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Are aptitude and working memory the same thing?

Vivienne Rogers, Tesni Galvin & Amelia Cobner

Outline

- Background on Working Memory and Aptitude
- Methodology
- Results
- Discussion and Conclusion

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Background: Working Memory

What is working memory?

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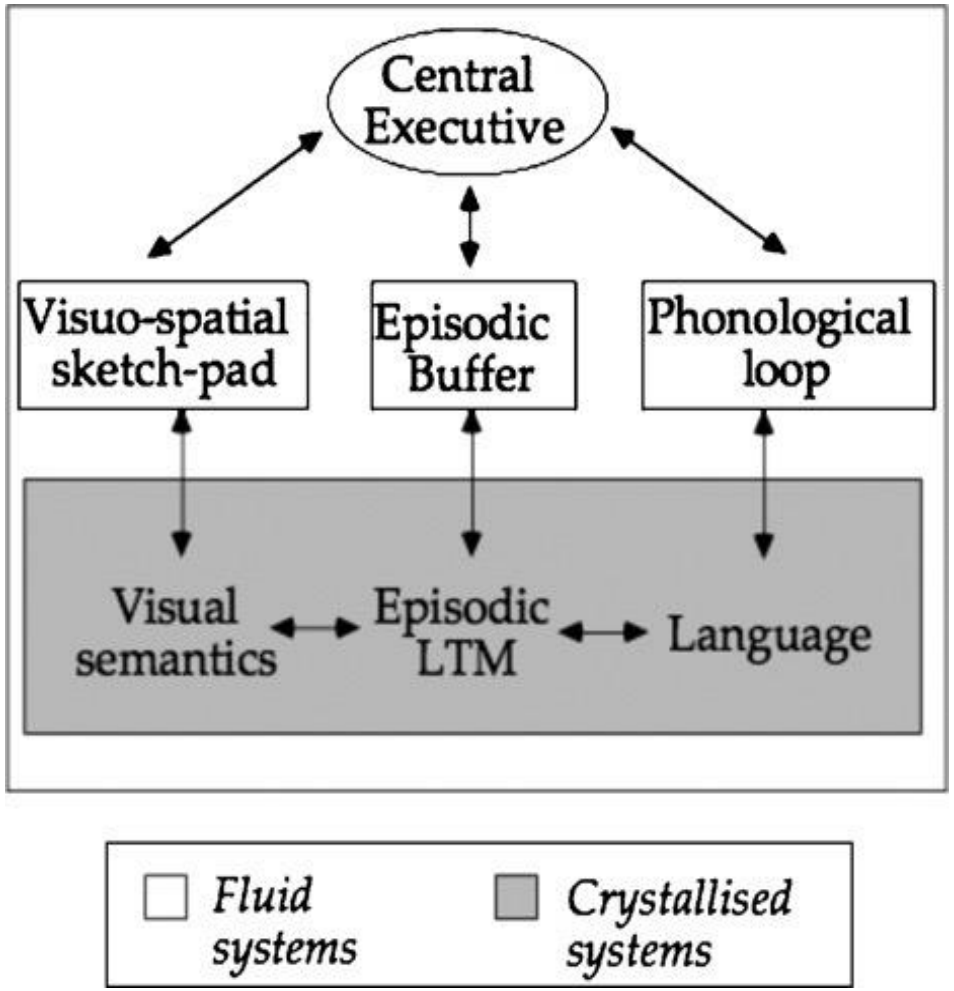
"Working memory refers to the system or systems that are assumed to be necessary in order to keep things in mind while performing complex tasks such as reasoning, comprehension and learning."
Baddeley (2010, p. 136)

STM: maintenance of information

WM: maintenance and manipulation



Revised WM model (Baddeley et al 2011)

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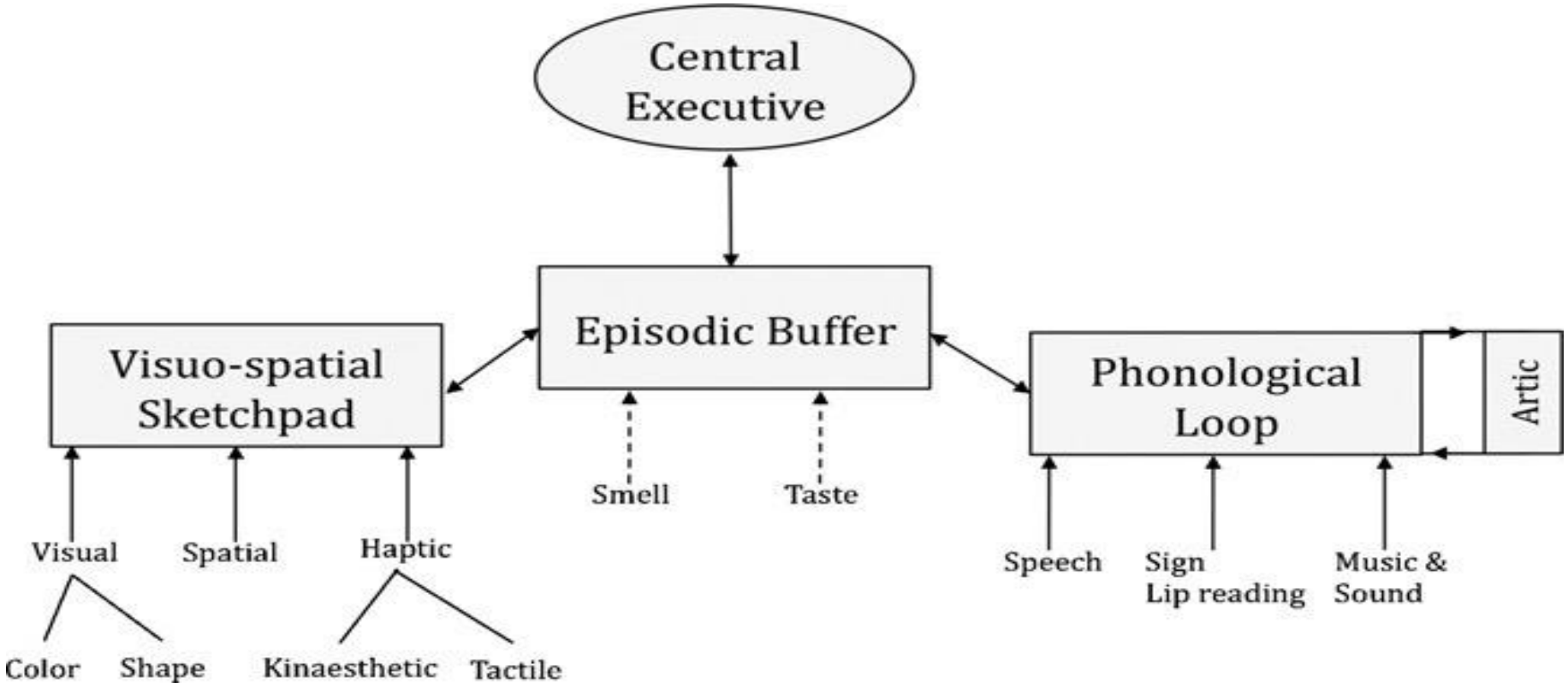

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Background: Aptitude

What is Language Learning Aptitude

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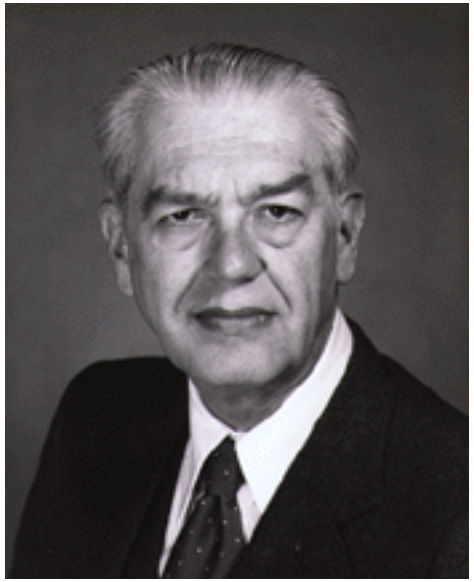
"the amount of time a student needs to learn a given task, unit of instruction, or curriculum to an acceptable criterion of mastery under optimal conditions of instruction and student motivation." (Carroll 1990 p. 26)



- 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?

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- 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 scare empirical evidence”

❖PWM = language learning device

❖EWM = language processes

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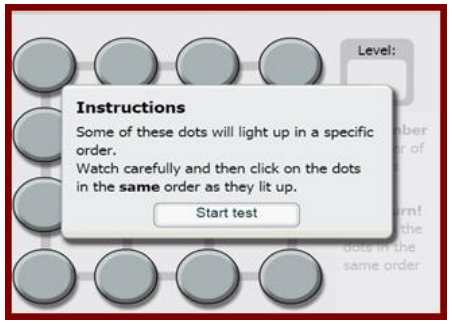
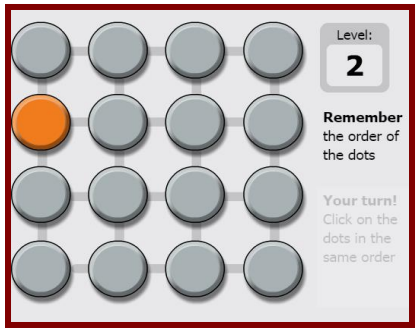
Research Question:

What is the Relationship between Working Memory and Language Learning Aptitude?

Tasks





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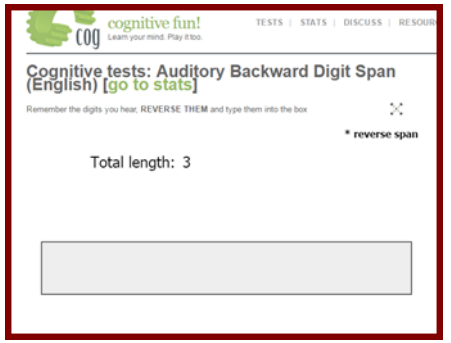
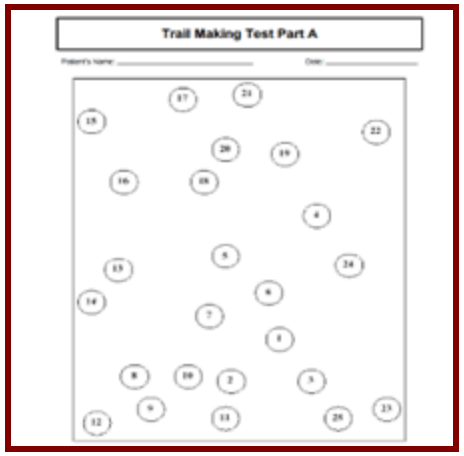
- All four LLAMA sub-tests.
- Working memory tests:
- Visuo-spatial task (reading)
- Auditory digits backwards task (PWM)
- TMT part A & B: attentional control (Central executive)
- Background questionnaire
  - age, gender, L1, L2 status, undergraduate course, education level





Swansea LLAMA tests (Meara, 2005)

www.lognostics.co.uk/tools/llama

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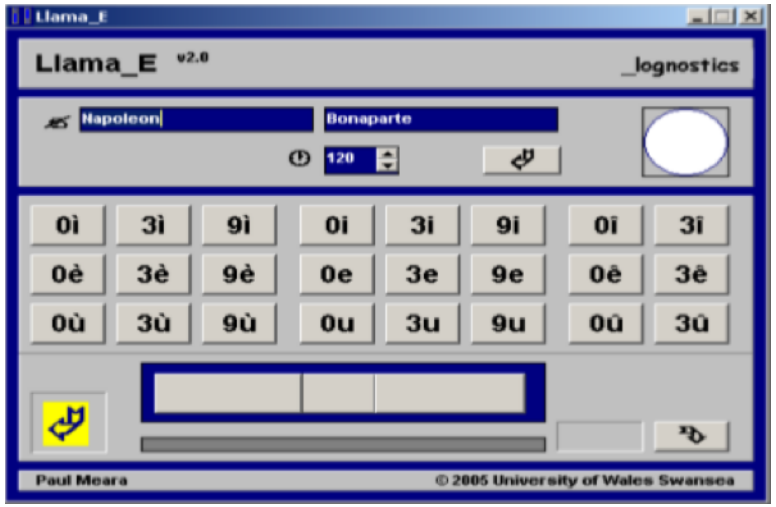
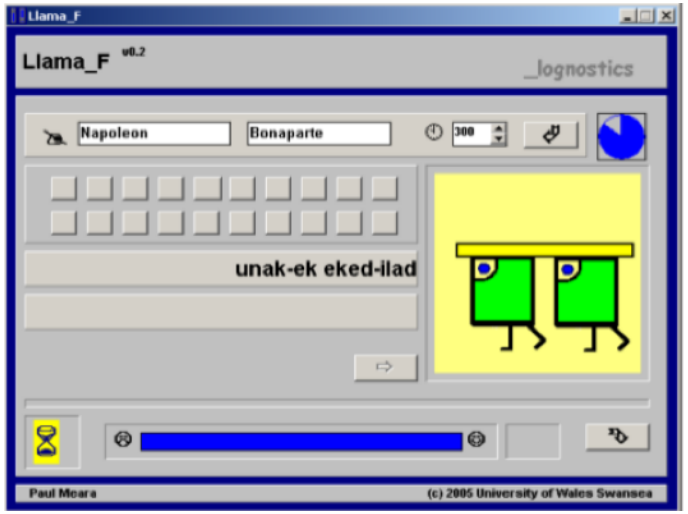
- Free, loosely based on MLAT
- LLAMA B = vocabulary measure
- LLAMA D = sound recognition (implicit learning)
- LLAMA E = sound-symbol correspondence
- LLAMA F = grammatical inferencing
- Has not been fully validated.





Tasks & Participants

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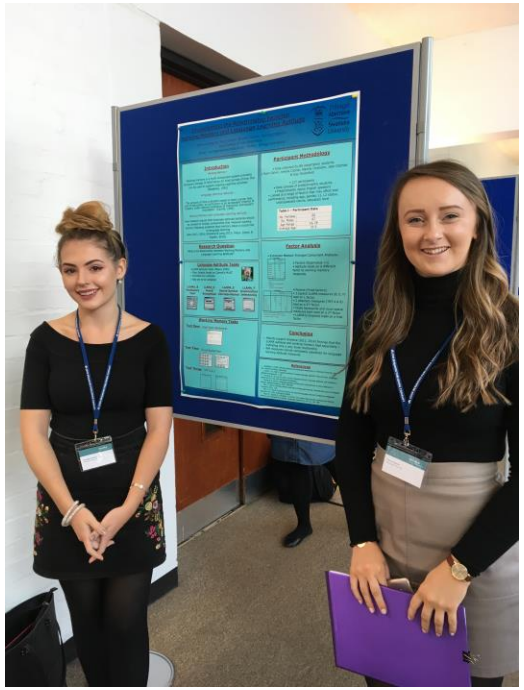
- Data collected by BA dissertation students:
  - Tesni Galvin, Amelia Cobner, Martha Chisholm, Jake Clothier & Issy Greenfield

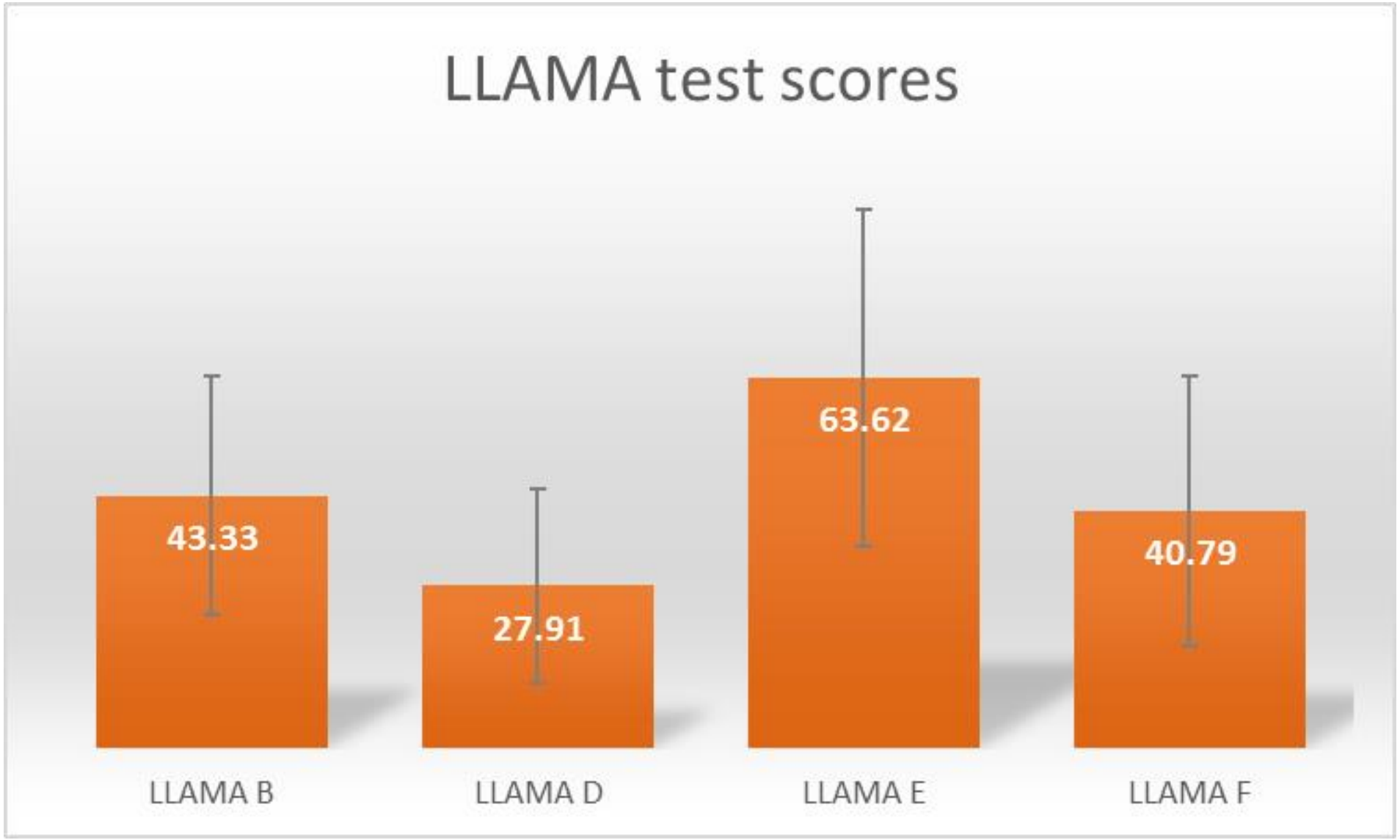
Table I – Participant Data

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

- 127 participants
  - predominantly students
- Typically L1 English speakers



Results: Aptitude



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Results: WM

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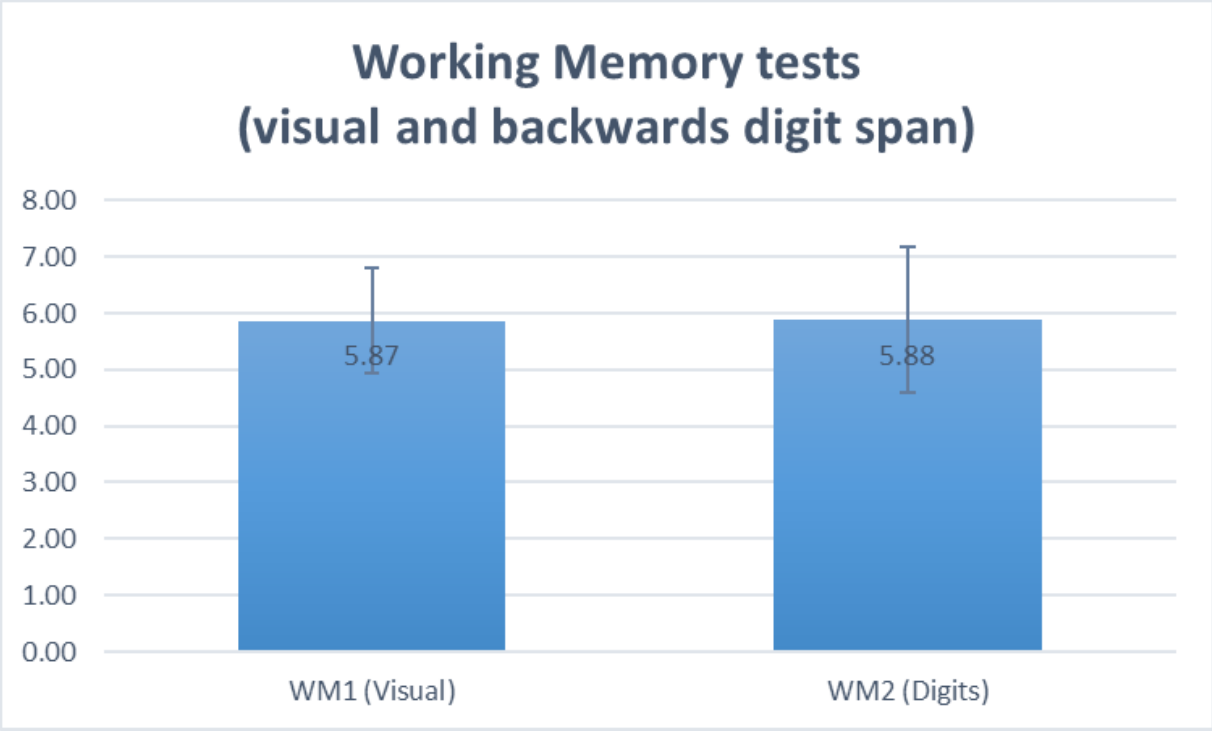

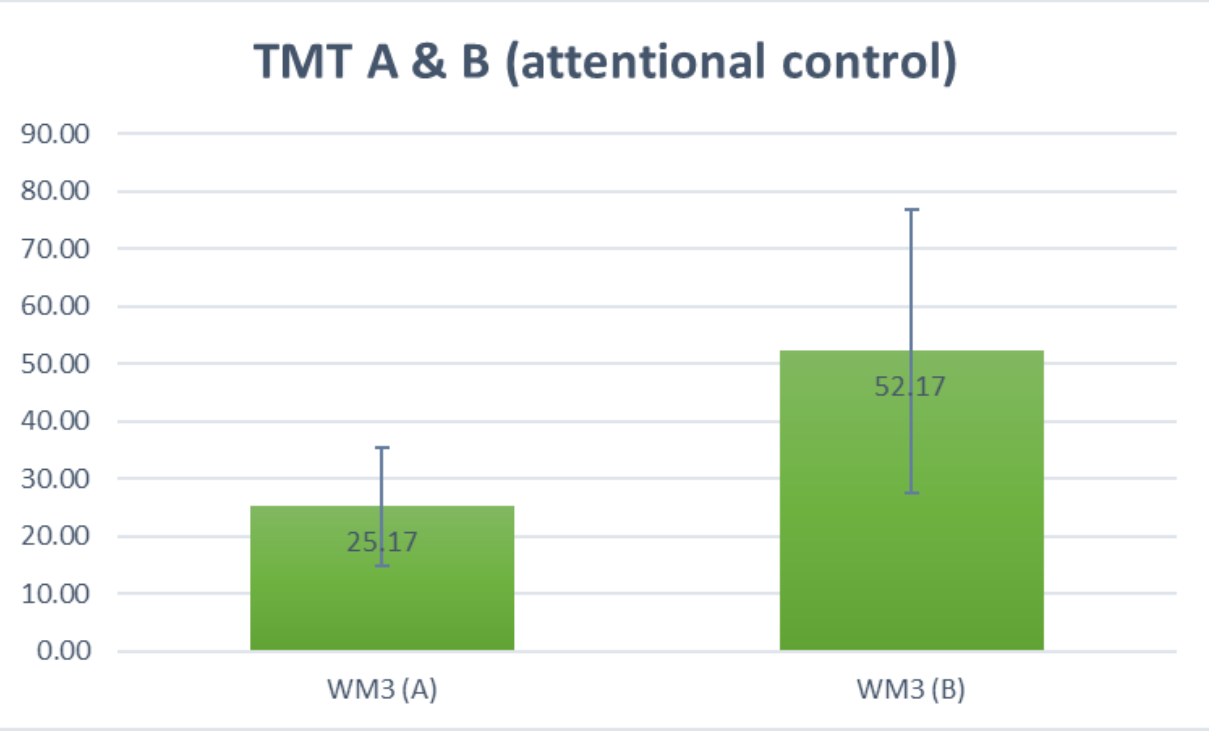

Pearson Correlations

		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 (sound recognition)

- 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

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: Oblimin 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 (PWM) 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: Oblimin with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Discussion

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- Support previous validation work by Grañena (2013) & Rogers et al (2017): LLAMA tests measure two different constructs (of aptitude?)
- WM and aptitude test scores correlate but do not load on the same factors.
- WM may be related to language learning aptitude.
  - Limited evidence for PWM replacing phonological aptitude tasks.
- This suggests that aptitude tests are not interchangeable with WM tests.
- WM may be a component of aptitude.
- Don’t know enough yet to claim WM ‘replaces’ aptitude.

Next steps

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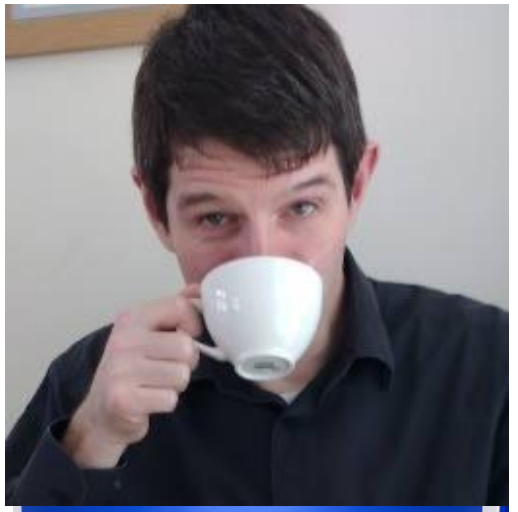
- Developed OpenSesame versions for reaction time and item analysis (technical help: Brian Rogers).
  - Revised layout of LLAMA E (Paul Meara)
  - Fixed some glitches in previous versions.
- Allows modelling of different scoring systems.
- Called ALPACAA test
- 123 participants
- Stroop & Flanker tasks, Digits backwards
  - Using PEBL (Mueller & Piper, 2014)
- Collected by 2018-19 BA dissertation students



Thank you! Diolch yn fawr! Merci!

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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: R2 = 9.1%
  - LLAMA D: R2 = 4.8%
  - LLAMA E: R2 = 3.4%
  - LLAMA F: R2 = 6.6%
- Only L2 status consistently was significant $p<.05$ (not for E).
  - LLAMA B: β = -.250, contribution to variance = 6.0
  - LLAMA D: β = .136, contribution to variance = 1.8
  - LLAMA F: β = -.165, contribution to variance = 2.6

Further evidence: age and bilingualism – see our poster!

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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