



# *Cognitive Changes in the Older Adult: Normal to Abnormal Changes*

<http://uuhsc.utah.edu/cacir/research.html>

Gordon J. Chelune, PhD, ABPP(CN)  
Professor of Neurology and Senior Neuropsychologist  
Center for Alzheimer's Care, Imaging and Research  
University of Utah School of Medicine  
E-mail: [gordon.chelune@hsc.utah.edu](mailto:gordon.chelune@hsc.utah.edu)



# This Presentation

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- Memory and Cognition: General Comments
- Reversible Causes of Memory/Cognitive Dysfunction in Older Adults
- Abnormal Conditions: Diagnostic Algorithms
- Case Examples



**Learning** is the acquisition of skills and knowledge

**Memory** is the persistence of Learning over time

Squire, 1987: *Memory and Brain*

Squire & Schacter, 2002, *Neuropsychology of Memory*



# Conceptual Perspectives

- Temporal:*** Recent vs. Remote  
Immediate vs. Delayed
- Process:*** Encoding: (learning)  
Decoding: (recall/retrieval)  
Recognition
- Modes:*** Verbal vs Visual; Auditory vs. Visual, etc
- Types:*** Declarative (Fact Based) -- Semantic  
-- Episodic  
Procedural (Skill and Perceptual-Based)

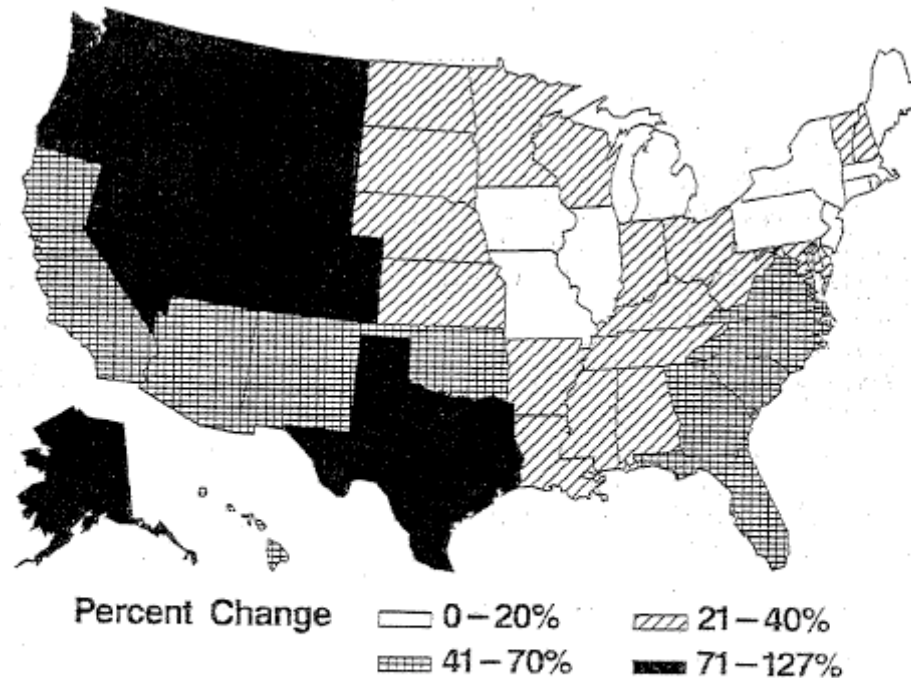


# Aging in Utah

- **Population Growth in Utah: 1990-2000**
  - 34<sup>th</sup> largest state in population
  - 4<sup>th</sup> fastest growing state
- **High proportion of elderly in Utah**
  - Utah youngest average age, but live long lives
  - 3<sup>rd</sup> highest life expectancy
  - Ranks 7<sup>th</sup> for proportion of population > 85 years
- **By 2025, 2.4-fold increase in population >65**



## Percentage Increase of AD Prevalence 2000-2025



*Figure. Percentage change in numbers of persons affected by Alzheimer disease expected between 2000 and 2025 in each state.*

Ref: Hebert et al., *Neurology*, 2004, 62, 1645

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Alzheimer's Disease will increase more in the Intermountain West than any other region, and in Utah more than in any other state

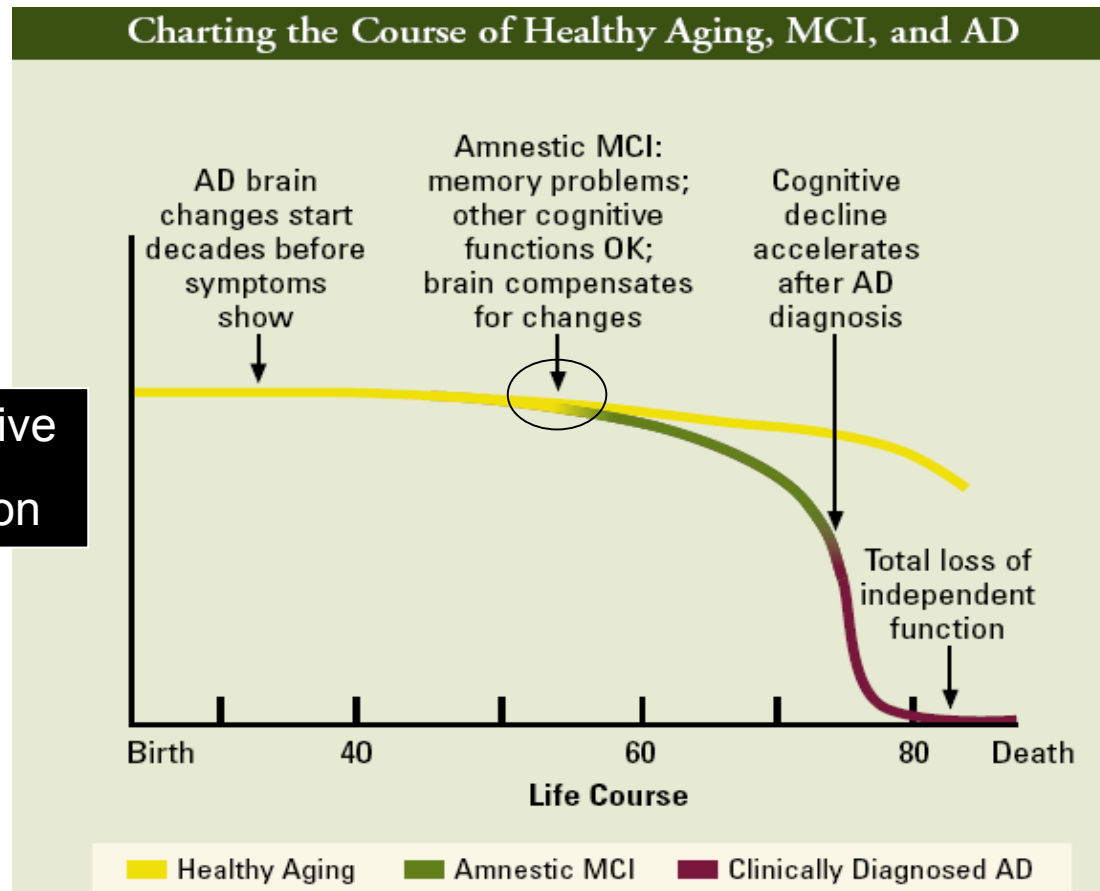
State	Current	2025	% Change 2000-2025
Utah	30,000	50,000	127%
Idaho	22,500	38,000	100%
Wyoming	8,500	15,000	114%

Ref: Hebert et al., Neurology 2004;62:1645



# Alzheimer's Disease

Cognitive Function



(Adapted from Progress Report on Alzheimer's Disease 2004-2005, NIH)



# Common Causes of Memory Difficulties

- Normal Aging
- Neurodegenerative Illnesses  
(AD, FTD, VCI, MID, DLB, PD, MS)
- Psychiatric Disorders  
(Chronic Stress, Depression, Anxiety)
- Alcohol and Drugs
- TBI and Infections
- Decreased Blood Oxygen Levels  
(Anoxia, Cardiac Arrest, General Anesthesia, COPD, Sleep Apnea)

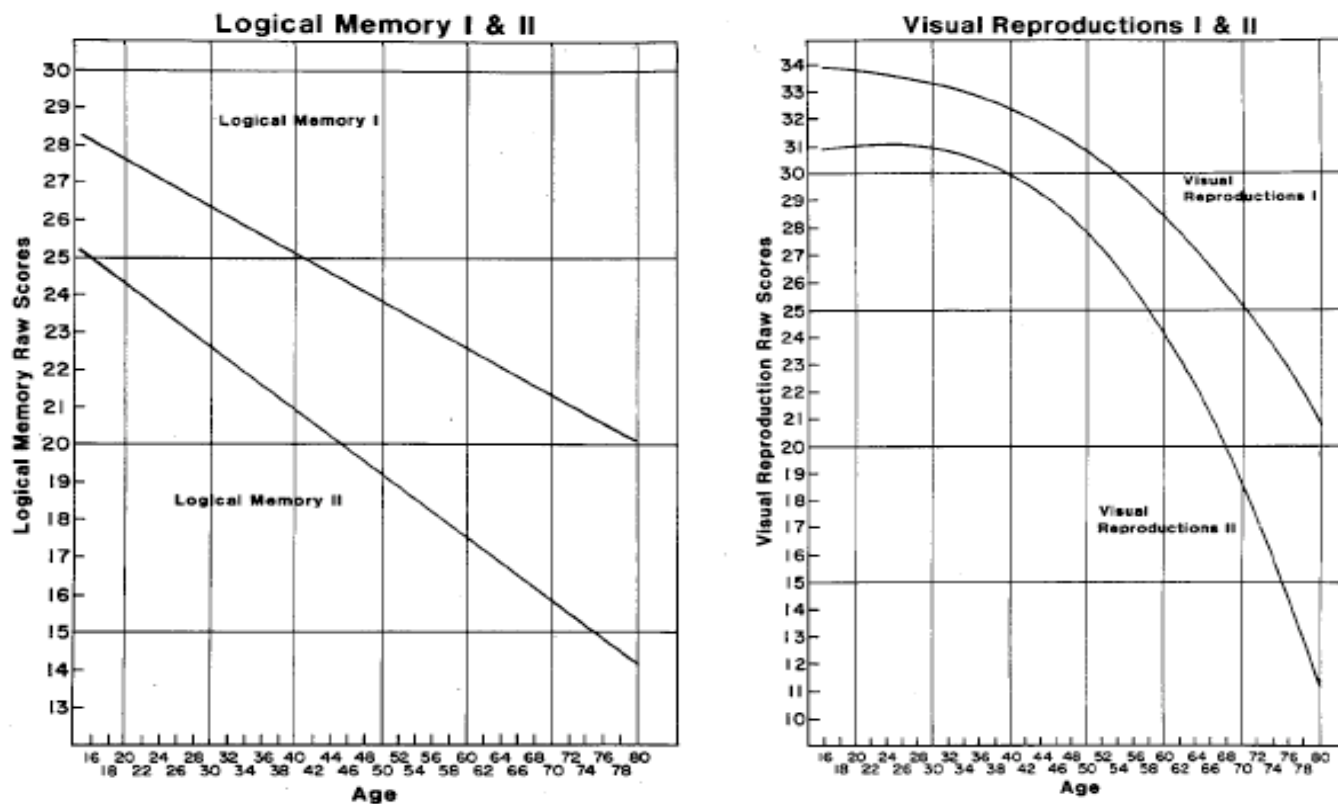


# Changes in Memory:

Normal Aging  
or  
Not so Normal Aging



# Age and Memory Decline: Cross Sectional Norms



**Figure 1.** Best-fit age regression lines for predicting raw score performance on the immediate and delayed trials of Logical Memory and Visual Reproductions on the basis of age. Regression lines were derived from median age and mean raw scores presented in the WMS-R Manual (Wechsler, 1987).

Chelune et al, 1990



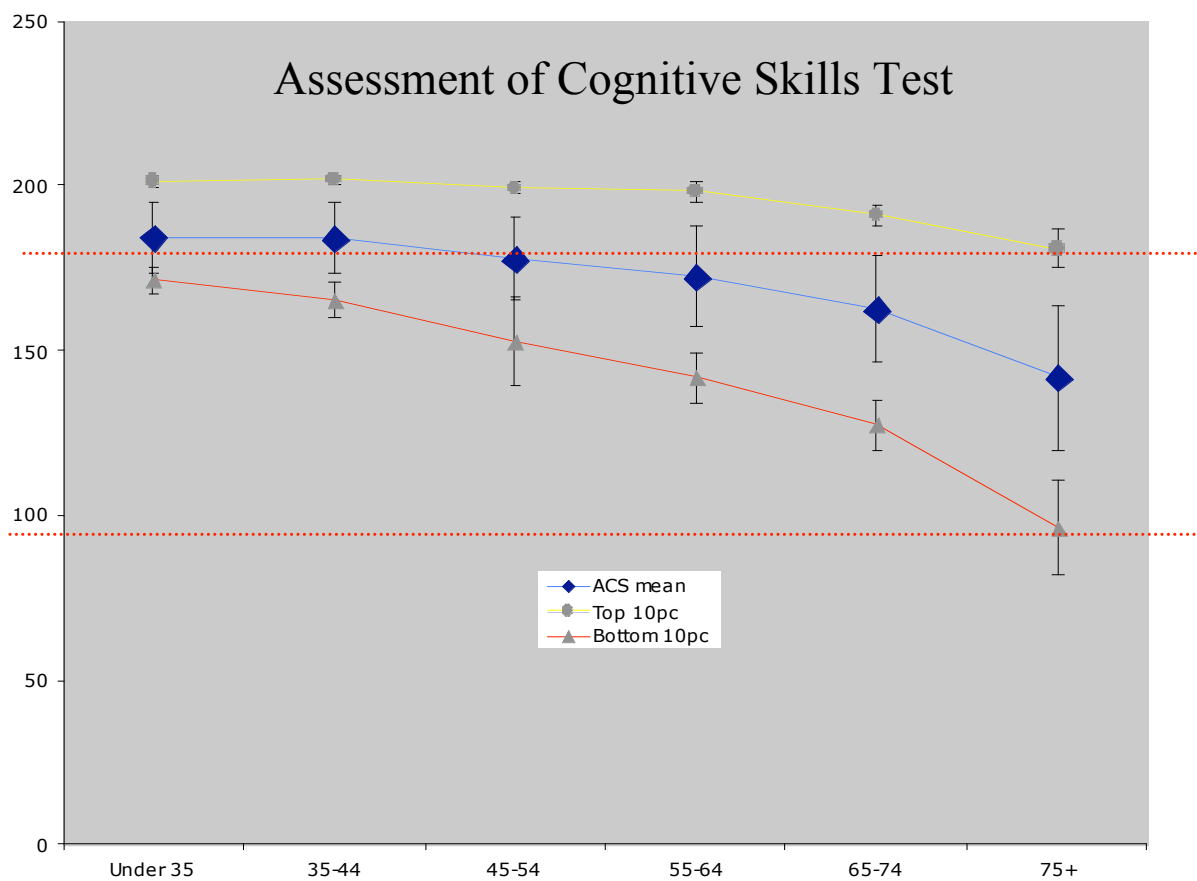
# Decline is Normal With Age?

- **Based on cross-sectional studies**
  - Mean declines with age on cognitive tests
  - Top percentiles don't change
  - Bottom percentiles much worse
  - Mean is "dragged down" by impaired scores
  
- **Longitudinal studies rare (\$\$, years)**
  - Show either stable or declining individuals
  - Not everybody declines
  - Decline probably "disease" related

Weintraub J *Geriatr Psychiatry* 1994; Comijs *Dement Geriatr Cogn Dis* 2004; 17: 136



# Florida Physicians Study

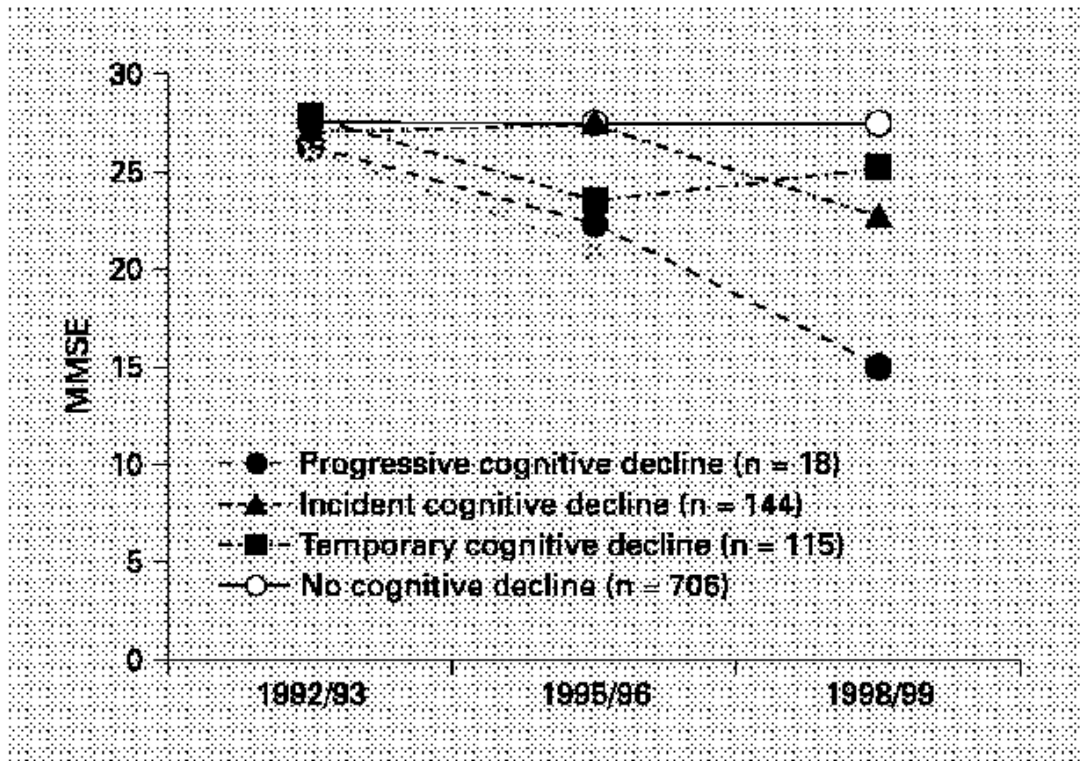


Weintraub J Geriatr Psychiatry 1994

The University of Utah Center for Alzheimer's Care, Imaging and Research



# Longitudinal study



Netherlands, n= 1313, 65+ years  
no dementia, mean MMSE=27.6

After 6 years follow-up:

No cognitive decline: 53.8%

Incident cognitive decline: 11%

Temporary cog. decline: 8.8%

Progressive cog. decline: 1.4%

...but 330 lost to follow-up

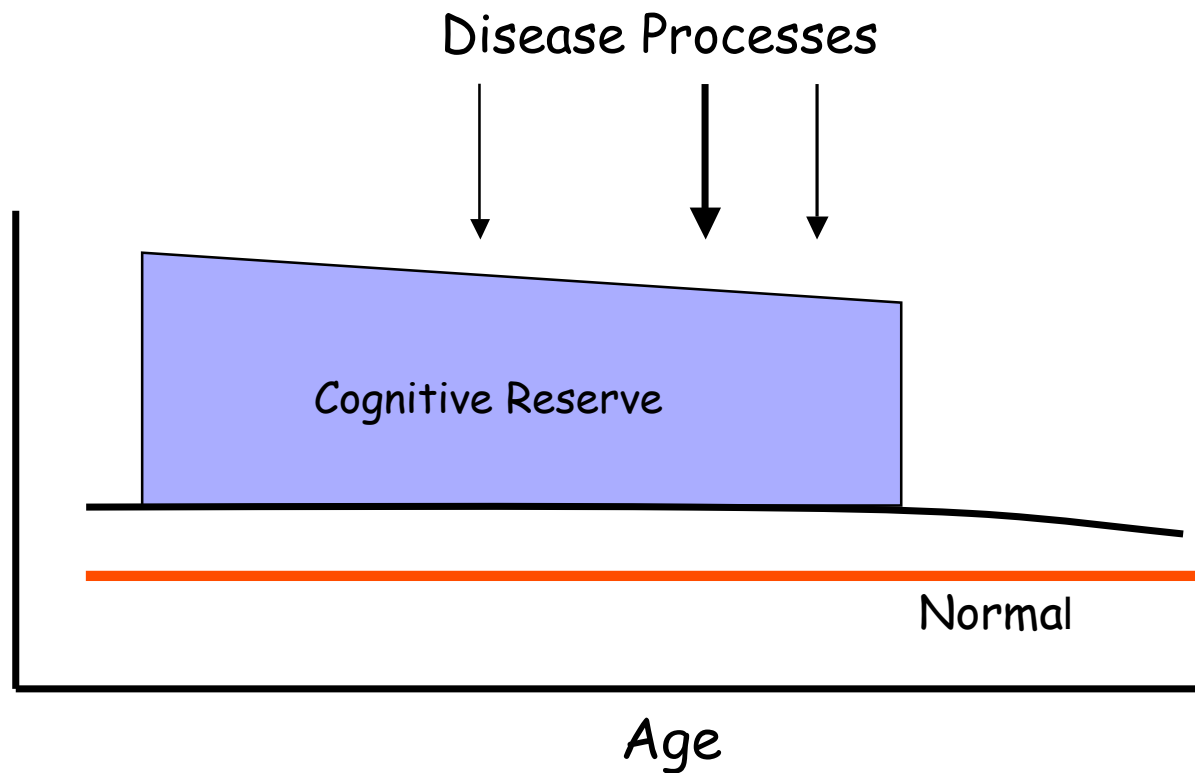
**Fig. 1.** The course of cognitive decline.

Comijs Dement Geriatr Cogn Disord 2004; 17: 136-142

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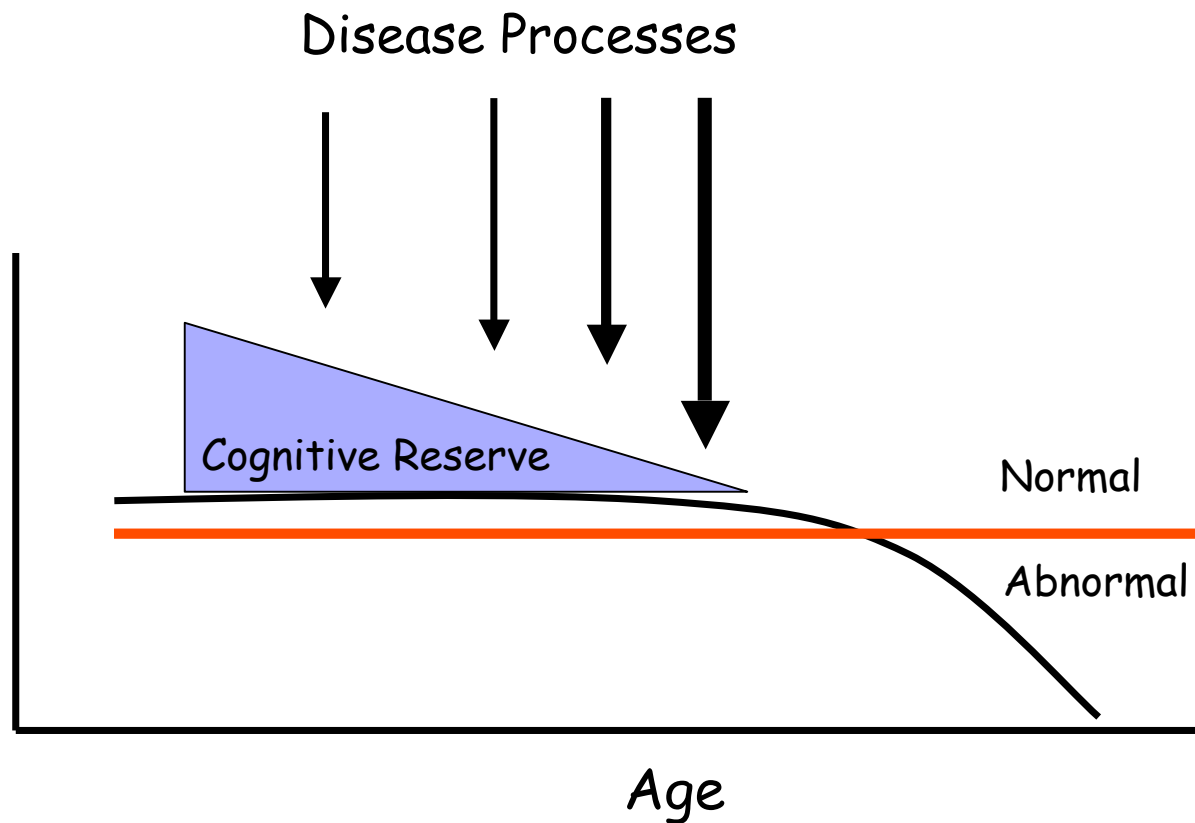


# Cognitive Reserve and Individual Risk





# Cognitive Reserve and Individual Risk





# Non-Degenerative Causes of Cognitive and Memory Changes in Older Adults



# Causes of Reversible Memory Problems

- ✓ Normal Aging
- ✓ General Health Issues
- ✓ Sleep
- ✓ Chronic Stress & Mental Health Issues
- ✓ Medications
- ✓ Alcohol Consumption
- ✓ Situational Illnesses/Infections
- ✓ Pain
- ✓ Surgeries
- ✓ Other Medical Conditions



# Abnormal Changes in Memory and Cognition in Older Adults: Neurodegenerative Disorders And the Dementias



# Definition of Dementia

- **A decline in intellectual ability from a previous level of performance that is caused by a medical disorder, and interferes with social or occupational functioning**
- **Affects Memory, Thinking, and Behavior**
  - Note that there is nothing in the definition about age, reversibility or severity
  - Neurobehavioral Syndrome with **MANY** different medical causes (up to 80 different causes)



# Critical Elements

Decline in Cognitive/Intellectual Ability

**AND**

Decline in Functional Abilities (ADLs)



# Memory, Thinking and Behavior in Dementia

- **Memory/Learning**
- **Executive Functions:**
  - Planning/Organization/Judgment
- **Attention/Concentration**
- **Language**
- **Visual Processing**
- **Processing Speed**
- **Emotional/Personality**





# Diagnostic Algorithms

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		Cognitive Deficits	
		+	-
Functional Complaints	+	++ Dementia Syndrome	-/+ Psychiatric Condition
	-	+/- Mild Cognitive Impairment	-/- Normal (worried-well)



# Diagnostic Algorithms

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If: Normal (-/-)

Stop - provide reassurances  
Consider Re-assessment if things  
change



# Diagnostic Algorithms

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If: **Mild Cognitive Impairment (+/-)**

Characterize the Impairment

- Amnestic type
- Multidomain
- Other domain (primarily language, visuospatial, other)

Re-assess in 12-18 months to determine if there is progression to Dementia (10-15%/year convert)



# Diagnostic Algorithms

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If: **Dementia Syndrome (+/+)**

Characterize Pattern of Impairment

- Alzheimer's Disease (AD)
- Vascular Cognitive Impairment
- Frontal Temporal Lobar Degeneration (FTD)
- Diffuse Lewy Body disease

Consider annual evaluations to monitor disease progression and trajectory



# Diagnostic Algorithms

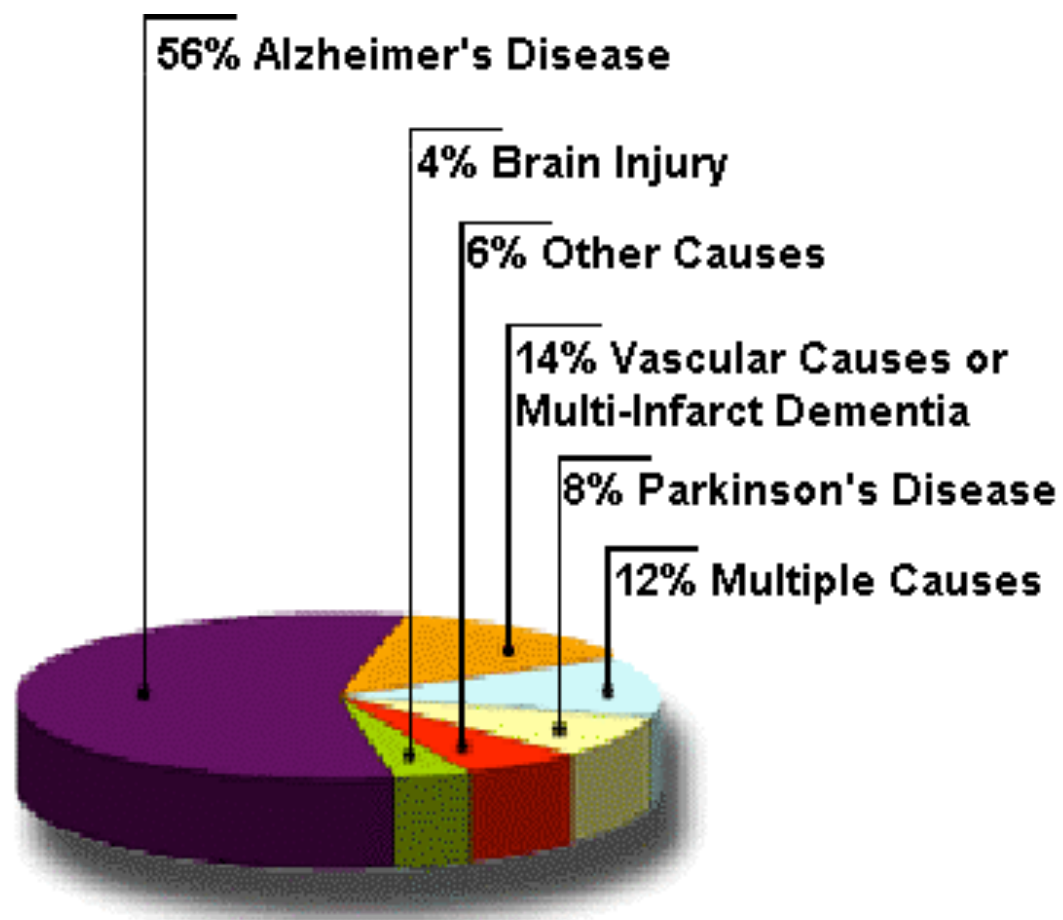
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If: **Functional Disturbance (-/+)**

- Consider additional personality testing
- Refer for formal Psychological/Psychiatric Evaluation



## Causes of Dementia





# Alzheimer's Disease

- **Most common form of dementia in late-life**
  - Accounts for ~ 2/3 of dementia types in late-life
- **For every 5-year age group over 65, % of people with AD doubles**
- **Approximately 4.5 million in US suffer from AD**
- **Projections for U.S. is that by 2050, AD will number 13.2 million\***

\*Herbert et al., *Arch of Neurol*, 2003.



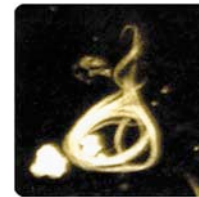
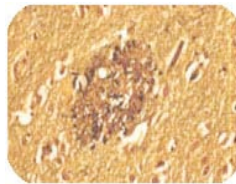
# Alzheimer's Disease (AD)

- AD is the most common dementia over age 65
- 1907 first description of AD



- **Neuropathological markers**

- Senile plaques
- Neurofibrillary tangles



Alois Alzheimer's first patient, Auguste D



# Cognitive & Behavioral Changes in AD

## ■ Early Symptoms

- **Memory:** New learning defective, remote recall impaired
- **Executive Skills:** Impaired reasoning, judgment, Multi-tasking
- **Language:** Mild dysnomia, limited generative fluency, circumlocutory spontaneous speech
- **Visuospatial skills:** Topographic disorientation
- **Motor system:** Normal
- **Personality:** Apathy, occasional irritability, sadness





# Key Cognitive Deficits in AD

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Pronounced Short-term Memory Deficits

Retrieval

Recognition Memory

Language with High Semantic Load

Confrontation Naming

Category Fluency



# Frontal-Temporal Dementia: FTD (Frontal-Temporal Lobar Degeneration)

- Affects frontal and temporal lobes (more left)
- Changes in behavior and/or language are often first symptoms
- Executive functions often severely impaired
- Variable Memory: can be intact, or affect retrieval processes
- Behavior/Personality Changes: Apathy and Indifference to Dysexecutive symptoms of Dysinhibition /Inappropriateness



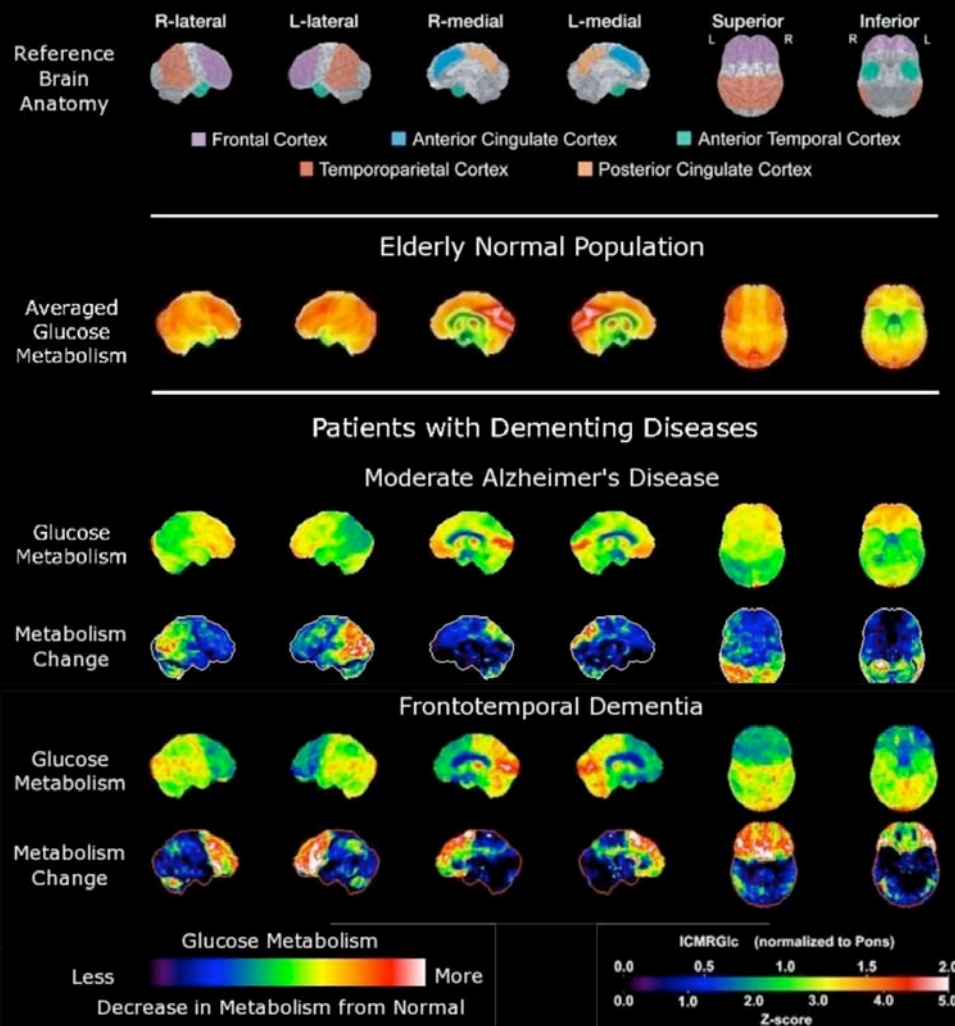
# Key Cognitive Deficits in FTD

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- Impaired Executive Functions: Judgment, Planning, Problem Solving, Flexibility, Inhibition, Goal-directed Behavior
- Decreased Generative Fluency, especially letter fluency vs. semantic fluency
- Poor Retrieval vs. Recognition Memory
- Impulsive/Behavioral Dyscontrol



# Alzheimer's Disease and Frontotemporal Dementia Stereotactic Projections of PET Images



# Vascular Dementia

## (Multi-infarct Dementia: MID)

- Focal neurological signs and symptoms (e.g., weakness on one side of the body) or other evidence of cerebrovascular disease temporally related to disorder
- Multiple strokes over time
- MID Relatively uncommon
- Memory: Retrieval Failure
- Other symptoms depend on location





# Vascular Cognitive Impairment



Describes a range of impairment  
Often Subcortical White Matter  
(small vessel ischemic disease)

## Key Deficits in VCI

- Reduced Mental Processing Speed
- Poor Retrieval with relatively preserved Recognition Memory
- Executive Dysfunction
- Depression



# Movement Problems and Dementia

- **Movement disorders common to many forms of dementia**
- **Parkinson's Disease (PD)**: Degenerative motor system disorder due to loss of dopamine in substantia nigra; dementia rare - occurs after motor difficulties are present
- **Parkinsonism**: motor system disorder with similar symptoms of PD but due to a variety of causes, including many other causes of dementia (Lewy Body) - dementia occurs at same time as motor symptoms



# Diffuse Lewy Body Dementia (DLB)

- **Characterized by:**
  - Fluctuations in alertness and attention
  - Vivid visual hallucinations
  - Parkinsonism
- **Sleep disturbance**
- **Prominent disturbance in visual processing**
- **Executive problems**
- **Memory Variable: Recall/AD-like**
- **Emotional Disturbance/Dysregulation**



# Cognitive Deficits: DLB vs. PD

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## Algorithm:

If Motor Sx precede onset of Cognitive Deficits by several years = **PD**

If Cognitive Sx start before or concurrently with motor SX = **DLB**

Fluctuating Cognitive Abilities = **DLB**



# Core Cognitive Test Battery at CACIR

Medical Hx  
Interview  
MMSE  
Mattis DRS\*  
WTAR~  
WAIS~  
GAI  
VCI  
POI/PRI  
PSI

WMS~  
LM-Imm~  
LM-Del~  
LM Recog~  
Hopkins VLT  
1st Recall  
Learning Trials  
Delay  
Recogn  
BVMT  
1st Recall  
Learning Trials  
Delay  
Recogn  
Digit Span~

Boston Naming\*  
Token Test\*  
COWA\*  
Cat Fluency\*  
JOLO\*  
KBNA  
Complex Fig  
Clocks

Trails A & B\*  
KBNA  
Pract Prob Solv  
Concept Shift  
(WCST)  
Grooved Pegs  
GDS  
(Beck AI)  
(PAI)



## Cognitive Dimensions

		AD	VCI	FTD
Intelligence:	Verbal Comprehension			+
	Perceptual Organization			+
	Processing Speed		xxx	x
Executive Functions	Sequencing	x	xx	xxx
	Set Maintenance	x	xx	xxx
	Reasoning/Problem Solving	x	xx	xxx
Memory	Immediate Recall	xxx	x+	x+
	Learning	xxx	x+	x+
	Delayed Recall	xxx	x+	x+
	Recognition/Cued Recall	xxx		
Language	Expressive - Naming	xx		x+
	Receptive - Comprehension			x+
	Fluency: Phonemic/Letter		x	xx
	Semantic	xx	x	x
Visuospatial Functions	Spatial Orientation	x		x
	Visual Discrimination			
	Constructional Praxis			xx
Emotional Status	Depression/Comportment		Depress	Comport

Levy & Chelune (2007). Cognitive-behavioral profiles of neurodegenerative dementias: Beyond Alzheimer's disease. *J. Geriatr Psychiatry & Neurology*

The University of Utah Center for Alzheimer's Care, Imaging and Research



# Case Examples



## SE: 74 y/o, Right-handed Female, 16 yrs Educ

GLOBAL MENTAL STATUS			
MMSE: 21/ 30	Date: 3/3/2009	3MS: /100	
<b>Dementia Rating Scale</b>	<i>Raw</i>	<i>Mayo SS</i>	<i>Mayo Demo</i>
Attention/ Concentration	35/ 37	10	9
Initiation/Perseveration	36/ 37	10	9
Constructional Praxis	6/ 6	10	9
Conceptualization	36/ 39	10	9
Memory	13/ 25	2	0
<b>Total</b>	<b>126/ 144</b>	<b>5</b>	<b>3</b>

WECHSLER TESTS			
WTAR: <i>Reading</i>	<i>Raw</i>	<i>SS</i>	<i>Demo Tc</i>
WAIS-III <i>Intelligence</i>			
General Ability Index	47	86	27
Verbal Comprehension Index	23	88	27
Perceptual Organization Index	24	88	33
Processing Speed Index	11	76	21

WMS-III Memory Scale			
Logical Memory Immediate	7	1	9
Logical Memory Delayed	3	3	16
Logical Memory Recognition	16	1%	

HOPKINS VERBAL LEARNING & BRIEF VISUOSPATIAL MEMORY					
HVLT-R	<i>Raw</i>	<i>Tc</i>	BVMT-R	<i>Raw</i>	<i>Tc</i>
Trial 1	2		Trial 1	2	37
Trial 2	4		Trial 2	2	26
Trial 3	6		Trial 3	0	19
Total 1-3	12	29	Total 1-3	4	22
Delay	0	19	Delay	2	27
Recog	12/24		Recog	10/12	

ATTENTION/SCANNING			
WAIS-III Digit Span	<i>Raw</i>	<i>SS</i>	<i>Demo</i>
	13	8	36

LANGUAGE	<i>Raw</i>	<i>Mayo SS</i>	<i>Mayo Demo</i>
Boston Naming	51	9	7.51
COWA Letter Fluency	38	11	9.86
Category Fluency	23	4	2.83
Token Test	42	10	8.81

VISUOSPATIAL FUNCTIONS	<i>Raw</i>	<i>SS</i>	<i>Demo</i>
Judge of Line Orient (Mayo)	20	9	7.76
<b>KBNA</b>			
Complex Figure	18/20		
Clocks	31/37		
Complex Fig & Clocks	49/57	9	

EXECUTIVE FUNCTIONS / COGNITION				
<b>Trail Making Test (Mayo)</b>		<i>Raw</i>	<i>SS</i>	<i>Demo</i>
Trails A	Time	77	6	5.23
Trails B	Time	254	2	.86
<b>Wisconsin Card Sorting (Heaton) 64 Card Version</b>				
Total Correct		47		
Total Errors		17	106	54
Perseverative Responses		10	107	55
Perseverative Errors		9	109	56
Categories Achieved		2	5	
Set Failures		1		

KBNA			
Practical Problem Solving	8 /10		
Conceptual Shifting	19 /20		
<b>Total</b>	<b>27 /30</b>	<b>11</b>	

**Diagnosis = AD**



## BB: 62 y/o Rt-handed Male with Ph.D.

<b>GLOBAL MENTAL STATUS</b>			
MMSE: 29/ 30	Date: 1/13/2009	3MS: /100	
			Mayo
Dementia Rating Scale	Raw	Mayo SS	Demo
Attention/ Concentration	37/ 37	13	12
Initiation/Perseveration	37/ 37	11	10
Constructional Praxis	6/ 6	10	9
Conceptualization	38/ 39	11	10
Memory	22/ 25	7	6
Total	140/ 144	11	10

<b>WECHSLER TESTS</b>	Raw	SS	Demo Tc
WTAR: Reading	49	125	116 Pred
<b>WAIS-III Intelligence</b>			
General Ability Index	82	126	58
Verbal Comprehension Index	46	131	61
Perceptual Organization Index	36	111	47
Processing Speed Index	19	96	41

<b>WMS-III Memory Scale</b>			
Logical Memory Immediate	30	8	35
Logical Memory Delayed	14	8	37
Logical Memory Recognition	19	10%	

<b>HOPKINS VERBAL LEARNING &amp; BRIEF VISUOSPATIAL MEMORY</b>					
HVLT-R	Raw	Tc	BVMT-R	Raw	Tc
Trial 1	7		Trial 1	3	38
Trial 2	8		Trial 2	6	41
Trial 3	7		Trial 3	3	20
Total 1-3	22	37	Total 1-3	12	31
Delay	0	19	Delay	0	19
Recog	18/24		Recog	10/12	

<b>ATTENTION/SCANNING</b>	Raw	SS	Demo
WAIS-III Digit Span	20	13	53

<b>LANGUAGE</b>	Raw	Mayo SS	Mayo Demo
Boston Naming	58	13	10.43
COWA Letter Fluency	46	13	10.58
Category Fluency	39	8	6.35
Token Test	44	12	10.23

<b>VISUOSPATIAL FUNCTIONS</b>	Raw	SS	Demo
Judge of Line Orient (Mayo)	30	16	14.54
<b>KBNA</b>			
Complex Figure	19/20		
Clocks	35/37		
Complex Fig & Clocks	54/57	12	

<b>EXECUTIVE FUNCTIONS / COGNITION</b>			
<b>Trail Making Test (Mayo)</b>			
Trails A	Time	38	8
Trails B	Time	63	11
<b>Wisconsin Card Sorting (Heaton) 64 Card Version</b>			
Total Correct		49	
Total Errors		15	99
Perseverative Responses		9	95
Perseverative Errors		9	93
Categories Achieved		3	5
Set Failures		1	
<b>KBNA</b>			
Practical Problem Solving		9 /10	
Conceptual Shifting		20 /20	
Total		29 /30	13



# MM: 78 y/o Rt-handed Female with 16yrs Educ

<b>GLOBAL MENTAL STATUS</b>			
MMSE: 26 / 30	Date: 6/5/2008	3MS: /100	
<b>Dementia Rating Scale</b>	<i>Raw</i>	<i>Mayo SS</i>	<i>Mayo Demo</i>
Attention/ Concentration	36/ 37	12	11
Initiation/Perseveration	37/ 37	4	2
Constructional Praxis	6/ 6	10	9
Conceptualization	37/ 39	11	10
Memory	15/ 25	2	0
<b>Total</b>	<b>121/ 144</b>	<b>5</b>	<b>3</b>

<b>WECHSLER TESTS</b>	<i>Raw</i>	<i>SS</i>	<i>Demo Tc</i>
WTAR: Reading	47	122	111 Pred
<b>WAIS-III Intelligence</b>			
General Ability Index	70	110	47
Verbal Comprehension Index	33	105	41
Perceptual Organization Index	37	114	53
Processing Speed Index	17	91	33

<b>WMS-III Memory Scale</b>			
Logical Memory Immediate	20	6	26
Logical Memory Delayed	5	6	27
Logical Memory Recognition	21	25%	

<b>HOPKINS VERBAL LEARNING &amp; BRIEF VISUOSPATIAL MEMORY</b>					
HVLT-R	<i>Raw</i>	<i>Tc</i>	BVMT-R	<i>Raw</i>	<i>Tc</i>
Trial 1	4		Trial 1	2	37
Trial 2	5		Trial 2	2	26
Trial 3	8		Trial 3	4	31
Total 1-3	17	39	Total 1-3	8	29
Delay	3	31	Delay	0	<20
Recog	20/24		Recog	12/12	
<b>WAIS-III Digit Span</b>	<b>18</b>	<b>12</b>	<b>51</b>		

<b>LANGUAGE</b>	<i>Raw</i>	<i>Mayo SS</i>	<i>Mayo Demo</i>
Boston Naming	57	14	12.86
COWA Letter Fluency	23	7	5.22
Category Fluency	35	10	9.37
Token Test	43	12	11.47

<b>VISUOSPATIAL FUNCTIONS</b>	<i>Raw</i>	<i>SS</i>	<i>Demo</i>
Judge of Line Orient (Mayo)	22	10	8.86
<b>KBNA</b>			
Complex Figure	18/20		
Clocks	33/37		
Complex Fig & Clocks	51/57	10	

<b>EXECUTIVE FUNCTIONS / COGNITION</b>			
Trail Making Test (Mayo)	<i>Raw</i>	<i>SS</i>	<i>Demo</i>
Trails A Time	41	10	9.63
Trails B Time	163	8	7.22
<b>KBNA</b>			
Practical Problem Solving	7 /10		
Conceptual Shifting	16 /20		
<b>Total</b>	<b>23 /30</b>	<b>7</b>	

Geriatric Depression Scale = 14/30

**Dx: Mixed Dementia (VCI + Depression)**



# MA: 67 y/o Rt-Handed Male with 16 yrs Educ

GLOBAL MENTAL STATUS			
MMSE: 24/ 30	Date: 12/16/2008	3MS: /100	
Dementia Rating Scale	Raw	Mayo SS	Mayo Demo
Attention/ Concentration	32/ 37	6	4
Initiation/Perseveration	31/ 37	6	4
Constructional Praxis	6/ 6	10	9
Conceptualization	32/ 39	6	4
Memory	16/ 25	2	0
Total	117/ 144	3	1

WECHSLER TESTS	Raw	SS	Demo Tc
WTAR: Reading	45	119	111 Pred
WAIS-III Intelligence			
General Ability Index	55	93	31
Verbal Comprehension Index	32	103	39
Perceptual Organization Index	23	86	30
Processing Speed Index	5	63	15

WMS-III Memory Scale	Raw	SS	Demo
Logical Memory Immediate	19	4	22
Logical Memory Delayed	10	6	30
Logical Memory Recognition	23	25%	

HOPKINS VERBAL LEARNING & BRIEF VISUOSPATIAL MEMORY					
HVLT-R	Raw	Tc	BVMT-R	Raw	Tc
Trial 1	3		Trial 1		
Trial 2	6		Trial 2		
Trial 3	8		Trial 3		
Total 1-3	17	28	Total 1-3		
Delay	8	42	Delay		
Recog	12/24		Recog	/12	

ATTENTION/SCANNING	Raw	SS	Demo
WAIS-III Digit Span	12	7	32

VISUOSPATIAL FUNCTIONS	Raw	SS	Demo
Judge of Line Orient (Mayo)	24	12	11.06
KBNA			
Complex Figure	15/20		
Clocks	24/37		
Complex Fig & Clocks	39/57	3	

EXECUTIVE FUNCTIONS / COGNITION				
Trail Making Test (Mayo)	Raw	SS	Demo	
Trails A Time	80	3	1.93	
Trails B Time	300	2	.86	
KBNA				
Practical Problem Solving	10 /10			
Conceptual Shifting	12 /20			
Total	22 /30	7		

Geriatric Depression Scale = 11

**Dx: Dementia with Lewy Bodies**