Results of Crosswalk Study

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of the UDS Neuropsychological work group

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Crosswalk aims

1. To assess the correlation between the tests
2. If correlated, create a crosswalk between old and new tests: (e.g., Digit Span score=? is equivalent to Number Span score=?) to maximize use of longitudinal data

UDS 2.0	UDS 3.0
MMSE	MoCA
Logical Memory Story Units	Craft Story
Boston Naming Test	MINT
Digit Span	Number Span

Sample size as of April 22

- 879 subjects from 24 Centers
- 100 initial visit subjects from 16 Centers
- 387 men, 492 women
- Median visit number is 4th visit
- 459 C1W tests first, 420 C1 tests first
- Median age 75
- 136 African American subjects, 24 Asian, 1 American Indian/Alaska Native, 27 mixed race

MMSE range	Sample size
26-30	626
21-25	140
16-20	64
10-15	39
<10	10

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Quality assurance

Only data that pass QA are included in final analysis

- Range checks
- Subscores sum to total
- A1 and C1 errors and alerts
- Confirmed correct Craft paraphrase scores
- Improbable combinations (MINT=30, Boston Naming Test =5)

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A priori correlation cut-offs

<.3	**Poor correlation** — crosswalk not possible
.3 –.6	**Moderate correlation** — these tests are only somewhat correlated; crosswalk may not be possible or at least not advisable
.6 –.8	**Good correlation** — these tests have good correlation; crosswalk possible
>.8	**Very good correlation**

Correlations

Using a rank correlation (Spearman) at all visits:

MMSE, MoCA (raw)	ρ = 0.78
MMSE, MoCA (education-adjusted)	ρ = 0.77
BNT, MINT	ρ = 0.77
Logical Memory, Craft Story 21 immediate	ρ = 0.73
Logical Memory, Craft Story 21 delayed	ρ = 0.77
Digit/Number Span Forward — trials correct	ρ = 0.75
Digit/Number Span Forward — length	k = 0.67
Digit/Number Span Backward — trials correct	ρ = 0.78
Digit/Number Span Backward — length	k = 0.74

Correlations

Using a **Pearson** correlation at all visits:

MMSE, MoCA (raw)	r = 0.85
MMSE, MoCA (education-adjusted)	r = 0.85
BNT, MINT	r = 0.87
Logical Memory, Craft Story 21 immediate	r = 0.76
Logical Memory, Craft Story 21 delayed	r = 0.79
Digit/Number Span Forward — trials correct	r = 0.76
Digit/Number Span Forward — length	k = 0.67
Digit/Number Span Backward — trials correct	r = 0.80
Digit/Number Span Backward — length	k = 0.73

Potential learning effects

- Anecdotes and quantitative research on learning effects for Logical Memory scores
  - ‘Retesting effect’ may be learning how to take the story test, which would also affect the Craft Story
  - ‘Retesting effect’ may be remembering specific aspects of the story, which would NOT affect the Craft Story score
- Plot new vs. old battery scores at the initial visit (no opportunity for learning effects), follow-up visit 2 (some opportunity), and follow-up visit 5 (large opportunity) to look for changes in the pattern of the scores

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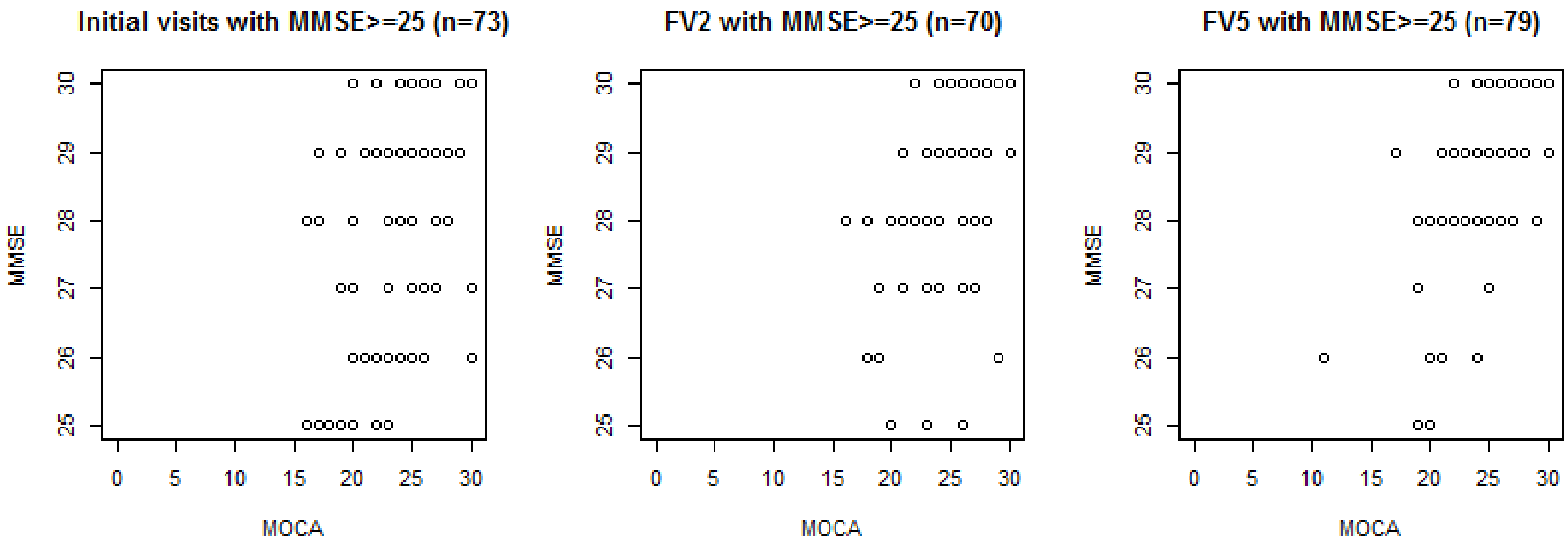
MMSE, MOCA



Little evidence for learning effect influencing scores

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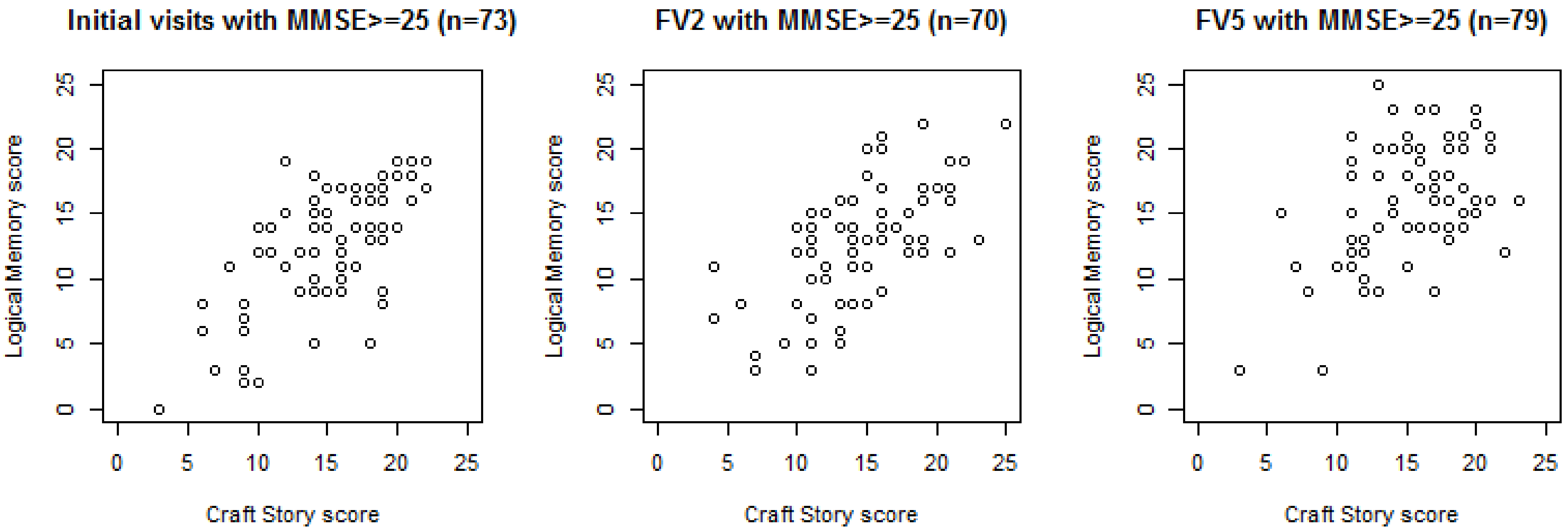
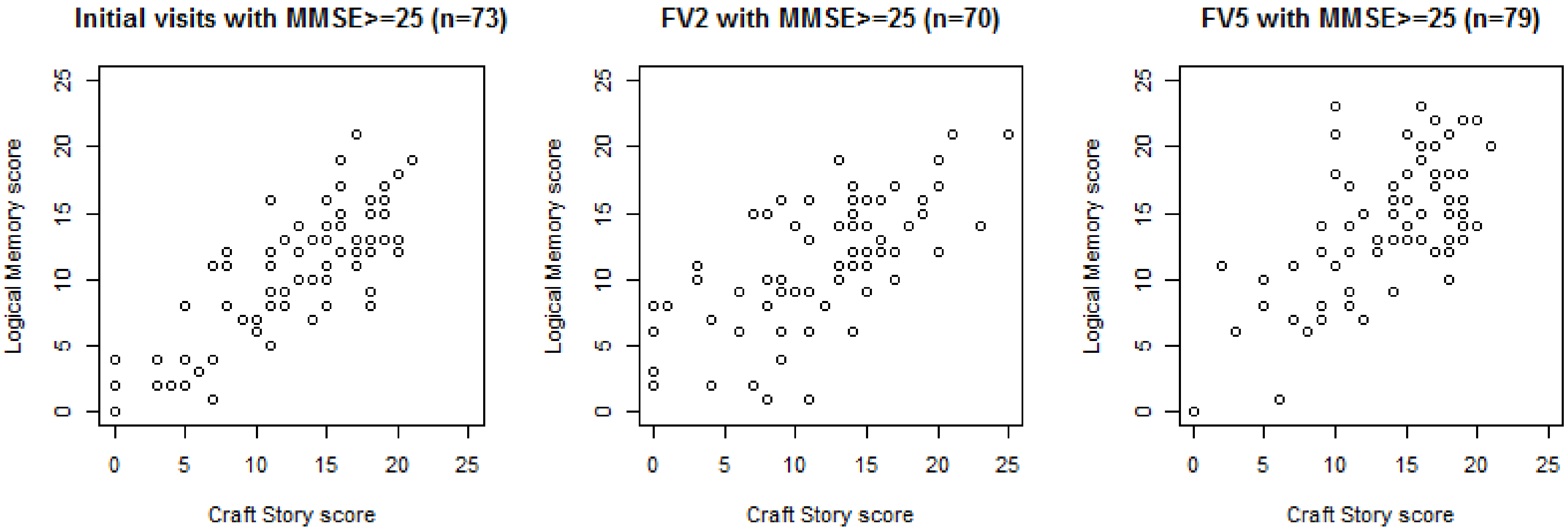
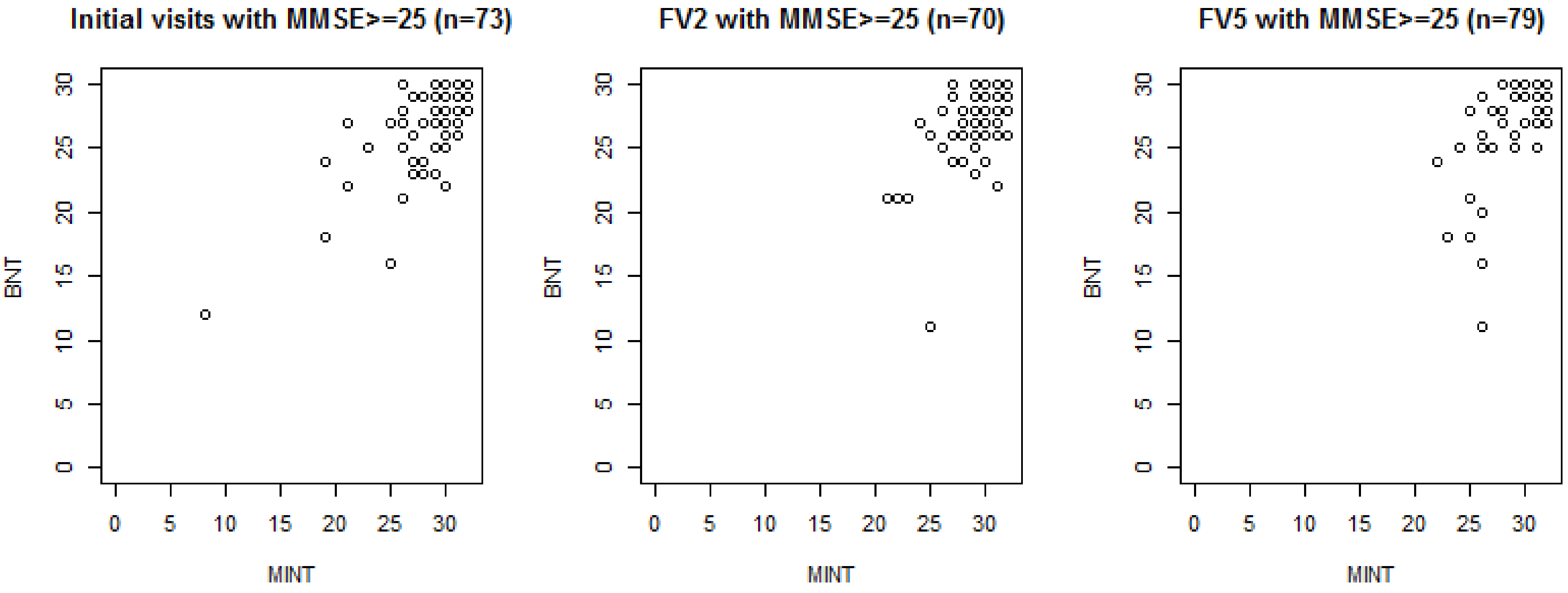
Logical Memory, Craft Story 21 paraphrase — immediate



Logical Memory, Craft Story 21 paraphrase — delayed

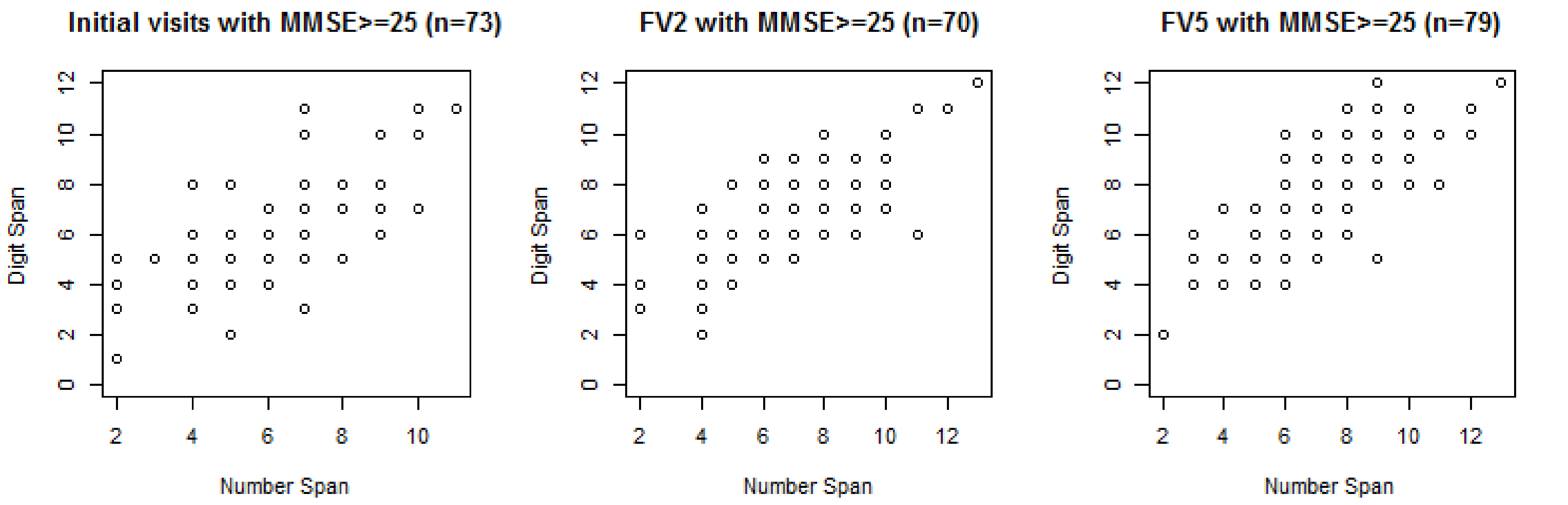


BNT, MINT



Initial visits with MMSE>=25 (n=73)
FV2 with MMSE>=25 (n=70)
FV5 with MMSE>=25 (n=79)
BNT
MINT
0
5
10
15
20
25
30

Digit/Number Span Forward — trials correct



Little evidence for learning effect influencing scores

Crosswalk method

- Equipercentile equating from standardized test literature
  - log-linear smoothing
  - Bootstrap 95% confidence intervals
- Gives single imputation
- Assumptions: continuous scores, similar populations taking both tests
- No distribution assumption; only ranks
- Allows tests to have different ranges

‘Model’ diagnostics

- How accurate is the imputation?
- Split data into training and validation data sets (70% and 30%) to evaluate accuracy of single imputation
- Observed MMSE — predicted MMSE
- Trends in accuracy of imputation
  - Higher vs. lower scores
  - Follow-up vs. initials
- Evaluate all crosswalks separately

Note on direction of Crosswalk

MoCA to MMSE only

- MoCA is more sensitive than MMSE
- MoCA has more information than MMSE
- Cannot create MoCA given MMSE (potentially a range but not an equivalent score)
- Converting MoCA to MMSE is the same as if we had never stopped administering the MMSE; eventually will have enough MoCA scores to use those instead of MMSE and converted MMSE

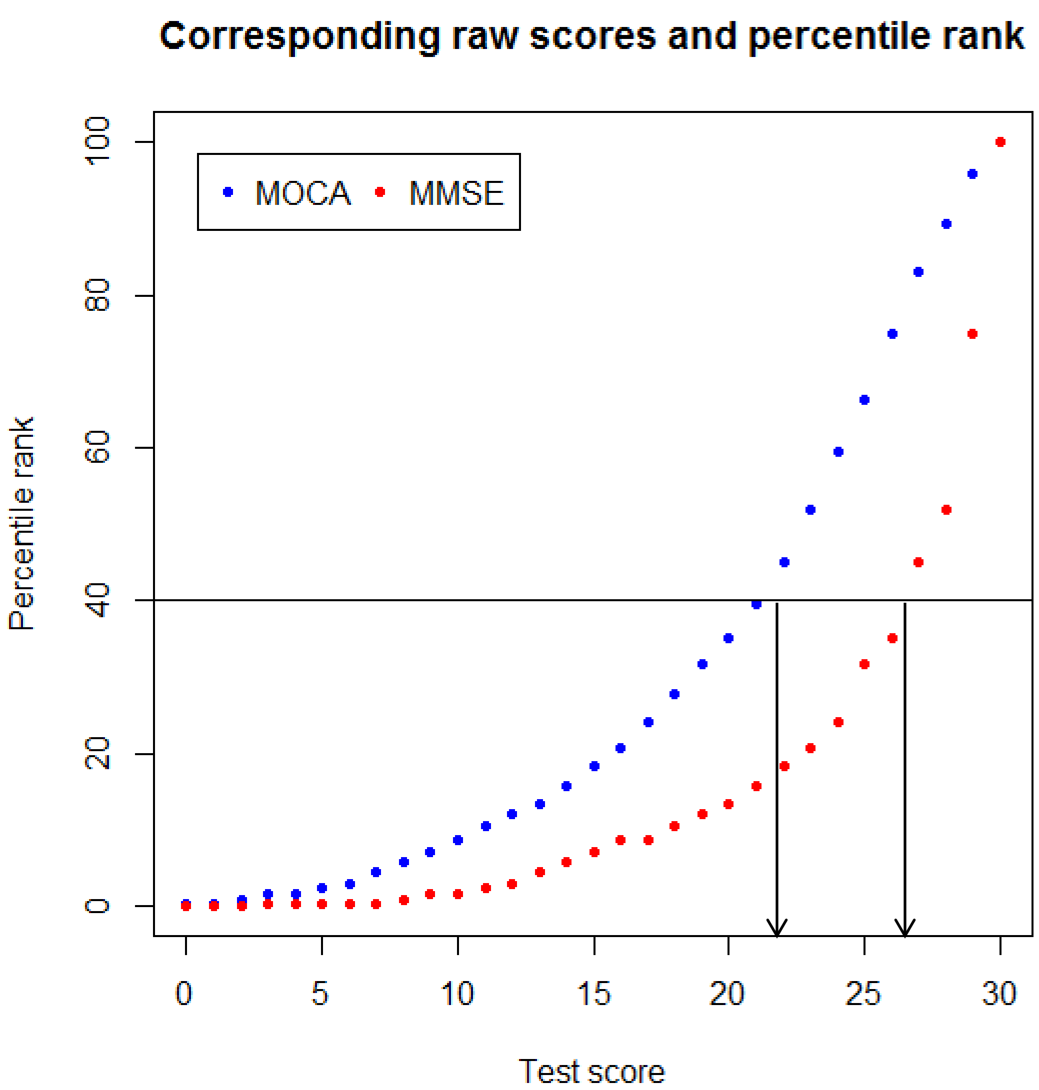
MMSE, MOCA

- Our crosswalk table similar to that of Penn study
- Acceptable variation

Raw MOCA	Equivalent MMSE-Penn*	Equivalent MMSE	95% CI
0	3	3	(0,6)
1	6	6	(3,9)
2	8	7	(5,10)
3	9	9	(6,11)
4	10	10	(712)
5	11	11	(8,13)
6	12	12	(9,14)
7	13	13	(11,15)
8	14	14	(12,16)
9	15	15	(13,17)
10	16	16	(12,17)
11	17	17	(14,18)
12	19	18	(15,19)
13	20	19	(16,20)
14	21	21	(18,21)
15	22	22	(19,22)
16	23	23	(20,23)
17	23	24	(21,24)
18	24	25	(22,25)
19	25	26	(24,26)
20	26	26	(25,26)
21	26	27	(25,27)
22	27	27	(26,28)
23	28	28	(27,28)
24	28	28	(28,28)
25	29	29	(28,29)
26	29	29	(29,29)
27	29	30	(29,30)
28	30	30	(30,30)
29	30	30	(30,30)
30	30	30	(30,30)

*Roalf et al. 2013

MMSE, MOCA

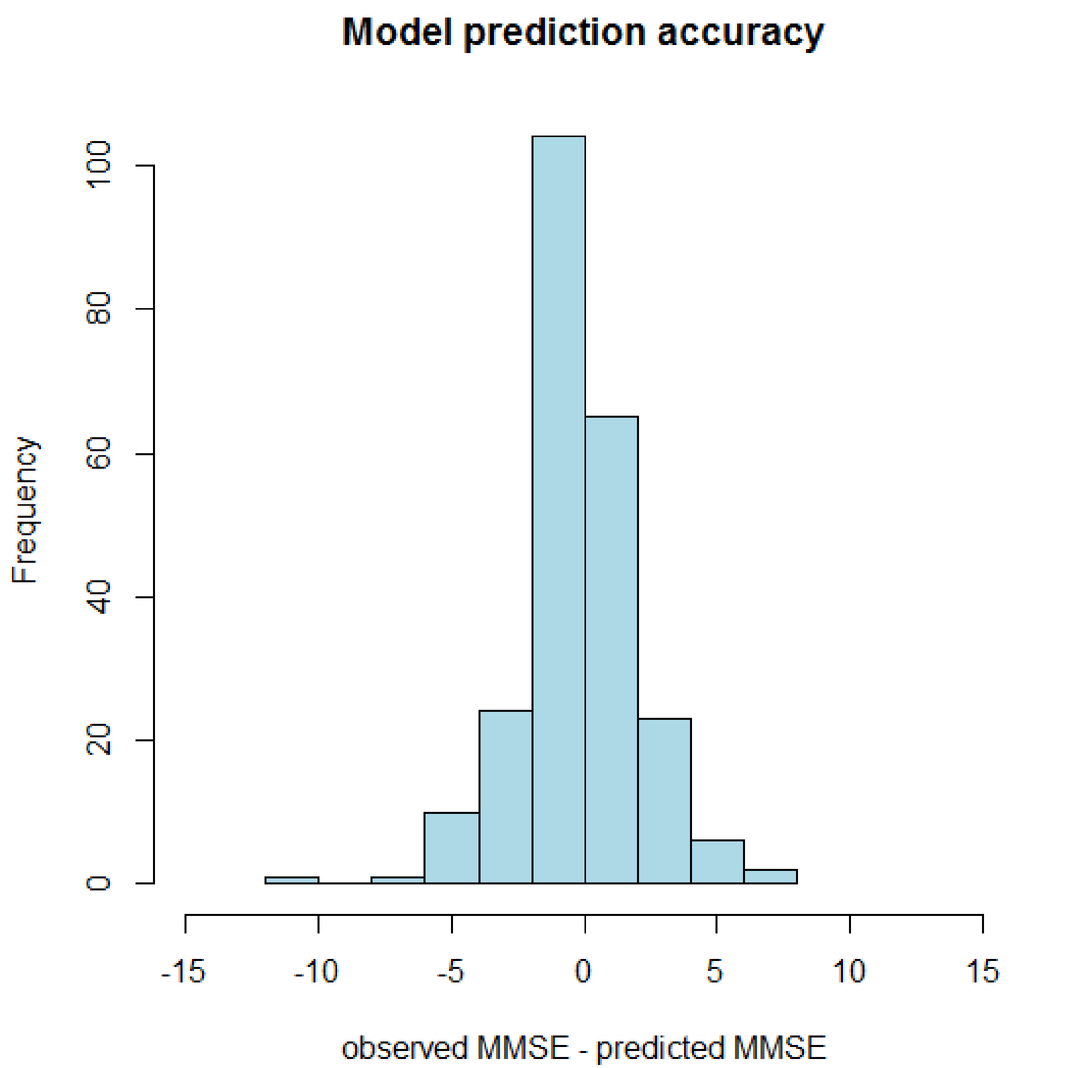


MOCA=22
MMSE=27

MMSE, MOCA

Observed MMSE – predicted MMSE range*	n	(%)
0	65	(26%)
-1, 1	153	(61%)
2 or -2	210	(84%)

*Limited to subjects with MMSE≥16 (n=250)



Logical Memory, Craft Story 21 paraphrase — immediate

- Acceptable variation

Raw Craft immediate	Equivalent Logical Memory immediate	95% CI
0	0	(0,0)
1	0	(0,1)
2	1	(0,2)
3	2	(1,3)
4	2	(1,4)
5	3	(2,5)
6	4	(3,6)
7	5	(4,7)
8	6	(5,8)
9	7	(6,9)
10	9	(7,10)
11	10	(8,11)
12	11	(10,12)
13	12	(11,13)
14	13	(12,14)
15	14	(14,15)
16	15	(15,16)
17	16	(16,17)
18	18	(17,18)
19	19	(18,19)
20	20	(19,20)
21	21	(20,21)
22	22	(21,22)
23	23	(22,24)
24	24	(23,25)
25	25	(24,25)

Logical Memory, Craft Story 21 paraphrase — delayed

- Acceptable variation

Raw Craft immediate	Equivalent Logical Memory immediate	95% CI
0	0	(0,0)
1	1	(1,2)
2	2	(1,4)
3	3	(2,5)
4	4	(3,6)
5	5	(4,7)
6	6	(4,8)
7	7	(5,9)
8	8	(6,9)
9	9	(7,10)
10	10	(8,11)
11	11	(9,12)
12	12	(11,13)
13	13	(12,13)
14	14	(13,14)
15	15	(14,15)
16	16	(15,16)
17	17	(16,18)
18	18	(17,19)
19	19	(18,20)
20	20	(20,21)
21	21	(21,22)
22	23	(22,23)
23	24	(23,24)
24	25	(24,25)
25	25	(25,25)

BNT, MINT

- Acceptable variation

Raw MINT	Equivalent Boston Naming Test	95% CI
0	1	(0,2)
1	3	(0.5)
2	4	(1,6)
3	5	(2,7)
4	5	(2,8)
5	6	(3,9)
6	6	(3,9)
7	7	(4,10)
8	7	(4,10)
9	8	(5,11)
10	8	(5,11)
11	9	(6,12)
12	9	(6,12)
13	10	(7,13)
14	10	(8,13)
15	11	(8,14)
16	12	(9,15)
17	13	(10,15)
18	14	(11,16)
19	15	(12,17)
20	16	(13,18)
21	17	(15,19)
22	18	(16,20)
23	19	(18,21)
24	21	(19,22)
25	22	(21,23)
26	24	(23,24)
27	25	(24,26)
28	26	(25,27)
29	27	(27,28)
30	28	(28,29)
31	29	(29,29)
32	30	(30,30)

Digit/Number Span Forward — trials correct

- Acceptable variation

Raw Number Span Forward correct trials	Equivalent Digit Span Forward trials correct	95% CI
0	0	(0,1)
1	1	(0,2)
2	2	(1,3)
3	3	(3,4)
4	5	(4,5)
5	6	(5,6)
6	7	(6,7)
7	8	(7,8)
8	9	(8,9)
9	9	(9,10)
10	10	(10,11)
11	11	(11,11)
12	12	(11,12)
13	12	(12,12)
14	12	(12,12)

Digit/Number Span Forward — length

- Acceptable variation

Raw Number Span Forward length	Equivalent Digit Span Forward length	95% CI
3	4	(3,4)
4	5	(4,5)
5	5	(5,6)
6	6	(6,6)
7	7	(7,7)
8	8	(8,8)
9	8	(8,8)

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Digit/Number Span Backward — trials correct

- Acceptable variation

Raw Number Span Backward trials correct	Equivalent Digit Span Backward trials correct	95% CI
0	0	(0,1)
1	2	(1,2)
2	2	(2,3)
3	3	(3,4)
4	4	(4,4)
5	5	(5,5)
6	6	(6,6)
7	7	(7,7)
8	8	(8,8)
9	9	(9,9)
10	10	(10,11)
11	11	(11,12)
12	12	(11,12)
13	12	(12,12)
14	12	(12,13)

Digit/Number Span Backward — length

- Acceptable variation

Raw Number Span Backward length	Equivalent Digit Span Backward length	95% CI
0	0	(0,1)
2	2	(2,3)
3	3	(3,3)
4	4	(4,4)
5	5	(5,5)
6	6	(6,6)
7	7	(7,7)
8	7	(7,7)

Next steps

- Assess learning/retesting effects for story scores
- Subgroup analyses (e.g., race, age, education, diagnosis)
- **Publish results, provide summary tables to ADC as requested**
- Validation study (ROC analysis) by Hiroko Dodge

Email Sarah with questions about data analysis methods: smonsell@uw.edu

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Correlations

Using a rank correlation (Spearman):

	C1W first	C1 first
MMSE, MoCA (raw)	ρ= 0.79	ρ =0.77
MMSE, MoCA (education-adjusted)	ρ = 0.79	ρ =0.76
BNT, MINT	ρ = 0.78	ρ =0.75
Logical Memory, Craft Story 21 immediate	ρ = 0.73	ρ =0.73
Logical Memory, Craft Story 21 delayed	ρ = 0.78	ρ =0.76
Digit/Number Span Forward — trials correct	ρ = 0.76	ρ =0.75
Digit/Number Span Forward — length	k = 0.68	k =0.67
Digit/Number Span Backward — trials correct	ρ = 0.78	ρ =0.78
Digit/Number Span Backward — length	k = 0.73	k = 0.73

Correlations by visit number

	UDS visit*		
	IV	FV2	FV5
MMSE, MoCA (education-adjusted)	r= 0.74	r =0.85	r=0.82
BNT, MINT	r= 0.80	r =0.92	r=0.82
Logical Memory, Craft Story 21 immediate	r= 0.79	r =0.84	r=0.73
Logical Memory, Craft Story 21 delayed	r= 0.85	r =0.86	r=0.80

*All visits; not restricted by MMSE score

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