



# **USING NEUROPSYCHOLOGICAL TEST PERFORMANCE TO VALIDATE ANATOMICAL PREDICTORS** OF MILD COGNITIVE IMPAIRMENT OBTAINED FROM LOGISTIC STATISTICAL MODELS Renee DeVivo, B.A.<sup>1,2</sup>, Lauren Zajac M.S.<sup>1,2</sup>, Ron Killiany, Ph.D.<sup>1,2,3</sup>

# Introduction

- Mild Cognitive Impairment (MCI) has been described as the intermediate stage between the expected, mild declines in cognition associated with normal aging and the more pronounced decline in cognition seen in Alzheimer's disease.
- Neuropathological studies have established the presence of atrophy in medial temporal lobe regions of individuals with MCI.
- Previously, we used logistic statistical models built from anatomical regions of interest (ROI) data generated from magnetic resonance imaging (MRI) scans to identify the best set of classifiers for distinguishing individuals with MCI and healthy control subjects.
- Our prior structural classification model was built solely using volumetric measures and thus we were interested to see how a model using cognitive features would compare. The cognitive data utilized for this model included scores from tasks, such as the Mini Mental State Examination (MMSE), Geriatric Depression Scale (GDS), Logical Memory Recall, and Part B of the Trailmaking Test.

## **Participant Information**

• Participants were part of the Health Outreach Program for the Elderly (HOPE) study run through the Boston University Alzheimer's Disease Center (BU-ADC) and the Alzheimer's Disease Neuroimaging Initiative (ADNI). For the purposes of this study, there were 46 controls participants and 50 MCI participants.

## Methods

- HOPE participants were scanned at the Center for Biomedical Imaging (CBI) at the BUSM on a 3T Philips Achieva System with a 32-channel head coil.
- ADNI participants were scanned at participating ADNI sites across the USA on 3T Philips Achieva System with a 8-channel headcoil.
- Participants were scanned with comparable imaging parameters. Brain morphometric measures were generated using FreeSurfer version 6.0.

Selected ROI in **Classification Model** Left insula Left superior parietal cortex Left rostral middle frontal cortex Left superior temporal cortex Right middle temporal cortex Right pars opercularis Right paracentral lobule Right precentral cortex Right caudal anterior cingulate cortex Left whole hippocampus Right subiculum

- A stepwise nominal logistic regression model was created to identify which ROI classified participants best.
- The 11 selected regions are listed on the left.
- In addition to the selected ROI, bilateral hippocampal subfields (listed on the right), whole hippocampal formations, amygdalae, and entorhinal cortices were included in a principal component analysis including structural features and cognitive features.
- An additional stepwise nominal logical regression model was created to identify how well cognitive features could classify participants as controls or MCI.

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#### Figure 1. Axial View of Hippocampal Subfields



#### Figure 2. Example of MMSE Cognitive Test

#### The Mini-Mental State Exam

Patient			Ex
Maximum	S	core	
			Orientation
5	(	)	What is the (year) (sea
5	(	)	Where are we (state) (
			Registration
3	(	)	Name 3 objects: 1 seco
	82	12	all 3 after you have
			Then repeat them
			Trials
			Attention and Calcu
5	(	)	Serial 7's. 1 point for
	े	1	Alternatively spell
			Recall
3	(	)	Ask for the 3 objects re
			Language
2	(	)	Name a pencil and wat
1	(	)	Repeat the following "
3	(	) (	Follow a 3-stage comn
	2	20 20	"Take a paper in yo
1	(	)	Read and obev the foll
1	è	) í	Write a sentence.
1	Ì	)	Copy the design shown
			$\sim$

\_\_\_\_

Total Score

xaminer

Date

ason) (date) (day) (month)? (country) (town) (hospital) (floor)?

ond to say each. Then ask the patient said them. Give 1 point for each correct answer. until he/she learns all 3. Count trials and record.

#### ulation

each correct answer. Stop after 5 answers. "world" backward.

repeated above. Give 1 point for each correct answer.

"No ifs, ands, or buts" our hand, fold it in half, and put it on the floor."

lowing: CLOSE YOUR EYES

ASSESS level of consciousness along a continuum Alert Drowsy Stupor Coma

### Results

- *p* < 0.0001).
- **Structural Classification Model**

	Pre
Actual Group	Contro
Control	44
MCI	2

#### Principal

component analys (see right) showed features of cognition were n related to features of structural changes in the classification of controls and MCI Furthermore, this analysis showed components of structure and cognition are unrelated to one another.

#### Conclusion

These findings suggest that classification models built from MRI data outperform those built from cognitive data. While the basis for this needs further exploration, the variable nature of cognition is likely a central factor.

 Our classification model based on structural features (R<sup>2</sup> = 0.7710, whole model test chi square = 102.4794, p < 0.0001) was a better fit than the classification model based on cognitive features ( $R^2 = 0.3655$ , whole model test chi square = 44.08254,

 The classification model based upon volumetric measures had a better classification rate, 0.9583 (misclassification rate = 0.0417) than the classification model based upon cognitive measures, which had a classification rate of 0.7816 (misclassification rate = 0.2184). **Cognitive Classification Model** 

l Count		Predicte	ed Coul
MCI	Actual Group	Control	N
2	Control	34	
48	MCI	10	

\*9 subjects were excluded from the cognitive classification model due to missing cognitive test scores.

	Measures	Principal 1	Principal 15
	Residual Right Precentral Cortex Volume	0.815689	-0.0014
SIS	Residual Left Rostral Middle Frontal Cortex Volume	0.765047	0.000964
d	Residual Left Superior Parietal Cortex Volume	0.697031	0.001033
<b>~</b>	Residual Right Middle Temporal Cortex Volume	0.693919	0.002051
	Residual Left Superior Temporal Cortex Volume	0.665819	0.002996
ot	Residual Left Insula Volume	0.601357	-0.003621
Οl	Residual Right Paracentral Lobule Volume	0.590528	-0.007425
S	Residual Right Amygdala	0.504781	-0.157565
	Residual Left Amygdala	0.47494	0.268847
	Residual Left Subiculum	0.444202	-0.054174
	Residual Presubiculum	0.381439	0.018342
	Residual Left CA1	0.320215	0.005584
	Residual Left Whole Hippocampus	0.440591	-0.041347
	Residual Left Molecular Layer	0.42308	-0.017576
	Residual Left Dentate Gyrus	0.441379	-0.011906
	Residual Left CA4	0.42193	0.013366
21	Residual Left Hippocampal Amygdala Transition Area	0.372728	0.065604
uS	Residual Left CA2/3	0.300142	-0.000994
	Residual Right Pars Opercularis Volume	0.49494	-0.001254
	Residual Right Caudal Anterior Cingulate Cortex Volume	0.344395	-0.010035
	Part B of Trailmaking Test	-0.124924	0.705405
	MMSE	0.010618	0.642772
	Education	0.019754	0.640147
	Logical Memories Immediate	0.055795	0.571468
	Logical Memories Delayed	0.070506	0.547365
	Residual Left Fimbria	0.344538	0.001495
	GDS	-0.078025	0.383719