently in this study.

SIGNIFICANCE

The only statistically significant difference in the results was Trial VI of the *RAVLT*. This trial assessed delayed recall, a specific ability within the domain of memory. Trial VI was the only subtest within the four assessments analyzed in this study to focus on the delayed recall ability. The results of Trial VI report a significantly lower average in delayed recall in middle-age adults when compared to young adults.

There are no significant differences in memory abilities between young and middle-age adults except in the area of delayed recall. Also, no significant difference in attention abilities between young and middle-age adults were reported. Comparing the subgroups of middle-age adults, no significant differences were found in attention and memory abilities. These results contradict previous studies and causes need for further studies.

SUMMARY

Common assumption has placed declines in attention and memory due to aging not typically coming into affect until the individual reaches older adulthood. Following the direction of Johnson et al. (2006), this study investigated the difference between young and middle-aged adults in terms of attention and memory cognitive skills. Results found that significant differences are not found between the age groups in the scores of seven of eight subtests of cognitive assessments; *Ross Information Processing Assessment, Rey Auditory Verbal Language Test, Wechsler Memory Scale III,* and *Cognitive-Linguistic Quick Test*. Delayed recall was the only subtest that resulted in a significant difference between young and middle-age adults. The results of this study contradict previous studies and raise more questions than find answers. Such findings should be further studied to aid the possible development of new assessments and therapy programs to address attention and memory declines in middle-age populations.

APPENDIX

Participant Screening

Age	Sex	High School	Years College	MedHx	Health	Hearing	Exercise	Social	Puzzles	Volunteer	MMSE
20	F	Y	2	None	Good	P	Y	Y	Y	Y	29
20	F	Y	0	None	Good	P	Y	Y	Y	Y	30
21	M	Y	2	None	Good	P	Y	Y	N	Y	30
21	M	Y	3	None	Good	P	Y	Y	N	N	30
21	F	Y	3	None	Good	P	Y	Y	N	Y	30
21	F	Y	2	None	Good	P	Y	Y	Y	Y	29
21	F	Y	3	None	Good	P	Y	Y	Y	Y	30
22	M	Y	3	None	Good	P	Y	Y	Y	Y	30
22	F	Y	4	None	Good	P	N	Y	Y	Y	30
23	F	Y	5	None	Good	P	Y	Y	Y	N	30
23	M	Y	3	None	Good	P	Y	Y	Y	Y	30
23	F	Y	4	None	Good	P	N	Y	N	N	30
24	F	Y	6	None	Good	P	Y	Y	N	N	30
24	F	Y	4	None	Good	P	Y	Y	N	N	29
24	F	Y	4	None	Good	P	P	Y	Y	Y	30
26	M	Y	5	None	Good	P	Y	Y	N	N	30
27	M	Y	2	None	Good	P	N	Y	N	N	30
29	M	Y	2	None	Good	P	Y	Y	N	Y	30
31	F	Y	0	None	Good	P	N	Y	N	N	30
32	M	Y	6	None	Good	P	Y	Y	Y	N	30
33	M	Y	1	None	Good	P	N	Y	Y	N	30
34	F	Y	6	None	Good	P	N	Y	N	N	30
34	M	Y		None	Good	P	Y	Y	N	Y	29
35	M	Y	6	None	Good	P	Y	Y	N	Y	29
36	M	Y	0	None	Good	P	N	Y	N	N	30
38	F	Y	3	None	Good	P	N	Y	N	Y	29
40	F	Y	1	None	Good	P	Y	Y	Y	N	30
41	M	Y	1	None	Good	P	Y	Y	Y	N	30
42	F	Y	0	None	Good	P	N	Y	Y	Y	30
44	M	Y	0	None	Good	P	N	N	N	N	30
45	F	Y	2	None	Good	P	N	Y	Y	Y	29
47	F	Y	7	None	Good	P	Y	Y	Y	Y	30
48	M	Y	1	None	Good	P	N	Y	Y	N	29
49	M	Y	1	None	Good	P	N	Y	Y	N	29
49	F	Y	4	None	Good	P	Y	Y	Y	Y	30
49	F	Y	0	None	Good	P	N	Y	N	N	29
50	F	Y	4	None	Good	P	Y	Y	Y	Y	30
50	F	Y	1	None	Good	P	N	Y	Y	Y	29
50	F	Y	8	None	Good	P	Y	Y	N	Y	29
51	F	Y	0	None	Good	P	Y	Y	N	Y	29
51	F	Y	0	None	Good	P	N	Y	Y	N	30
51	F	Y	6	None	Good	P	N	N	N	N	30
51	M	Y	0	None	Good	P	N	Y	Y	N	29
52	M	Y	1	Yes	Good	P	N	N	N	N	30
52	F	Y	3	None	Good	P	N	Y	N	Y	30
53	F	Y	4	None	Good	P	Y	Y	Y	Y	28
53	F	Y	4	None	Good	P	Y	Y	Y	Y	30
54	F	Y	6	None	Good	P	N	Y	Y	N	29
54	F	Y	2	None	Good	P	Y	Y	Y	Y	30
55	F	Y	8	None	Good	P	Y	Y	N	Y	30
56	F	Y	2	None	Good	P	Y	Y	N	Y	29
56	F	Y	0	None	Good	P	N	Y	Y	N	29
57	F	Y	2	None	Good	P	N	Y	Y	Y	29
57	M	Y	2	None	Good	P	N	Y	Y	N	29

Max points on the MMSE: 30 pts

Ross Information Processing Assessment, Second Edition

	Subtest Standard Scores										Subtest Percentiles									
Age	I	II	III	IV	V	VI	VII	VIII	IX	X	I	II	III	IV	V	VI	VII	VIII	IX	X
20	13	15	14	13	14	14	15	12	18	13	84	95	91	84	91	91	95	75	99	84
20	18	15	14	14	14	14	15	16	18	14	99	95	91	91	91	91	95	98	9	91
21	12	15	12	14	14	14	15	14	12	11	75	95	75	91	91	91	95	91	75	63
21	11	15	14	14	14	14	11	13	15	12	63	95	91	91	91	91	63	84	95	75
21	11	15	14	14	14	14	15	12	17	14	63	95	91	91	91	91	95	75	99	91
21	13	13	13	13	14	14	15	16	16	13	84	84	84	84	91	91	95	98	98	84
21	13	15	14	14	14	14	15	16	18	14	84	95	91	91	91	91	95	98	99	91
22	11	15	14	13	14	14	13	15	16	12	63	95	91	84	91	91	84	95	98	75
22	13	15	14	14	10	15	11	12	18	12	84	95	91	91	50	95	63	75	99	75
23	14	15	13	14	14	14	15	13	18	14	91	95	84	91	91	91	95	84	99	91
23	18	15	14	14	14	14	15	16	16	14	99	95	91	91	91	91	95	98	98	91
23	15	15	12	14	14	14	15	14	17	14	95	95	75	91	91	91	95	91	99	91
24	18	15	14	13	14	14	13	16	18	14	99	95	91	84	91	91	84	98	99	91
24	13	15	14	14	14	14	13	16	16	12	84	95	91	91	91	91	84	98	98	75
24	14	15	14	14	14	14	15	16	18	14	91	95	91	91	91	91	95	98	99	91
26	18	15	14	14	14	14	15	16	18	14	99	95	91	91	91	91	95	98	99	91
27	13	15	14	14	14	14	15	13	16	14	84	95	91	91	91	91	95	84	98	91
29	17	14	14	14	14	14	15	16	16	14	99	91	91	91	91	91	95	98	98	91
31	18	15	14	14	14	14	15	16	18	14	99	95	91	91	91	91	95	98	99	91
32	15	15	13	14	14	14	15	15	18	14	95	95	84	91	91	91	95	95	99	91
33	14	10	12	14	14	10	11	12	13	8	91	50	75	91	91	50	63	75	84	25
34	14	15	13	13	14	14	14	15	18	14	91	95	84	84	91	91	91	95	99	91
34	12	15	14	13	10	14	15	14	17	14	75	95	91	84	50	91	95	91	99	91
35	15	15	14	14	14	14	13	15	17	14	95	95	91	91	91	91	84	95	99	91
36	15	15	14	14	14	14	15	16	18	14	95	95	91	91	91	91	95	98	99	91
38	13	14	14	14	11	14	14	15	15	12	84	91	91	91	63	91	91	91	95	75
40	11	14	14	14	10	11	10	12	13	11	63	91	91	91	50	63	5	75	84	63
41	17	15	11	14	14	10	10	15	18	14	99	95	63	91	91	50	50	95	99	91
42	17	15	14	14	14	14	14	16	17	14	99	95	91	91	91	91	91	98	99	91
44	17	15	14	14	14	14	15	16	18	14	99	95	91	91	91	91	95	98	99	91
45	9	15	13	14	14	14	13	15	18	14	37	95	84	91	91	91	84	95	99	91
47	17	15	14	14	14	14	14	16	14	14	99	95	91	91	91	91	91	98	91	91
48	11	15	13	13	14	14	13	16	17	14	63	95	84	84	91	91	84	98	99	91
49	14	15	14	14	14	14	15	14	17	12	91	95	91	91	91	91	95	91	99	95
49	15	15	14	14	14	14	15	16	18	14	95	95	91	91	91	91	95	98	99	91
49	14	14	14	13	11	14	15	15	17	12	91	91	91	84	63	91	95	95	99	75
50	14	15	14	9	14	14	15	16	18	14	91	95	91	37	91	91	95	98	99	91
50	10	13	12	11	14	14	11	15	14	11	50	84	75	63	91	91	50	95	91	63
50	17	15	12	14	14	14	15	16	18	14	99	95	75	91	91	91	95	98	99	91
51	14	14	14	13	14	14	11	12	16	14	91	91	91	84	91	91	63	75	98	91
51	10	15	10	10	11	14	12	16	18	14	50	95	50	50	63	91	75	98	99	91
51	17	15	14	14	14	14	14	15	13	14	99	95	91	91	91	91	91	95	84	91
51	12	13	14	14	14	14	14	16	18	14	75	84	91	91	91	91	91	98	99	91
52	12	15	14	12	14	14	14	14	18	14	75	95	91	75	91	91	91	91	99	91
52	14	14	14	14	14	14	15	16	18	14	91	91	91	91	91	91	95	98	99	91
53	10	15	14	13	11	14	14	13	16	14	50	95	91	84	63	91	91	84	98	91
53	13	15	12	14	14	11	14	12	16	14	84	95	75	91	91	63	91	75	98	91
54	10	14	14	13	14	14	15	15	17	13	50	91	91	84	91	91	95	95	99	84
54	15	15	14	14	14	14	15	16	17	14	95	95	91	91	91	91	95	98	99	91
55	13	15	14	14	14	14	15	13	18	14	84	95	91	91	91	91	95	84	99	91
56	10	15	13	13	14	14	13	13	14	14	50	95	84	84	91	91	84	84	91	91
56	15	15	13	14	9	14	10	16	18	14	95	95	84	91	37	91	50	98	99	91
57	15	15	12	12	14	14	11	13	17	14	95	95	75	75	91	91	63	84	99	91
57	10	15	14	14	14	14	13	16	18	14	50	95	91	91	91	91	84	98	99	91

Rey Auditory Verbal Learning Test

Age	Trial I	Trial II	Trial III	Trial IV	Trial V	List B	Trial VI	Trial I-V Total
20	7	11	11	14	13	7	12	66
20	5	8	13	15	14	11	15	54
21	8	8	9	12	11	6	12	48
21	7	9	12	15	15	7	15	58
21	5	9	13	13	14	6	10	54
21	8	9	11	12	14	6	9	54
21	7	9	8	14	15	7	10	53
22	7	9	11	14	15	6	10	56
22	7	13	15	15	15	8	12	65
23	7	15	15	15	15	10	15	67
23	9	5	7	10	9	6	7	40
23	6	14	15	15	15	9	15	65
24	6	9	11	13	15	5	11	39
24	7	13	13	13	15	7	15	61
24	6	8	9	12	14	4	14	49
26	8	7	13	12	14	7	10	55
27	5	6	10	10	12	5	9	43
29	5	5	9	9	10	8	7	38
31	6	8	10	10	13	5	11	47
32	10	13	14	14	15	9	14	66
33	4	5	4	11	12	3	10	36
34	7	10	15	13	15	6	15	60
34	6	10	11	12	15	6	13	54
35	7	9	12	12	13	5	11	53
36	3	7	9	15	15	5	10	49
38	3	8	11	10	11	3	12	43
40	5	7	8	10	13	4	11	43
41	5	7	7	9	10	3	8	38
42	5	7	8	9	13	5	11	42
44	6	10	7	11	13	4	11	57
45	7	9	12	12	12	6	11	52
47	9	10	15	15	15	5	15	64
48	6	10	10	11	11	6	11	48
49	3	5	9	10	13	4	6	40
49	5	7	10	12	12	4	11	46
49	6	9	13	14	14	6	11	56
50	7	10	13	13	13	5	14	66
50	3	7	9	8	8	4	4	35
50	5	12	15	15	15	6	14	62
51	6	6	8	10	11	5	8	41
51	6	7	7	11	9	6	9	40
51	9	14	13	14	15	5	14	65
51	5	7	8	11	12	5	8	43
52	6	9	11	11	11	8	11	48
52	10	14	15	13	15	10	15	67
53	6	10	10	12	13	6	9	51
53	6	10	13	12	15	8	13	56
54	6	8	9	13	12	4	10	48
54	7	12	15	15	15	10	12	64
55	8	10	14	12	13	4	13	57
56	6	8	12	11	11	3	5	48
56	6	12	14	15	12	6	11	59
57	4	5	7	8	10	4	8	34
57	6	7	8	12	12	5	10	45

Max points on the RAVLT:
Each Trial: 15 pts
Trials I-V Total: 75 pts

Wechsler Memory Scale, Third Edition: Working Memory subtest

Age	Visual Reproduction	Letter-Number Sequence	Spatial Span Forward	Spatial Span Backward	Forward/ Reverse Total	Sum or Scaled Scores	Index	Percentile
20	94	11	10	8	18	21	102	55
20	99	13	12	10	22	26	118	88
21	95	8	9	8	17	17	91	27
21	96	11	8	7	15	18	93	32
21	100	11	11	6	17	20	99	47
21	93	15	11	7	18	25	115	84
21	99	11	13	10	23	25	115	84
22	101	14	10	11	21	26	118	88
22	94	13	9	10	19	24	111	77
23	104	18	12	9	21	30	131	98
23	97	11	9	7	16	19	96	39
23	100	12	9	9	18	22	105	63
24	94	16	9	9	18	26	118	88
24	97	10	12	8	20	21	102	55
24	95	11	8	7	15	18	93	32
26	91	13	10	9	19	24	111	77
27	79	8	10	7	17	18	93	32
29	97	13	10	13	23	27	121	92
31	103	14	10	11	21	28	124	95
32	100	14	10	10	20	27	121	92
33	97	9	9	7	16	18	93	32
34	103	13	7	9	16	23	108	70
34	93	10	5	8	13	17	91	27
35	96	13	10	10	20	27	121	92
36	89	9	14	13	27	27	121	92
38	95	10	8	6	14	18	93	32
40	90	12	7	6	13	20	99	47
41	104	18	10	9	19	32	141	99.7
42	98	12	10	8	18	22	105	63
44	99	14	10	11	21	26	121	92
45	97	7	8	7	15	16	88	21
47	104	16	9	9	18	30	131	98
48	81	11	10	10	20	25	115	84
49	85	14	10	9	19	27	121	92
49	84	10	11	10	21	26	121	92
49	94	14	11	10	21	28	124	95
50	99	9	10	8	18	24	111	77
50	77	9	7	5	12	16	88	21
50	97	14	6	8	14	24	111	77
51	75	8	9	8	17	20	99	47
51	88	12	7	5	12	19	96	39
51	85	13	8	9	17	25	115	84
51	91	10	10	8	18	23	108	77
52	85	11	9	9	18	24	111	77
52	92	15	9	6	15	26	118	88
53	90	12	9	5	14	19	96	39
53	96	14	10	9	19	28	124	95
54	67	11	7	5	12	24	111	77
54	10	9	16	32	26	27	121	92
55	89	13	7	8	15	25	115	84
56	96	14	7	10	17	28	124	95
56	78	10	9	6	15	22	105	63
57	39	11	10	6	16	24	111	77
57	88	12	8	7	15	24	111	77

Max points on the WMS-III:
Visual Reproduction I: 104 pts
Letter-Number Sequencing: 21 pts
Spatial Span Forward: 16 pts
Spatial Span Backward: 16 pts

Cognitive Learning Quick Test

	Subtests									
Age	Personal Facts	Symbol Cancelation	Confrontatior Naming	Clock Drawing	Story Retelling	Symbol Trails	Generative Naming	Design Memory	Mazes	Design Generation
20	8	12	10	13	10	10	9	5	7	8
20	8	12	10	13	8	10	9	6	8	11
21	8	12	10	13	7	10	8	6	8	7
21	8	12	10	13	7	10	8	5	7	11
21	8	12	10	13	8	10	9	6	7	9
21	8	12	10	13	9	9	9	6	7	12
21	8	12	10	13	8	10	9	6	8	8
22	8	12	10	13	7	10	9	6	8	13
22	8	12	10	13	7	10	7	6	8	10
23	8	12	10	13	9	10	9	6	7	11
23	8	12	10	12	5	10	7	6	8	8
23	8	11	10	13	8	10	6	6	7	10
24	8	12	10	13	7	10	9	6	8	11
24	8	12	10	12	9	10	7	6	7	9
24	8	12	10	13	8	10	9	6	8	9
26	8	12	10	13	8	10	8	6	8	5
27	8	12	10	13	3	10	7	4	8	4
29	8	12	10	13	8	10	7	6	8	9
31	8	12	10	13	8	10	6	6	8	10
32	8	12	10	13	6	10	9	6	7	11
33	8	12	10	13	5	10	6	6	7	9
34	8	12	10	13	9	10	8	6	8	10
34	8	12	10	13	10	9	8	6	8	6
35	8	12	10	13	7	10	7	6	8	11
36	8	12	10	13	7	10	6	6	8	8
38	8	12	10	13	9	10	7	6	6	10
40	8	12	10	10	7	9	9	6	5	9
41	8	12	10	13	6	10	7	6	7	13
42	8	12	10	13	8	10	7	6	7	9
44	8	12	10	13	7	10	9	6	8	8
45	8	12	10	13	8	10	7	6	7	9
47	8	11	10	13	8	10	9	6	8	11
48	8	12	10	12	7	10	9	6	8	8
49	8	11	10	11	9	10	8	6	8	10
49	8	10	10	13	8	10	7	6	8	7
49	8	12	10	12	6	10	7	6	8	5
50	8	11	10	13	7	10	9	6	8	9
50	8	12	10	8	4	9	8	5	5	7
50	8	12	10	13	9	9	8	6	8	8
51	8	12	10	13	8	10	8	5	7	11
51	8	12	10	13	7	10	9	6	8	6
51	8	12	10	13	8	9	4	6	5	11
51	8	12	10	13	4	10	8	6	8	6
52	8	8	10	12	8	8	8	6	6	5
52	8	12	10	13	8	10	8	5	6	10
53	8	12	10	12	7	10	7	8	7	5
53	8	12	10	13	10	10	8	5	8	10
54	8	12	10	13	8	10	8	4	8	9
54	8	12	10	13	9	10	7	6	7	8
55	8	12	10	13	10	10	8	5	8	7
56	8	12	10	12	9	8	9	6	8	11
56	8	12	10	13	8	9	7	6	6	6
57	8	12	10	13	5	10	6	5	0	5
57	8	12	10	13	7	10	5	5	6	10

Max points on the CLQT:

Personal Facts: 8 pts
Symbol Cancelation: 12 pts
Confrontation Naming: 10 pts
Clock Drawing: 13 pts
Story Retelling: 10 pts
Symbol Trials: 10 pts
Generative Naming: 9 pts
Design Memory: 6 pts
Mazes: 8 pts
Design Generation: 13 pts

Cognitive Learning Quick Test

Cognitive Domains						
Age	Attention	Memory	Executive Functions	Language	Visuospatial Skills	Composite Severity
20	204	175	34	37	93	WNL
20	209	173	38	35	103	WNL
21	203	166	33	33	99	WNL
21	210	156	36	33	96	WNL
21	203	173	35	35	98	WNL
21	205	179	37	36	99	WNL
21	206	173	35	35	100	WNL
22	209	167	40	34	105	WNL
22	206	165	35	32	102	WNL
23	209	181	27	36	100	WNL
23	200	153	33	30	100	WNL
23	189	170	33	32	97	WNL
24	207	167	38	36	103	WNL
24	205	186	33	34	98	WNL
24	207	167	36	35	101	WNL
26	203	172	31	34	97	WNL
27	188	139	29	28	88	MILD
29	207	165	34	33	101	WNL
31	208	170	34	32	102	WNL
32	201	161	37	33	94	WNL
33	197	152	32	29	98	WNL
34	210	178	36	35	102	WNL
34	205	184	31	36	96	WNL
35	207	165	36	32	103	WNL
36	204	164	35	31	100	WNL
38	202	177	33	34	96	WNL
40	190	137	32	34	90	WNL
41	203	159	37	31	102	WNL
42	203	171	35	33	98	WNL
44	204	167	35	34	100	WNL
45	203	171	35	33	98	WNL
47	200	173	38	35	101	WNL
48	204	167	35	34	100	WNL
49	201	178	36	35	100	WNL
49	191	191	32	33	103	WNL
49	199	159	30	31	97	WNL
50	196	167	36	34	99	WNL
50	180	138	29	30	84	WNL
50	205	178	33	35	98	WNL
51	203	162	36	34	96	WNL
51	202	167	33	34	98	WNL
51	194	168	29	30	92	WNL
51	192	148	32	30	106	WNL
52	153	172	27	34	79	WNL
52	198	162	34	34	92	WNL
53	197	165	29	32	94	WNL
53	210	174	36	36	98	WNL
54	203	152	35	34	93	WNL
54	204	177	32	34	97	WNL
55	207	174	33	36	95	WNL
56	205	179	36	36	99	WNL
56	193	171	28	33	90	WNL
57	165	142	21	29	69	MILD
57	196	153	31	30	92	WNL

Max points on the CLQT Cognitive Domains:
Attention: 215 pts
Memory: 185 pts
Executive Functions: 40 pts
Language: 37 pts
Visuospatial Skills: 105 pts

Range of Severity:
Within Normal Limits (WNL)
Mild
Moderate
Severe

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