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Making a LLAMA into an ALPACAA: A revised attempt at assessing aptitude

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Outline

- Background on Aptitude and LLAMA tests
- Methodology: how we've revised the tests
- Results & Discussion
- Conclusion





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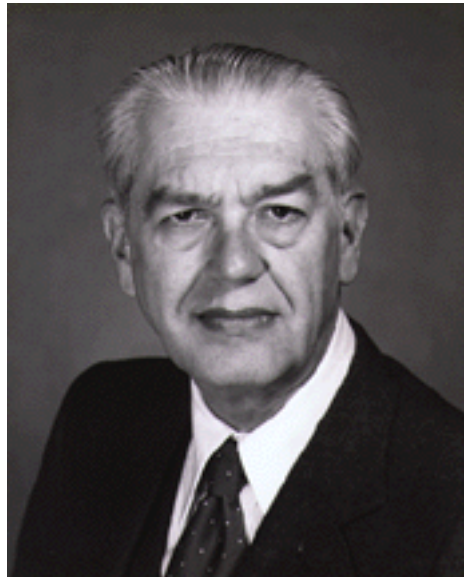
Background: Aptitude & LLAMA tests



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What is Language Learning Aptitude

“the amount of time a student needs to learn a given task, unit of instruction, or curriculum to an acceptable criterion of mastery under optimal conditions of instruction and student motivation.”
(Carroll 1990 p. 26)



- A 'knack for learning languages'. A cognitive variable - something you are born with.
- What does it mean?
- aptitude is different from other cognitive systems, including intelligence
- aptitude is stable (doesn't change)
- aptitude is made up of different components

Li (2015) Construct validity: meta analysis of 66 studies.



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- Aptitude is independent of other individual differences, e.g. motivation.
- executive working memory (EWM) more strongly associated with aptitude than phonological short-term memory (PSTM).
 - BUT Linck et al (2013): relevance of PSTM to advanced learners.
- strong predictor of general proficiency but not vocabulary learning or L2 writing.
- different components predicted different aspects of learning.
- negative correlation between anxiety and aptitude.
 - Sparks & Patton (2013): anxiety as result not cause of low aptitude
- Granena (2013): LLAMA tests measure 2 different constructs:
 - Implicit (sound recognition task) & explicit (other three tasks)

WM as L2 aptitude?

- Wen (2016, p. 142)
 - ❖ “to what extent [can] PWM... complement (or even replace) the phonetic coding ability of language aptitude and, similarly, to what extent EWM can outperform the language analytical ability of language aptitude.”
 - ❖ “premature... to claim that WM ‘replaces’ L2 aptitude given our currently limited knowledge of their relationship and relatively scarce empirical evidence”
- ❖ PWM = language learning device
- ❖ EWM = language processes

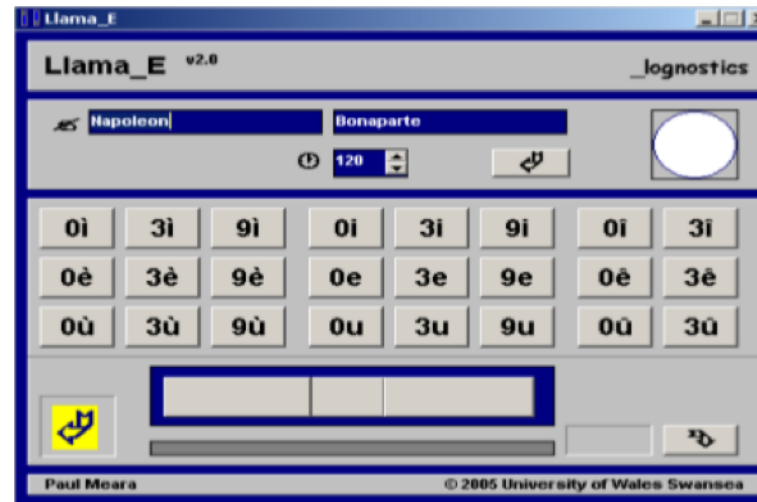
Swansea LLAMA tests (Meara, 2005)

www.lognostics.co.uk/tools/llama



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- Free, loosely based on MLAT
- LLAMA B = vocabulary measure
- LLAMA D = sound recognition (implicit learning)
- LLAMA E = sound-symbol correspondence
- LLAMA F = grammatical inferencing
- Has not been fully validated.





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Purpose/ Research questions

Purpose/ Research questions



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- This study has three purposes:
- to remedy some of the test flaws.
- to revise the scoring method of the LLAMA test
- to examine if the revised tests overlap with working memory measures

- Research Questions:
- What is the impact of different scoring mechanisms on the distribution of ALPACAA scores?
- Do all the items discriminate between participants?
- What is the relationship between the new scoring method and WM, and
- What impact do different background variables have on the ALPACAA scores (*not today*)

Methodology



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- Re-programmed the LLAMA tests into OpenSesame – called ALPACAA
- Changed order of administration:
 - D then B, E, F
 - Kept: 2 mins learning B & E, 5 mins learning F
- Fixed errors in original.
- No feedback to participant during test.
- End: given average RT and total correct.
- Clearer instructions (English)
- Can start test early



- **ALPACAA_1 (sound recognition): Pre-listening instructions**

- Welcome to Part 2 of the experiment.
- There are four sections within this part. This is the first section.
- Please put on your headphones.
- You will hear a series of words in another language.
- All you have to do is listen to the words.
- Press any key when you are ready.

- **ALPACAA_1 (sound recognition): Post listening instructions**

- Thank you.
- You will now hear another series of words.
- Some of them are the same as the words you have just heard. Others are not.
- After each word, you will be asked if you have heard the word before.
- If you have heard the word before, press Y.
- If you have not heard the word before, press N.
- Only respond when you see the question.
- Press spacebar to continue.

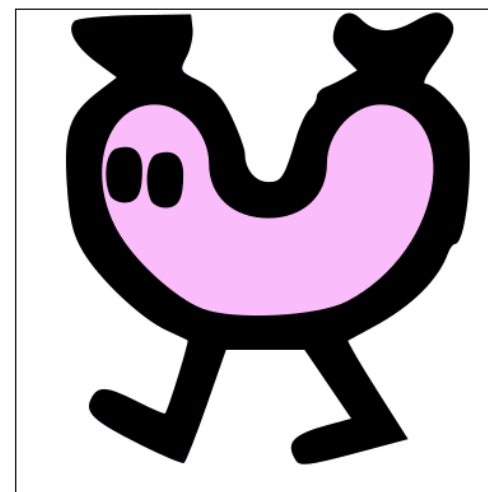
ALPACAA_2 (vocabulary) learning



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1 min
and
48 sec left

CHUEN



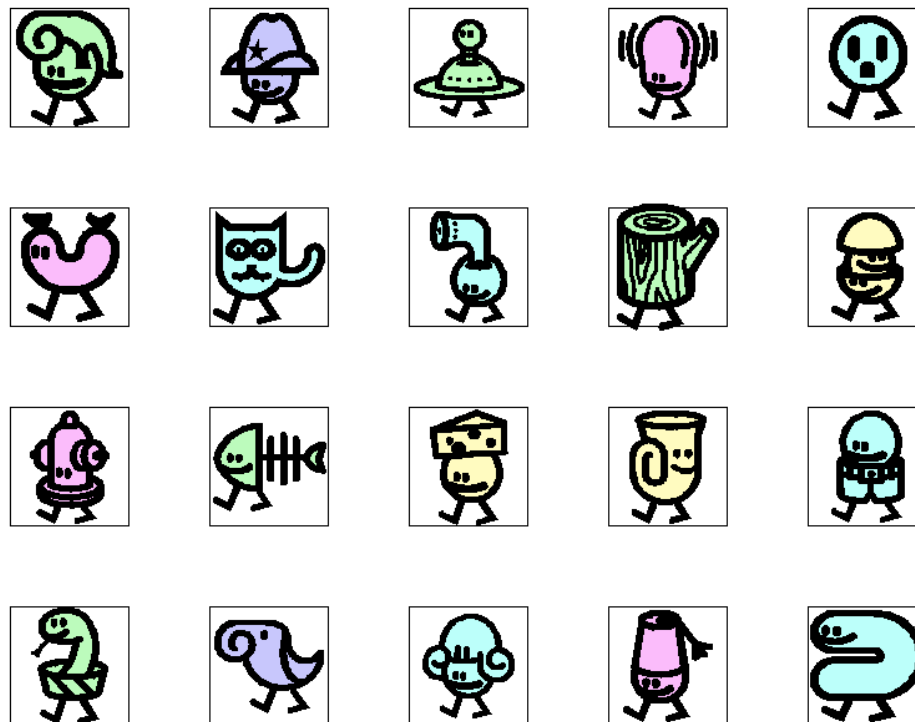
Start test

ALPACAA_2 (vocabulary) test phase



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Find the OC



ALPACAA_3 (sound-symbol) learning



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0i	3i	9i	0i	3i	9i	0î	3î
0ë	3ë	9ë	0e	3e	9e	0ê	3ê
0ü	3ü	9ü	0u	3u	9u	0û	3û

1 min
and
59 sec left

Start test

ALPACAA_3 (sound-symbol) test instructions



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In this section, you will hear a new sound and be asked which symbol it matches.

These new sounds are a combination of two sounds that you have just learnt.

You should use the mouse to click on the symbol that matches the sound.

Press spacebar to continue.

ALPACAA_3 (sound-symbol) test layout



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Click on the word in the grid

0ě3ě	9ű3ě	3ě3ě	0i3ě	9i3e
9ű0ě	9ě0ê	0i0ê	3i3ê	0ě3ű
0i3ű	3i3ű	0ê9ű	3ě3u	0u0u
3u3i	0ű3i	3ű3i	3u0i	9ě3u

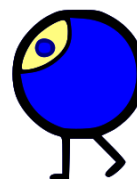
ALPACAA_4 (grammatical inferencing) learning



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4 min
and
56 sec left

atak-arap-sa



Start test

ALPACAA_4 (grammatical inferencing) test



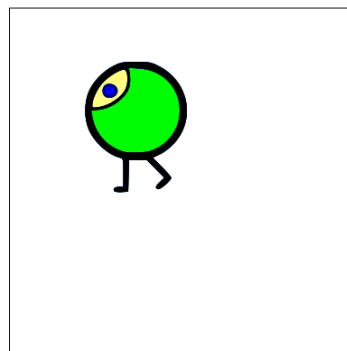
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1

eket-arap-sa

2

eket-arap



Methodology



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- Administered to 123 participants
- Age 17-55, (M=23.5, S.D.=5.576)
- Male = 56, Female = 67
- L1 English speakers = 77
- Bilingual L1 English speakers = 7
- L2 English speakers = 39
- Also administered Stroop, Flanker and auditory Digits backwards.
- Collected by BA dissertation students (L-R, Dafydd, Megan, Amy)

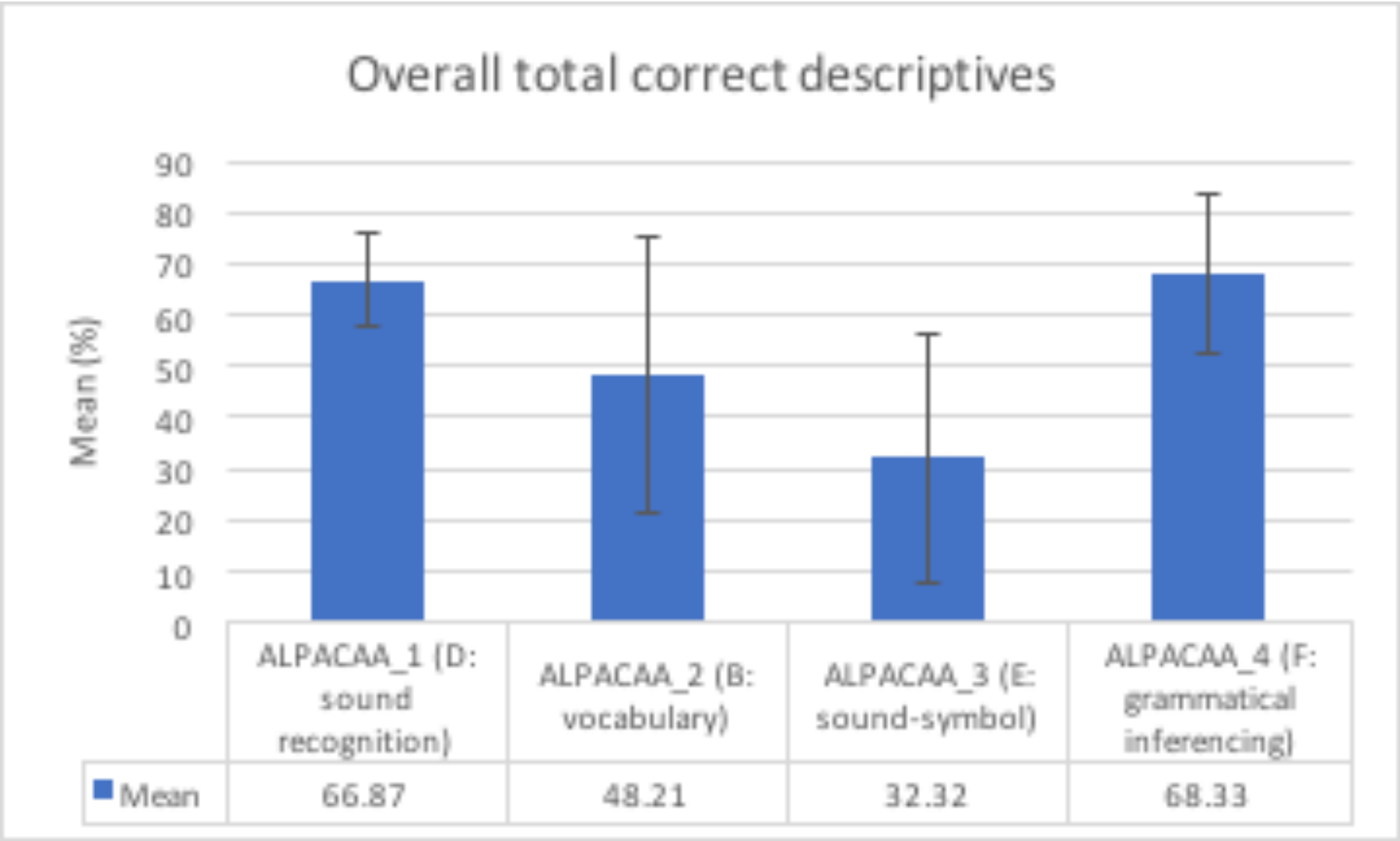


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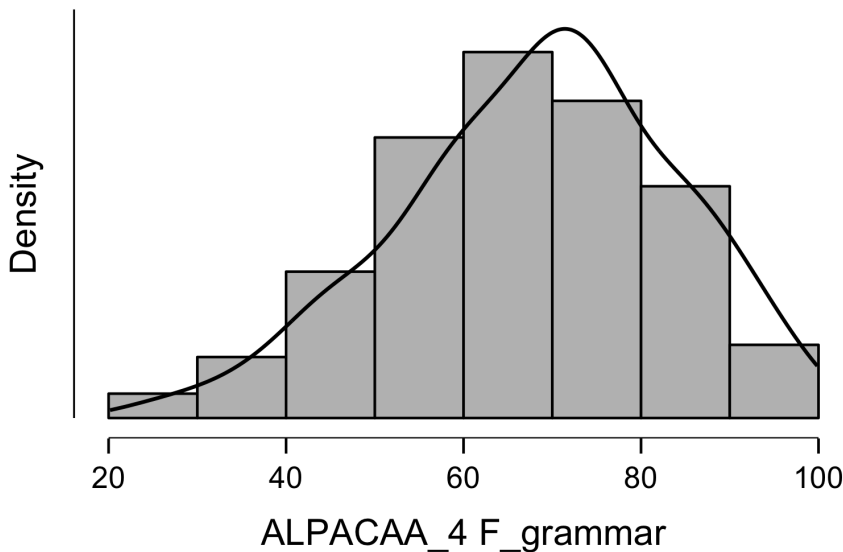
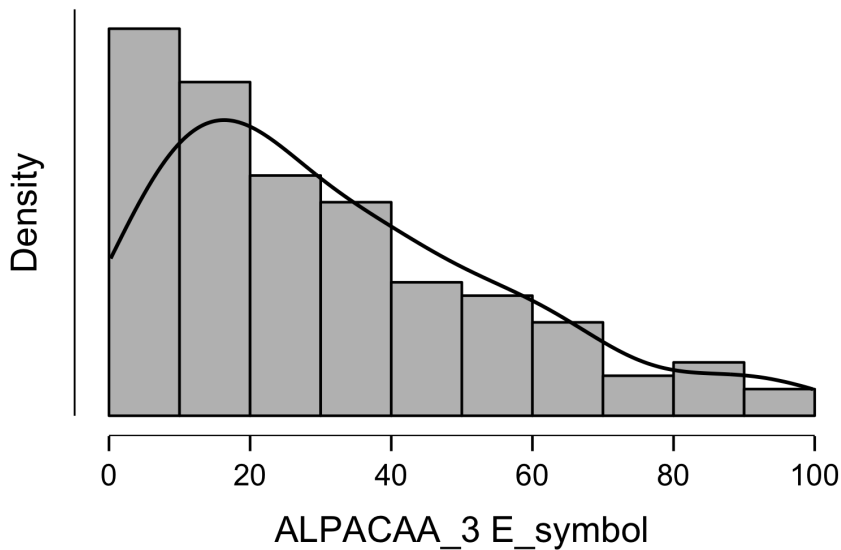
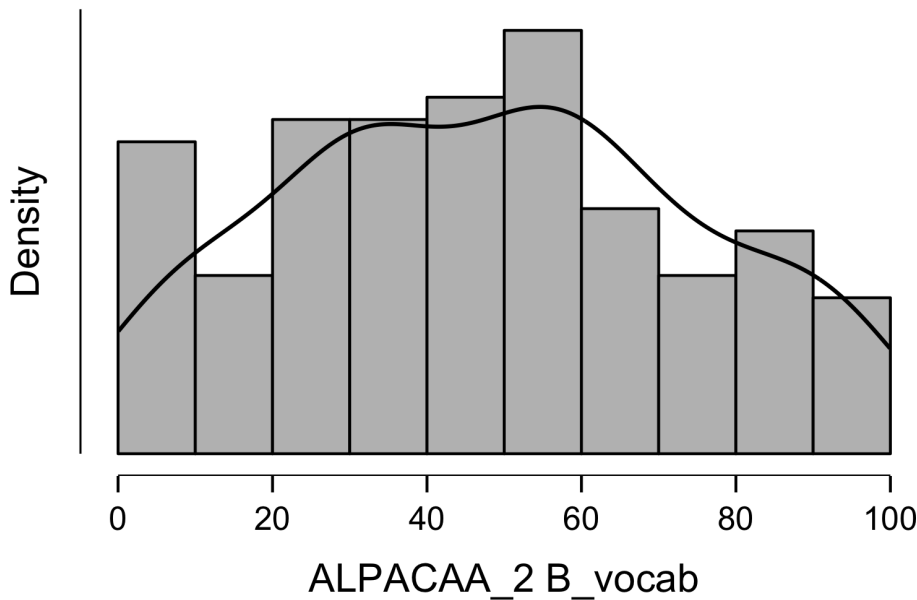
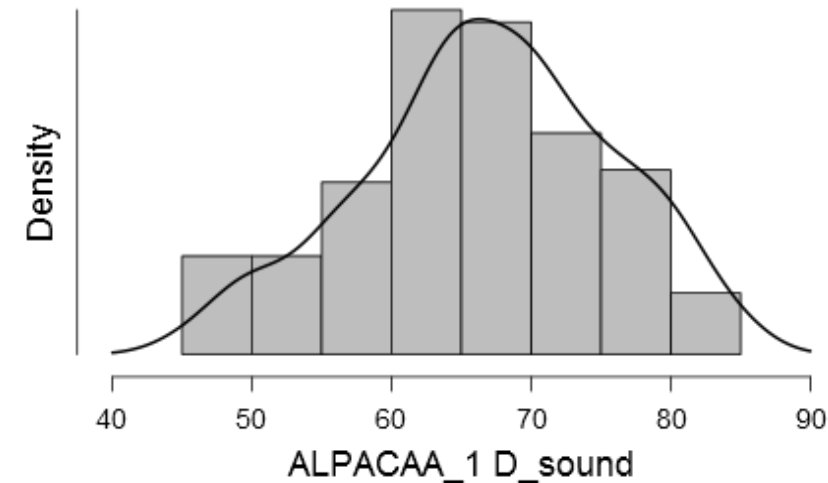
RQ1:

What is the impact of different scoring mechanisms
on the distribution of ALPACAA scores?

Overall descriptive: total correct – n=123



- Distribution of scores in tests (total correct)



Adjusting for guessing



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- **Step 1**

- Adjusted for not doing learning phase (20 items)
- Criteria – must click on each item at least once.
- ALPACAA_2 (vocab): 6 removed n=117
- ALPACAA_3 (sound/symbol): 3 removed, n=120
- ALPACAA_4 (grammatical inferencing): 3 removed, n=120

- **Step 2: Applied LLAMA penalties**

- LLAMA D, E, F – lose 1 mark (5%) for incorrect answer (binary choice)
- ALPACAA_1 (D)
 - M=33.74, S.D=17.86
 - Mean was 68.67
 - Range: -10 – 70
- ALPACAA_4 (F)
 - M=36.50, S.D=31.35
 - Mean was 68.33
 - Range: -50 - 100



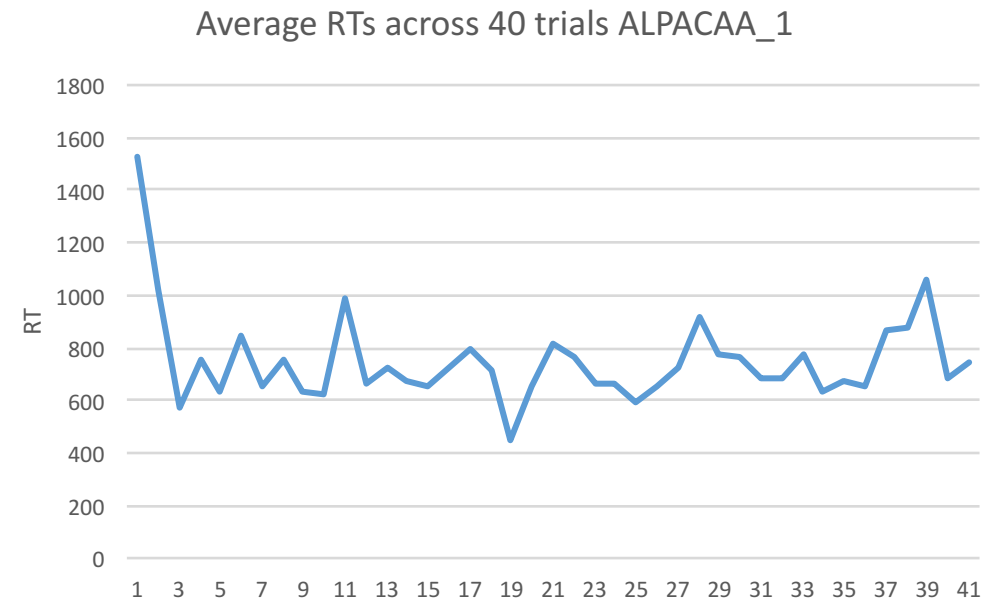
What about adjusting for guessing? Using RTs

- Have RTs for all test items for all participants..
- Excluded any RTs faster than 200ms.
- ALPACAA_1_D: In test phase, heard sound then question prompt then click.
 - More than 200ms after sound so no exclusions.
- ALPACAA_2_B: Three items identified (out of $117 \times 20 = 2340$)
 - Two were correct: removed.
- ALPACAA_3_E: No items
- ALPACAA_4_F: Four items identified (out of $120 \times 20 = 2400$)
 - Two were correct: removed.

As they have to navigate with mouse then 200ms not an appropriate cut off?

Discussion

- Participants use the learning phase (12/369)
- Few react within 200ms (7/7140)
- Penalising doesn't change distribution but lowers mean (a lot).
- Lots more could be done with RT data.
- Very slow on first question but then flatten.
- Exclude items based on +/- 2 S.D.'s.





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RQ2:

Do all the items discriminate between participants?

Internal reliability (Cronbach's alpha)

	n	Cronbach's α	Average inter item correlation	95% CI Lower	95% CI Higher
ALPACAA_1 (sound recognition) all	123	0.385	0.017	0.329	0.438
ALPACAA_1 (sound recognition) correct	123	0.544	0.502	0.502	0.584
ALPACAA_2 (vocabulary)	117	0.850	0.227	0.836	0.863
ALPACAA_3 (sound/symbol)	120	0.883	0.272	0.872	0.893
ALPACAA_4 (grammatical inferencing)	120	0.617	0.079	0.581	0.650

ALPACAA_1 Item Reliability Statistics (all items)



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	mean	sd	item-rest correlation	If item dropped Cronbach's α
latd11-n	0.463	0.501	-0.137	0.417
latd12-n	0.545	0.500	-0.076	0.406
latd03-y1	0.894	0.309	0.183	0.368
latd13-n	0.236	0.426	-0.048	0.398
latd08-y1	0.301	0.460	0.161	0.365
latd14-n	0.683	0.467	0.160	0.365
latd15-n	0.642	0.481	0.003	0.392
latd05-y1	0.813	0.391	0.015	0.388
latd04-y1	0.691	0.464	0.243	0.350
latd06-y1	0.780	0.416	0.040	0.385
latd16v-n	0.740	0.441	0.092	0.377
latd09-y1	0.585	0.495	-0.168	0.422
latd17-n	0.740	0.441	-0.030	0.396
latd10-y1	0.602	0.492	0.048	0.384
latd07-y1	0.732	0.445	0.146	0.368
latd18-n	0.496	0.502	0.012	0.391
latd19-n	0.732	0.445	0.082	0.378
latd20-n	0.366	0.484	-0.006	0.393
latd01-y1	0.951	0.216	0.115	0.378
latd02-y1	0.553	0.499	0.160	0.364
latd21-n	0.821	0.385	0.051	0.383
latd22-n	0.740	0.441	0.157	0.366

	mean	sd	item-rest correlation	If item dropped Cronbach's α
latd04-y2	0.756	0.431	0.124	0.371
latd06-y2	0.732	0.445	0.195	0.359
latd07-y2	0.748	0.436	0.129	0.370
latd23-n	0.829	0.378	0.189	0.363
latd08-y2	0.382	0.488	0.042	0.385
latd10-y2	0.659	0.476	0.058	0.382
latd24-n	0.667	0.473	0.177	0.361
latd25-n	0.740	0.441	0.206	0.358
latd26-n	0.699	0.460	0.163	0.364
latd03-y2	0.764	0.426	0.057	0.382
latd27-n	0.780	0.416	-0.010	0.392
latd05-y2	0.675	0.470	0.099	0.375
latd02-y2	0.561	0.498	0.128	0.370
latd01-y2	0.846	0.363	0.222	0.360
latd28-n	0.675	0.470	0.054	0.383
latd09-y2	0.618	0.488	-0.033	0.398
latd29-n	0.748	0.436	0.179	0.362
latd30-n	0.764	0.426	0.096	0.376

ALPACAA_1 Inter-Item Reliability (all items)

	n	Cronbach's α	Average inter item correlation	95% CI Lower	95% CI Higher
ALPACAA_1 (sound recognition) all	123	0.385	0.017	0.329	0.438
ALPACAA_1 (sound recognition) revised	123	0.535	0.036	0.492	0.575

ALPACAA_1 Item Reliability Statistics (yes only)

	mean	sd	item-rest correlation	If item dropped Cronbach's α
latd03-y1	0.894	0.309	0.180	0.532
latd08-y1	0.301	0.460	0.106	0.543
latd05-y1	0.813	0.391	0.091	0.544
latd04-y1	0.691	0.464	0.258	0.517
latd06-y1	0.780	0.416	-0.129	0.576
latd09-y1	0.585	0.495	-0.007	0.564
latd10-y1	0.602	0.492	0.217	0.524
latd07-y1	0.732	0.445	0.162	0.533
latd01-y1	0.951	0.216	0.124	0.539
latd02-y1	0.553	0.499	0.284	0.511
latd04-y2	0.756	0.431	0.185	0.530
latd06-y2	0.732	0.445	0.169	0.532
latd07-y2	0.748	0.436	0.300	0.510
latd08-y2	0.382	0.488	0.103	0.544
latd10-y2	0.659	0.476	0.219	0.523
latd03-y2	0.764	0.426	0.216	0.525
latd05-y2	0.675	0.470	0.178	0.531
latd02-y2	0.561	0.498	0.268	0.514
latd01-y2	0.846	0.363	0.336	0.509
latd09-y2	0.618	0.488	0.252	0.517



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Inter-item reliability (Cronbach's alpha)

	n	Cronbach's α	Average inter item correlation	95% CI Lower	95% CI Higher
ALPACAA_1 (sound recognition) all	123	0.385	0.017	0.329	0.438
ALPACAA_1 (sound recognition) revised	123	0.535	0.036	0.492	0.575
ALPACAA_1 (sound recognition) correct	123	0.544	0.502	0.502	0.584
ALPACAA_1 (sound recognition) correct revised	123	0.593	0.075	0.555	0.629

ALPACAA_4 Item Reliability Statistics

	mean	sd	item-rest correlation	If item dropped Cronbach's α
eket-arap-sa	0.825	0.382	0.173	0.609
ipod-ilad-za	0.850	0.359	0.247	0.601
eket-arap	0.733	0.444	0.316	0.591
atak-arap-sa	0.767	0.425	0.299	0.594
ipot-arap	0.592	0.494	0.095	0.621
atag-ilad	0.583	0.495	0.349	0.584
unak atak-arap-sa	0.875	0.332	0.321	0.595
umush-ek ipot-arap	0.783	0.414	0.306	0.593
unak-ek ipot-arap	0.642	0.482	0.255	0.599
inut-ek eket-arap	0.708	0.456	0.222	0.603
unak-em eked-ilad	0.592	0.494	0.245	0.600
umush-em ipod-ilad	0.675	0.470	0.253	0.599
unak ipot-arap-sa	0.692	0.464	0.253	0.599
umush ipot-arap-sa	0.633	0.484	0.137	0.615
ipod-orad-za	0.817	0.389	0.220	0.604
atag-orad-za	0.508	0.502	-0.003	0.635
eked-orad-za	0.650	0.479	0.315	0.590
umush-ek atag-orad	0.658	0.476	0.334	0.587
unak-em atag-orad	0.650	0.479	0.291	0.593
ipod-orad	0.400	0.492	-0.219	0.662



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Internal reliability (Cronbach's alpha)



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	n	Cronbach's α	Average inter item correlation	95% CI Lower	95% CI Higher
ALPACAA_4 (grammatical inferencing)	120	0.617	0.079	0.581	0.650
ALPACAA_4 (grammatical inferencing) revised	120	0.682	0.108	0.652	0.710

Discussion



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- ALPACAA_2 & 3 (vocab and sound/symbol) discriminate well.
 - Participants chose from 20 pictures.
- ALPACAA_1 & 4 (sound recognition and grammatical inferencing) do not discriminate well.
 - Participants given binary choice.
- Need more participants.
- More detailed analysis of items.
- Follow Bokander & Bylund (2019)



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RQ3: What is the relationship
between the new scoring method
and WM



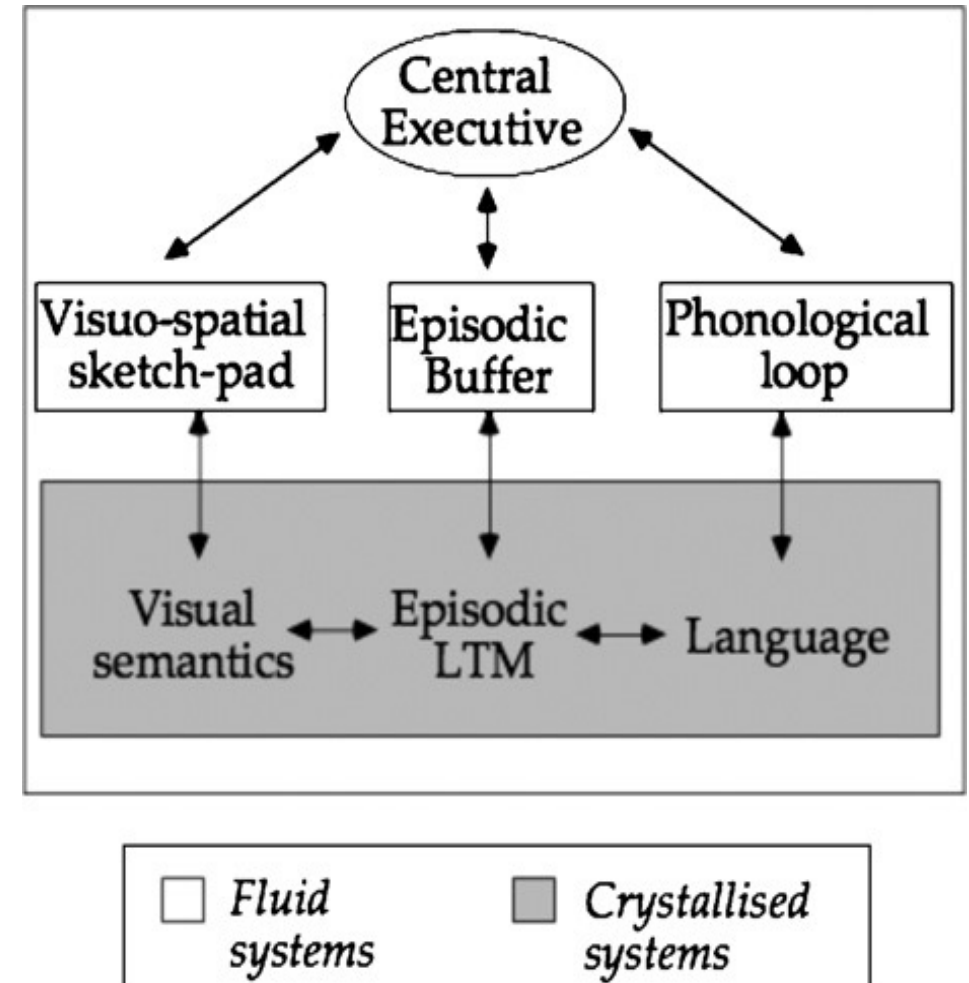
What is working memory?

“Working memory refers to the system or systems that are assumed to be necessary in order to keep things in mind while performing complex tasks such as reasoning, comprehension and learning.”

Baddeley (2010, p. 136)

STM: maintenance of information

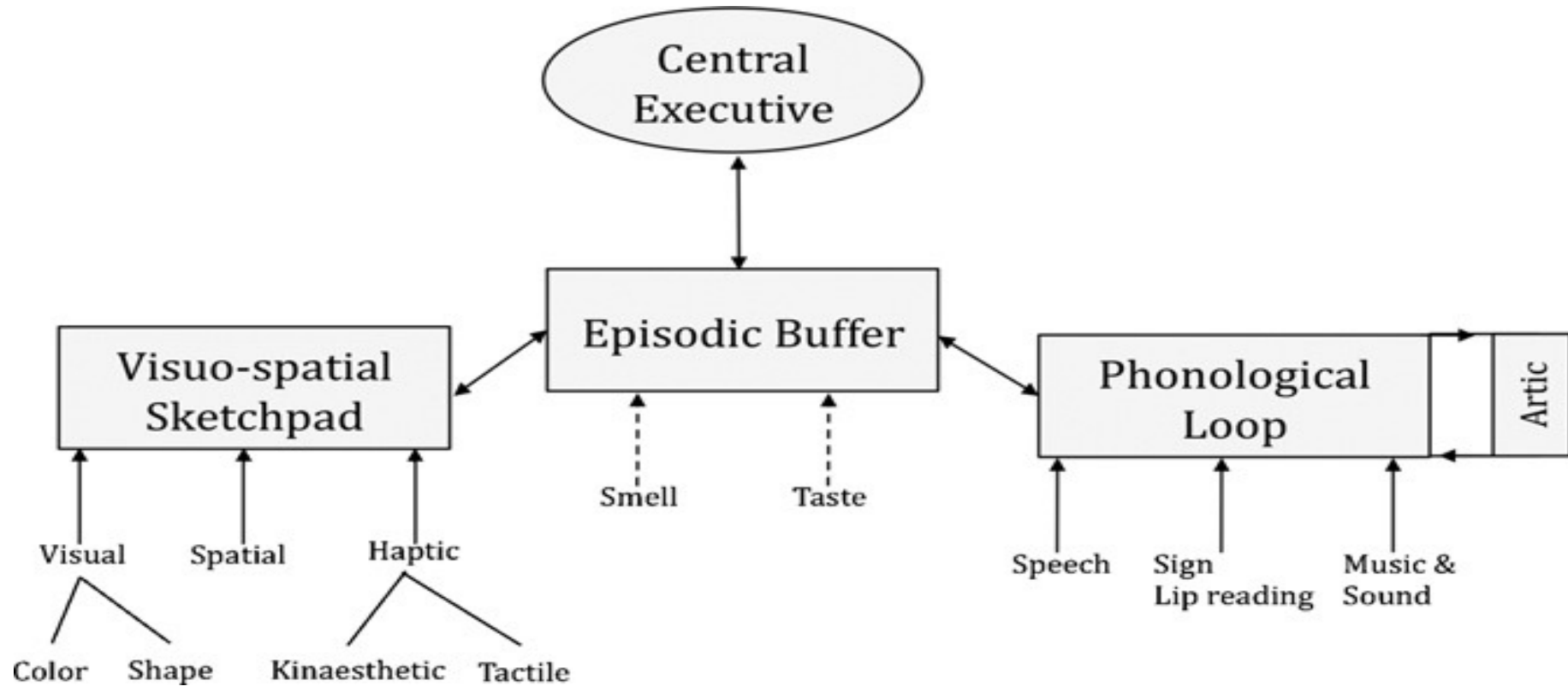
WM: maintenance and manipulation



Revised WM model (Baddeley et al 2011)



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Previous work with LLAMA (presented at EUROSILA 2017)



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- Data collected by BA dissertation students:
 - Tesni Galvin, Amelia Cobner, Martha Chisholm, Jake Clothier & Issy Greenfield
- 127 participants
 - predominantly students
- Typically L1 English speakers

Table I – Participant Data

No. Females	60
No. Males	67
Age Range	16-78
Average Age	33.5



Results: PCA

- No LLAMA test loads on the same factor as any of the working memory and attention tests.

Pattern Matrix ^a		
	Component	
	1	2
LLAMA E	.807	
LLAMA F	.799	
LLAMA B	.670	
LLAMA D	.546	
WM3 (A)		.906
WM3 (B)		.877
WM1 (Visual)		-.498
WM2 (Digits)		-.392
Extraction Method: Principal Component Analysis.		
Rotation Method: <u>Oblimin</u> with Kaiser Normalization.		
a. Rotation converged in 6 iterations.		

Results: PCA part 2

- Even if forced to four factors, LLAMA tests load differently to the WM/attention tests.
- LLAMA B, E & F measure something different to LLAMA D (similar to Grañena 2013).
- TMT parts A & B measure different aspect of WM to the digits backwards (PSTM) and visuo-spatial/ storage measures.

Pattern Matrix ^a				
	Component			
	1	2	3	4
LLAMA F	.831			
LLAMA E	.828			
LLAMA B	.672			
WM3 (A)		.914		
WM3 (B)		.867		
WM2 (Digits)			.897	
WM1 (Visual)			.586	
LLAMA D				.947
Extraction Method: Principal Component Analysis.				
Rotation Method: <u>Oblimin</u> with Kaiser Normalization.				
a. Rotation converged in 6 iterations.				



Working memory results (n=121)

	flanker conflict cost	stroop conflict cost	DB_span
Mean	45.440	127.297	5.537
Std. Deviation	20.379	114.391	1.317
Minimum	0.025	-43.880	3.000
Maximum	110.550	1123.434	9.000

Only significant correlation (Spearman's) between
Stroop and Digits Backwards ($r = -0.252, p = .005$)

Spearman Correlations

		flanker cost	stroop cost	DB_span	A1	A2	A3	A4
flanker	Spearman's rho	—						
conflict cost	p-value	—						
stroop	Spearman's rho	0.065	—					
conflict cost	p-value	0.478	—					
DB_span	Spearman's rho	0.049	-0.252**	—				
	p-value	0.590	0.005	—				
A1_total_corr ect	Spearman's rho	0.006	-0.046	0.073	—			
	p-value	0.948	0.616	0.428	—			
A2_total_corr ect	Spearman's rho	-0.012	-0.186*	0.432***	0.200*	—		
	p-value	0.901	0.045	1.161e -6	0.031	—		
A3_otal_corr ect	Spearman's rho	0.019	-0.178	0.252**	0.178	0.467***	—	
	p-value	0.834	0.052	0.005	0.052	1.253e -7	—	
A4_total_corr ect	Spearman's rho	-0.021	-0.193	0.200*	0.191*	0.523***	0.455***	—
	p-value	0.821	0.036	0.029	0.037	1.988e -9	2.254e -7	—

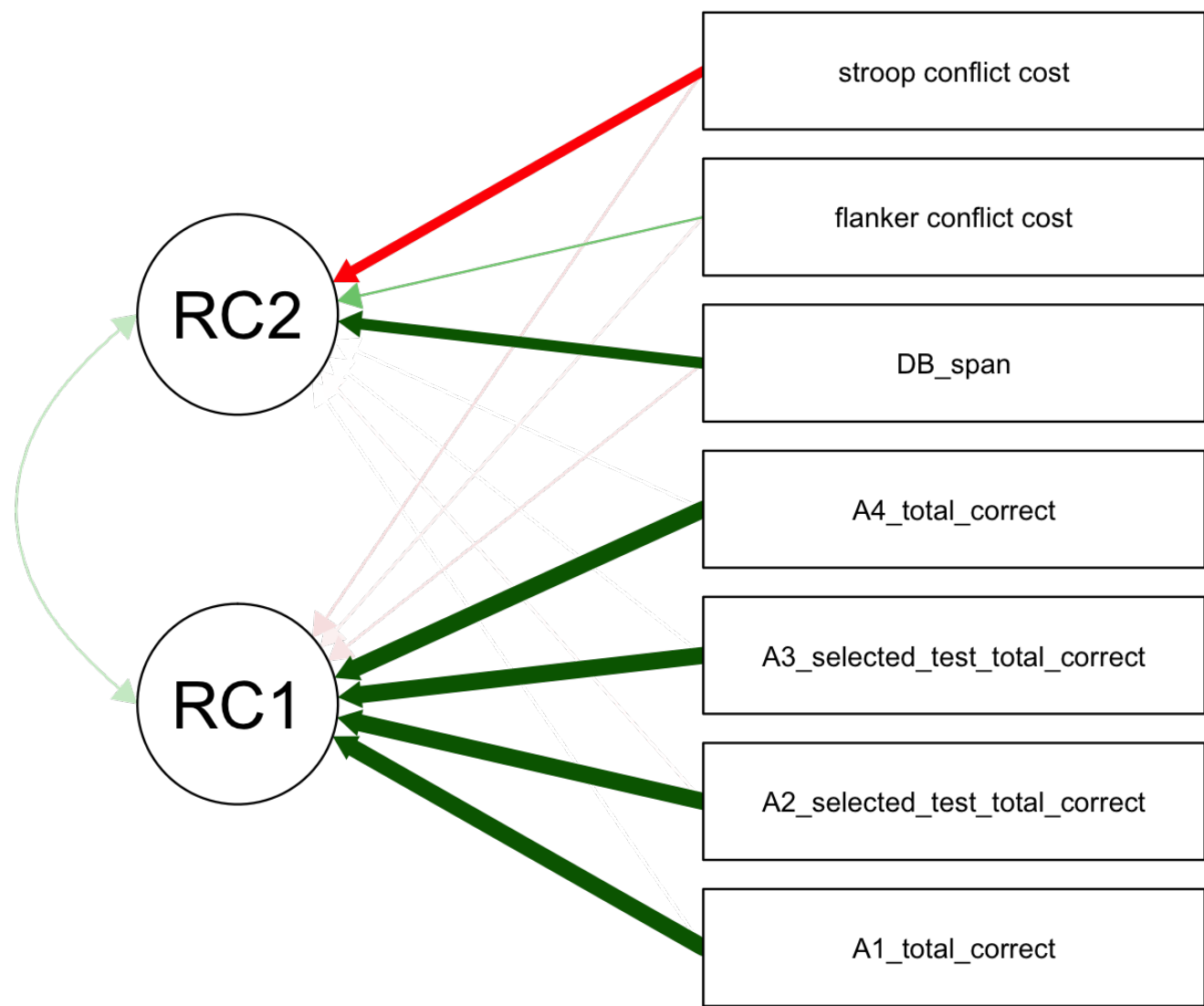
* p < .05, ** p < .01, *** p < .001

PCA analysis: WM and ALPACAA component total correct scores

Component Loadings

	RC 1	RC 2	Uniqueness
A1_total_correct	1.000	.	1.821e -4
A2_selected_test_total_correct	1.000	.	1.895e -4
A3_selected_test_total_correct	1.000	.	2.005e -4
A4_total_correct	1.000	.	1.792e -4
DB_span	.	0.765	0.417
flanker conflict cost	.	.	0.958
stroop conflict cost	.	-0.714	0.484

Note. Applied rotation method is promax.





Discussion

- WM tests and ALPACAA aptitude tests (total correct) are measuring different things.
- WM may be part of aptitude but doesn't replace it
 - (cf Wen, 2016)
- Comparable to previous findings on LLAMA and WM.
 - Different WM tests (Corsi block, TMT A&B & Digits backwards)
- Didn't find difference with sound recognition and other tests.
 - Scores to 100 and no penalties?



Overall conclusion

- ALPACAA are an (initial) attempt to refine the LLAMA tests.
- Further work needed on:
 - ALPACAA_4 (grammatical inferencing) and ALPACAA_1 (sound recognition) in terms of reliability.
 - ALPACAA_3 (sound/symbol) in terms of negative skew.
 - Are layout revisions enough?
- More detailed analysis of RT and items needed.
- New versions of LLAMA are also in development – see Paul Meara's website (www.lognostics.co.uk) for updates.

Thank you!

Diolch yn fawr!

Tack så mycket!

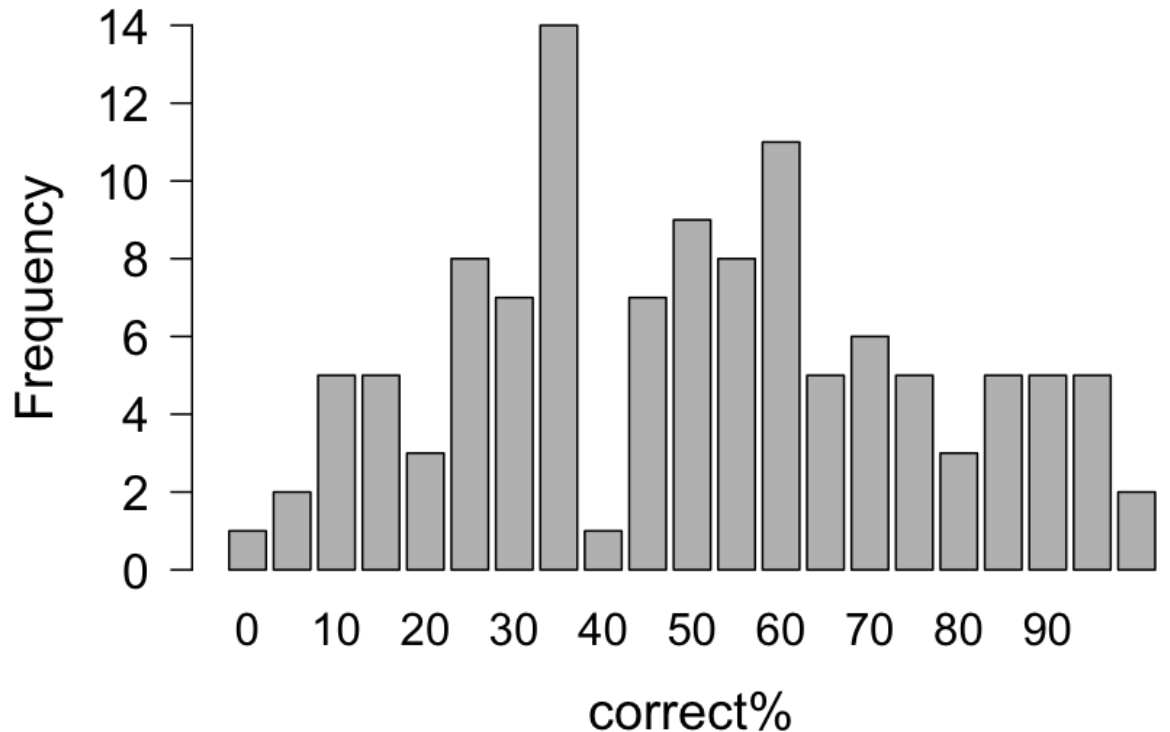
Vivienne Rogers: v.e.rogers@swansea.ac.uk

Paul Meara: p.m.meara@gmail.com



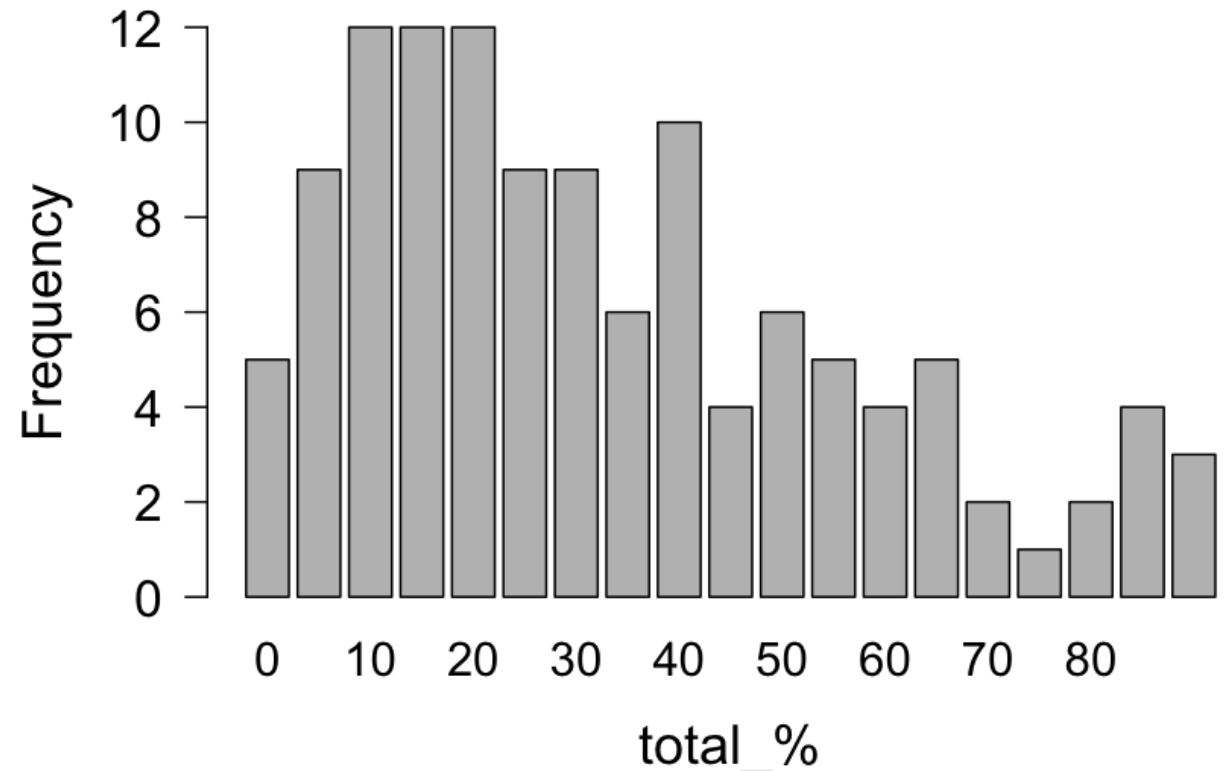
- **ALPACAA 2 (vocabulary)**
- Adjusted for not doing learning phase (20 items)
- Criteria – must click on each item at least once

- Removal of 6 participants
- $n=117$
- Average clicks in learning phase = 49.89, S.D = 15.643
- Range = 21-95
- Adjusted mean=50.5%
- Adjusted S.D = 25.337



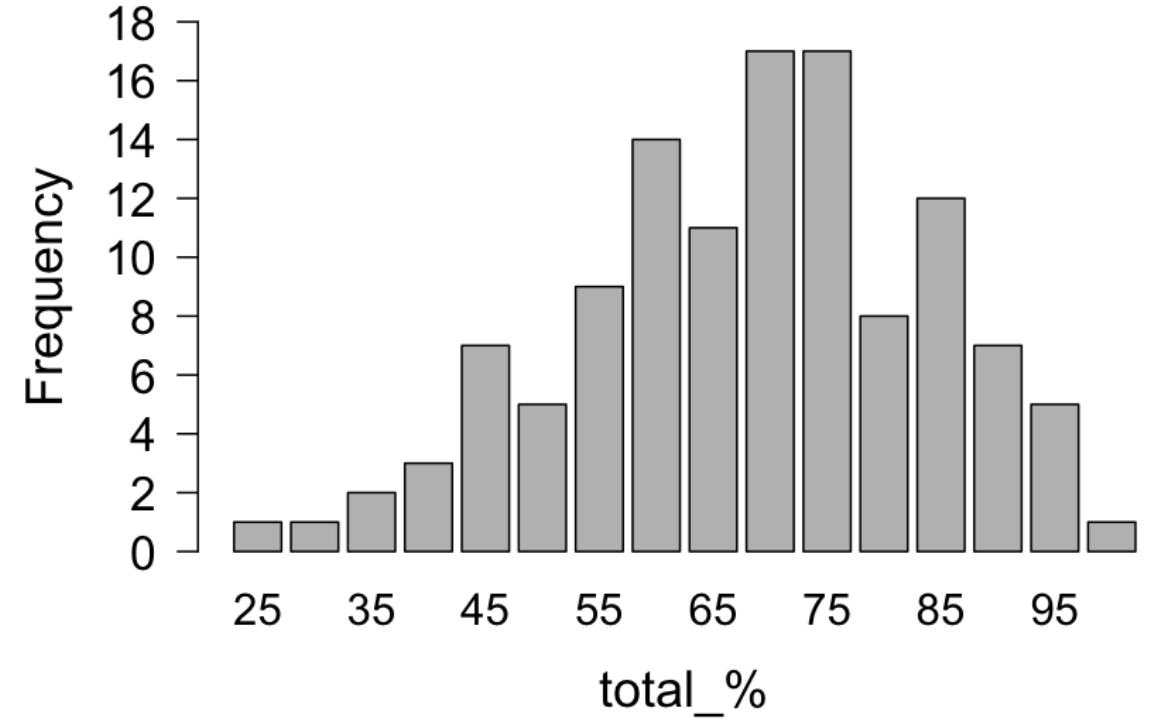
- **ALPACAA 3 (sound-symbol)**
- Adjusted for not doing learning phase (20 items)
- Criteria – must click on each item at least once

- Removal of 3 participants
- $n=120$
- Average clicks in learning phase = 62.66, S.D = 17.191
- Range = 21-109
- Adjusted mean=33.71%
- Adjusted S.D = 24.94



- **ALPACAA 4 (grammatical inferencing)**
- Adjusted for not doing learning phase (20 items)
- Criteria – must click on each item at least once

- Removal of 3 participants
- $n=120$
- Average clicks in learning phase = 102.5, S.D = 44.56
- Range = 21-259
- Adjusted mean=68.25%
- Adjusted S.D = 15.67





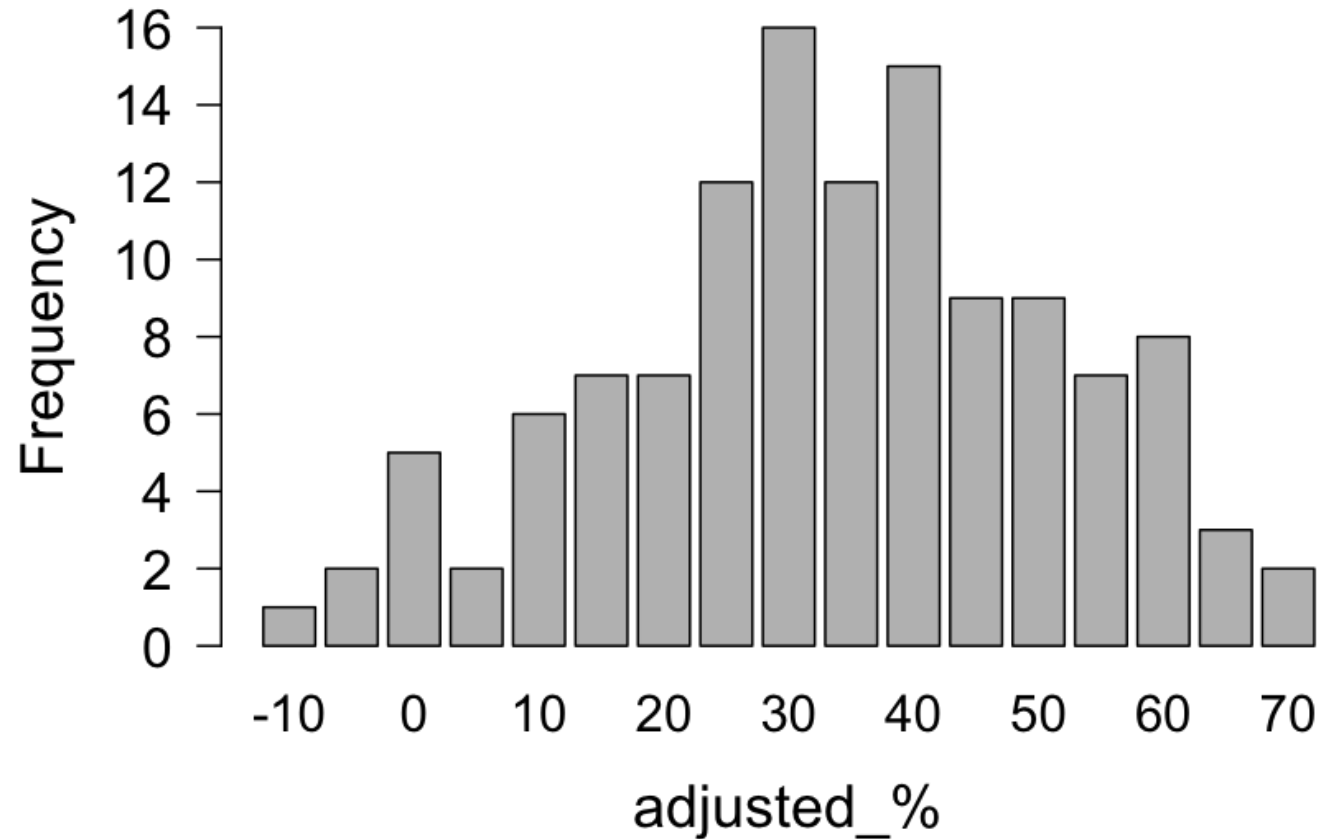
What about adjusting for guessing?

- Previous figures were total correct only.
- ALPACAA_2 (vocabulary): chose one from 20 options – guessing at 5%
- ALPACAA_3 (sound/symbol): chose one from 20 options – guessing at 5%
- BUT:
- ALPACAA_1 (sound recognition): chose one from 2 options – guessing at 50%
- ALPACAA_4 (grammatical inferencing): chose one from 2 options
 - first answer: 12/20 (or 60%)
 - second answer: 8/20 (or 40%)



What about adjusting for guessing?

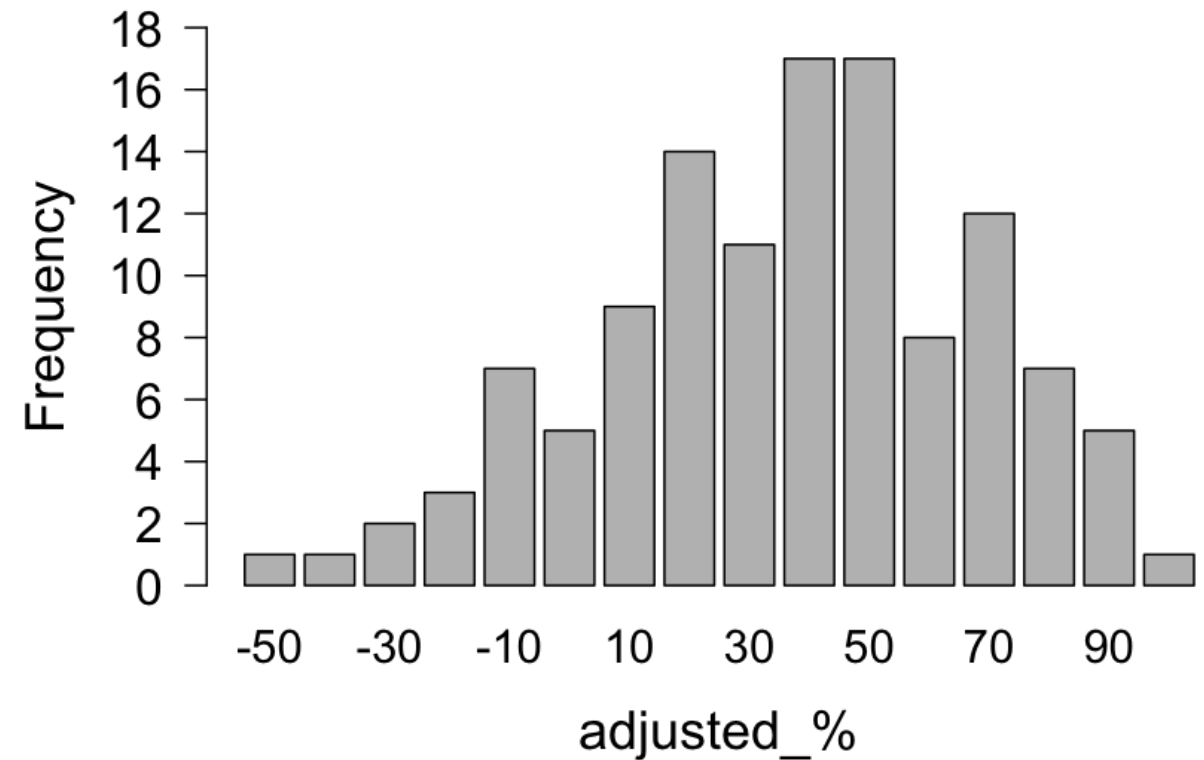
- ALPACAA_1 (sound recognition):
chose one from 2 options
- LLAMA: lose 1 mark (5%) for
every incorrect choice
- Adjusted for incorrect scores:
- $M=33.74$, $S.D=17.86$
 - Mean was 68.67
- Range: -10 - 70





What about adjusting for guessing?

- ALPACAA_4 (grammatical inferencing):
chose one from 2 options
- LLAMA: lose 1 mark (5%) for every
incorrect choice
- Adjusted for incorrect scores:
- $M=36.50$, $S.D=31.35$
 - Mean was 68.33
- Range: -50 - 100



Previous validation work: Grañena



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- Grañena (2013):
 - Internal consistency, Gender and Language neutrality
 - n=187 aged 18-39
 - L1s: Spanish, Chinese and English
 - internal consistency but two forms of aptitude
 - LLAMA D measures implicit and others explicit?
- Grañena (2018):
 - Compared 4 LLAMA tests with 4 Hi-LAB (n=135)
 - Found 3 underlying constructs across the tests.
 - Only the factor with LLAMA D and ALTM Synonym
 - (Hi-LAB) significantly predicted L2 fluency (pruned speech rate per min).

Rogers, V., Meara, P., Barnett-Legh, T., Curry, C., & Davie, E. (2017).
Examining the LLAMA aptitude tests.. *Journal of the European
Second Language Association*, 1(1), 49–60.
DOI: <http://doi.org/10.22599/jesla.24>



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- **How much of the LLAMA test score variance do the individual factors measures account for?**
- Factors included age, L1, L2 status, education level, gender, playing of logic puzzles.
- 404 participants in total.
- 346 took all 4 parts of the LLAMA tests and background questionnaires.
- Multiple regression analysis for 6 factors.
Overall variance for:
 - LLAMA B: $R^2 = 9.1\%$
 - LLAMA D: $R^2 = 4.8\%$
 - LLAMA E: $R^2 = 3.4\%$
 - LLAMA F: $R^2 = 6.6\%$
- Only L2 status consistently was significant $p < .05$ (not for E).
 - LLAMA B: $\beta = -.250$, contribution to variance = 6.0
 - LLAMA D: $\beta = .136$, contribution to variance = 1.8
 - LLAMA F: $\beta = -.165$, contribution to variance = 2.6

Further evidence: age and bilingualism



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- WM and aptitude are affected by age and bilingualism in different ways.
- Bilingual advantage in older group across 3 of the LLAMA aptitude tests.
- Age advantage on one of the WM tests (TMT A).

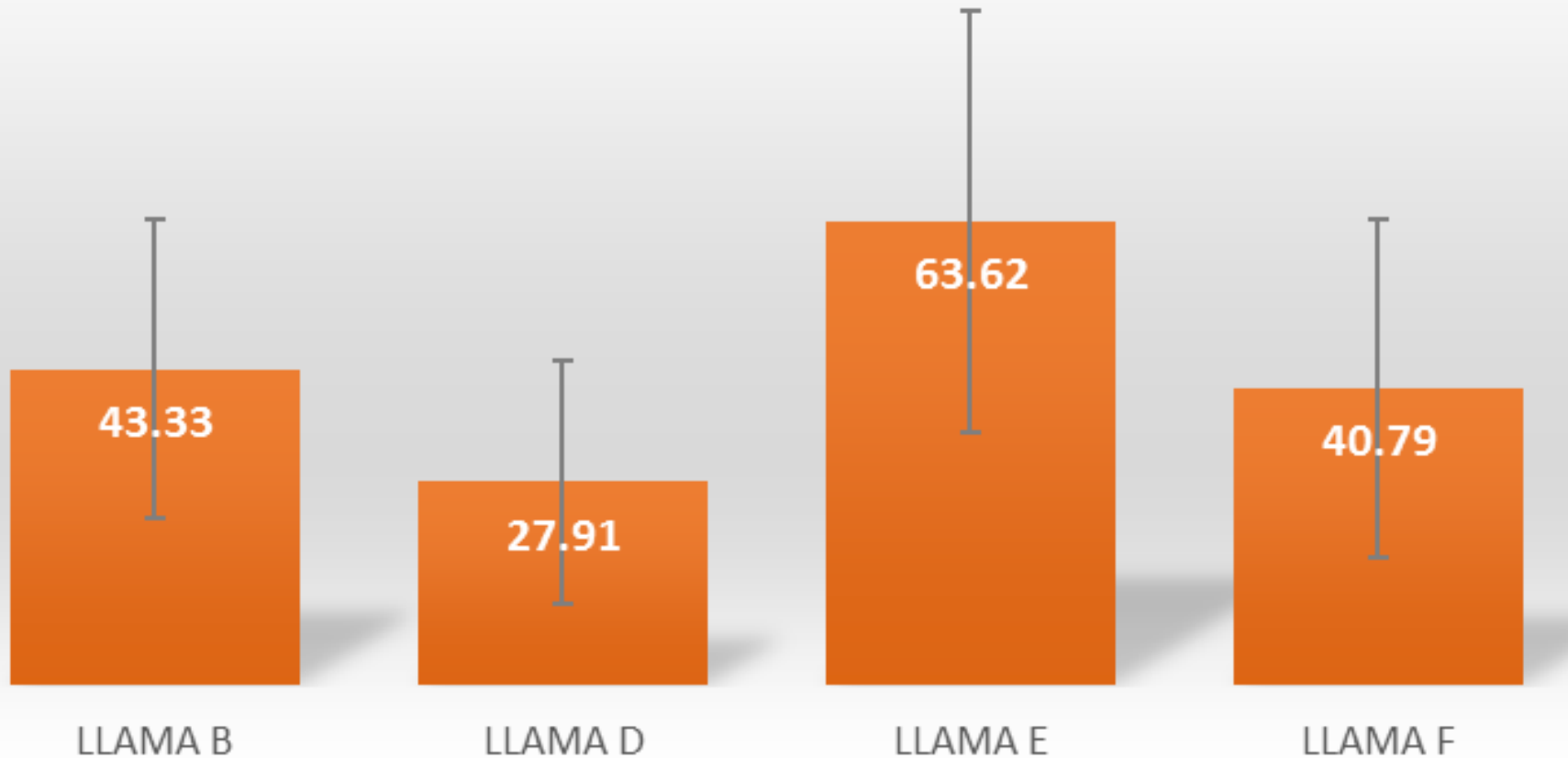
	Group 1	Group 2
Mean age (range)	21 (18-23)	61.5 (50-78)
Bilingual	14 (7 F, 7M)	14 (7 F, 7M)
Monolingual	14 (7 F, 7M)	14 (7 F, 7M)
n	28	28

Results: Aptitude



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LLAMA test scores

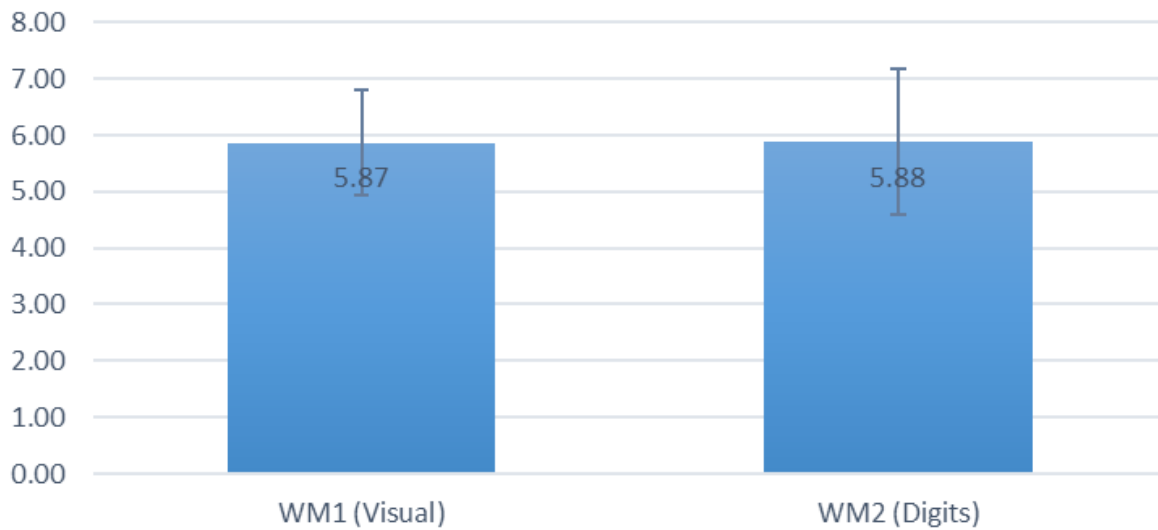


Results: WM

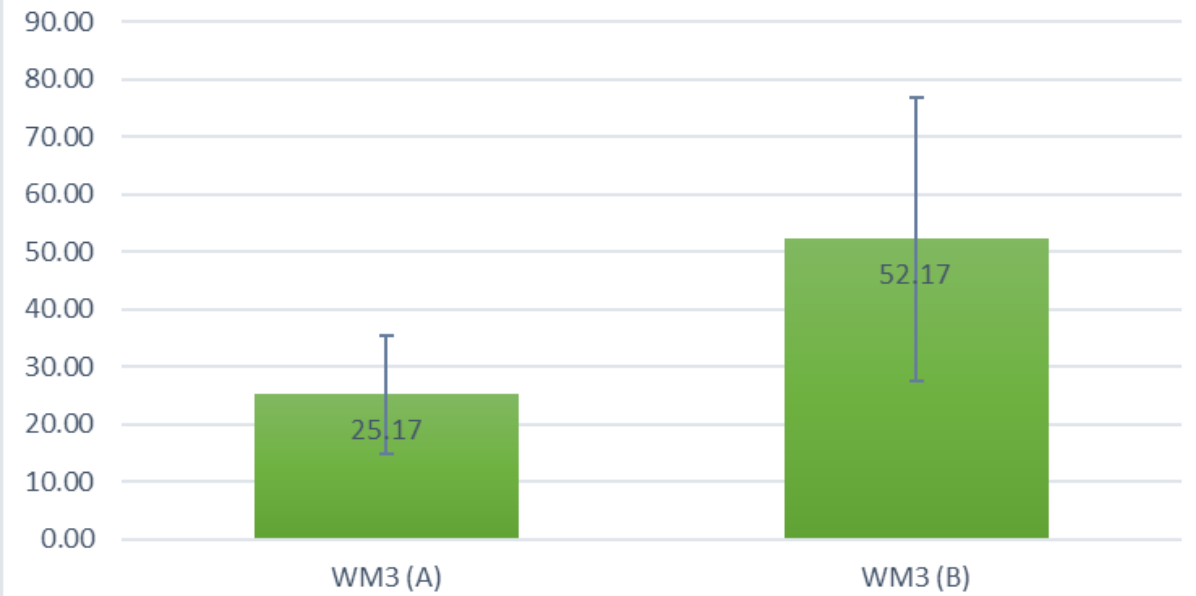


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**Working Memory tests
(visual and backwards digit span)**



TMT A & B (attentional control)



		LLAMA B	LLAMA D	LLAMA E	LLAMA F	WM1 (Visual)	WM2 (Digits)	WM3 (A)
LLAMA B	Pearson's r	—						
	p-value	—						
LLAMA D	Pearson's r	0.299 ***	—					
	p-value	< .001	—					
LLAMA E	Pearson's r	0.387 ***	0.240 **	—				
	p-value	< .001	0.006	—				
LLAMA F	Pearson's r	0.500 ***	0.263 **	0.524 ***	—			
	p-value	< .001	0.003	< .001	—			
WM1 (Visual)	Pearson's r	0.242 **	0.143	0.345 ***	0.340 ***	—		
	p-value	0.006	0.107	< .001	< .001	—		
WM2 (Digits)	Pearson's r	0.201 *	0.149	0.233 **	0.258 **	0.440 ***	—	
	p-value	0.023	0.092	0.008	0.003	< .001	—	
WM3 (A)	Pearson's r	-0.263 **	-0.153	-0.089	-0.152	-0.234 **	-0.169	—
	p-value	0.003	0.083	0.318	0.086	0.008	0.056	—
WM3 (B)	Pearson's r	-0.253 **	-0.107	-0.166	-0.281 **	-0.274 **	-0.195 *	0.639 ***
	p-value	0.004	0.226	0.060	0.001	0.002	0.027	< .001

* p < .05, ** p < .01, *** p < .001

Correlational results



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- Significant weak correlations found with LLAMA B, E & F with Visual and Digits WM scores.
 - LLAMA B, E & F = explicit measures
 - WM = visuo-spatial (reading) & phonological loop
 - Lack of correlation with LLAMA D
- Significant weak correlations between TMT B and LLAMA B & F.
- Significant weak correlations between TMT A and LLAMA B
 - TMT A & B = central executive / attentional control
 - LLAMA B = vocabulary, LLAMA F = grammatical inferencing

