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# Multilingual Evaluation of Executive Functions and Reading Predictors with a novel digital tool: Insights from a Sample of 7-8-Year-Olds

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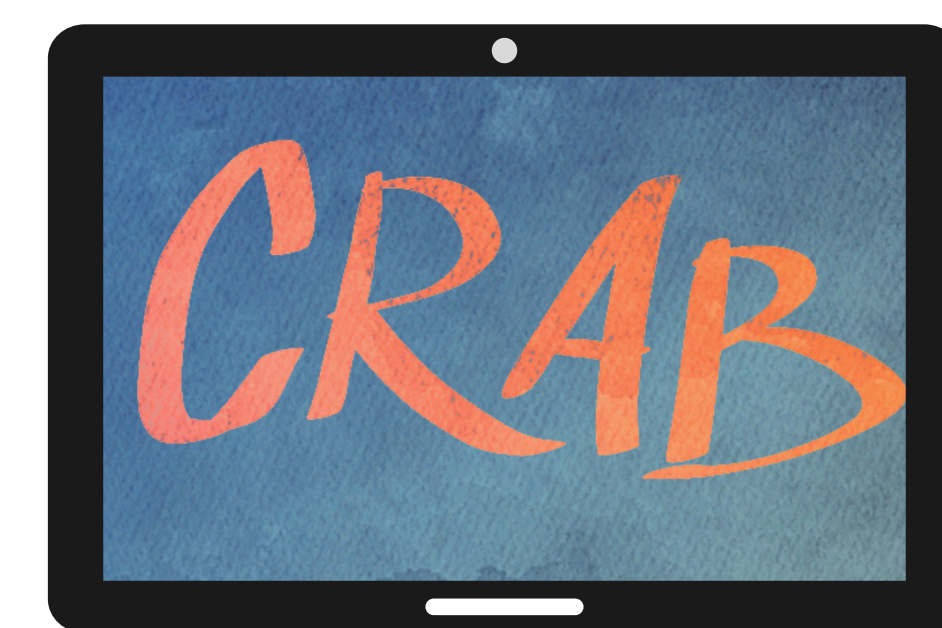
<sup>1</sup>University of Geneva <sup>2</sup>University of Zurich <sup>3</sup>University of Paris Cité <sup>4</sup>Aix-Marseille University <sup>5</sup>NCCR Evolving Language \*equal contributing

## INTRODUCTION

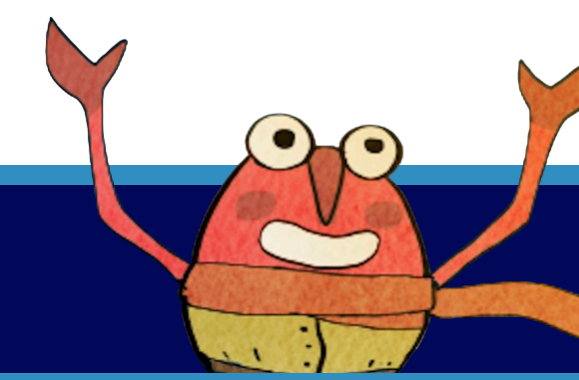
### THEORETICAL BACKGROUND

- Accurately modeling **individual differences in reading ability** requires data from large, diverse, and representative samples (Yeatman et al., 2022).
- However, standard clinical reading assessments, which involve paper-and-pencil tasks, are **time-consuming** and prone to **errors**.
- Reading relies on language abilities such as **phonological awareness** (Pennington, 2006), as well as **executive functions** like working memory capacity and attentional control.
- Additionally, the relative weight of these mechanisms is thought to vary **across languages**, calling for cross-linguistic assessment tools (Landerl et al., 2019; Lallier & Carreiras, 2018).

→ To improve reading assessments, **innovative digital tools** are needed that encompass diverse samples and cross-linguistic perspectives.



**Computerized Reading-related Assessment Battery**



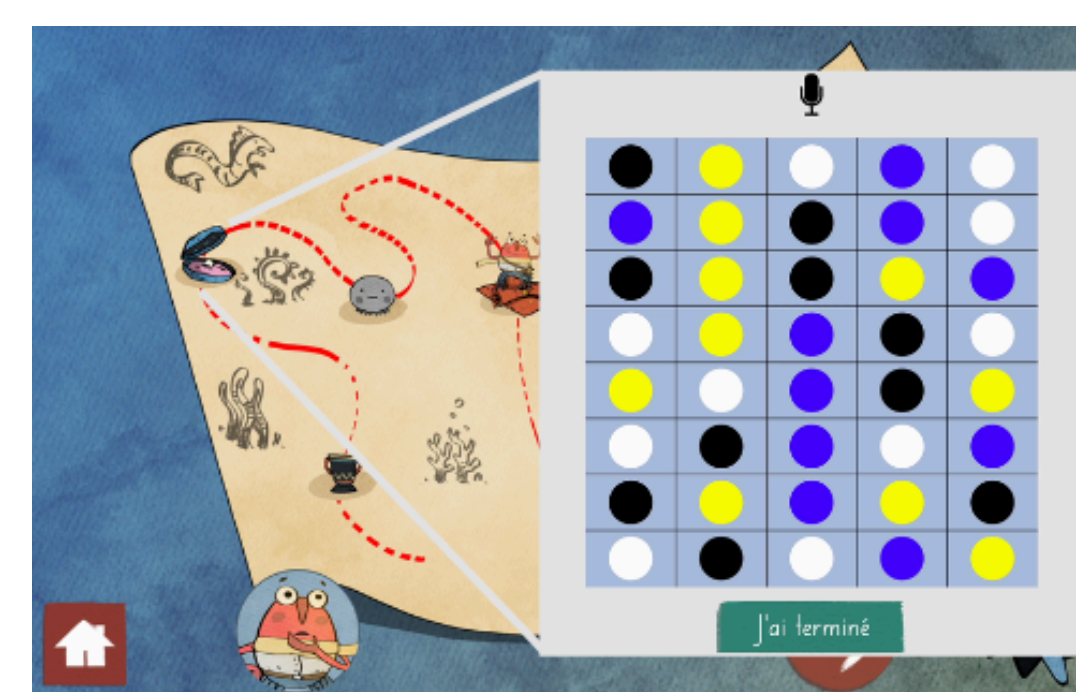
## METHOD

### PARTICIPANTS

- French** N = 154 Age = 7.5
- Italian** N = 157 Age = 7.5

### COMPUTERIZED ASSESSMENT BATTERY

- In class **collective** assessment
- Tablet-based** with **headphones**
- 2 languages:** French and Italian
- 3 versions:** Pre, Post, Follow-up
- About 2 experimenters for 15 children
- 11 gamified tasks**
- Automated, aided and unaided practice using automated speech recognition (ASR) in 5 tasks
- Adaptive algorithm using ASR in the digit span task



Left: one of the three maps where each icon corresponds to a task as well as the path to reach the final treasure.  
Right: the color RAN task which requires speech recognition.

Want to see a practice trial demo?



### ASSESSMENT TASKS (selected)

Cognitive	Skills	Main Outcome	Descriptive		
			median	mean	SD
<ul style="list-style-type: none"> <li>Digit span Backward                             <ul style="list-style-type: none"> <li>Forward</li> <li>Backward</li> </ul> </li> <li>Corsi span                             <ul style="list-style-type: none"> <li>Forward</li> <li>Backward</li> </ul> </li> <li>Barrage                             <ul style="list-style-type: none"> <li>30s</li> <li>120s</li> </ul> </li> <li>Multiple Object Tracking (MOT)</li> </ul>	Working memory	Digit Span: FORWARD	ASR fail	ASR fail	ASR fail
		Digit Span: BACKWARD	3	2.64	0.88
		Corsi Span: FORWARD	4	4.11	1.09
		Corsi Span: BACKWARD	4	3.74	1.23
	Attentional Control	Number targets found: at 30s	11.00	11.17	2.63
		Number targets found: at 120s	19.33	18.92	1.09
		Accuracy	0.61	0.62	0.14

### RESULTS

	MOT	Barrage 120s	Barrage 30s	Corsi BACK	Corsi FRWD
Digit BACK	0.06 ns	0.03 ns	0.00 ns	0.17 *	0.21 **
Corsi FRWD	0.15 *	0.12 ns	0.06 ns	0.31 ***	
Corsi BACK	0.16 *	0.23 ***	0.18 **		
Barrage 30s	0.07 ns	0.63 ***			
Barrage 120s	0.04 ns				

Highest correlations as expected:

- 2 Barrage measurements
- 3 Span measurements
- Corsi BACK with Attention demanding tasks (MOT and Barrage)

Language-Related	Skills	Main Outcome	Descriptive		
			median	mean	SD
<ul style="list-style-type: none"> <li>Vocabulary</li> <li>Color RAN</li> <li>Phoneme Deletion                             <ul style="list-style-type: none"> <li>WORD</li> <li>PSEUDOWORD</li> </ul> </li> <li>Visual Orthographic                             <ul style="list-style-type: none"> <li>LETTER</li> <li>SYMBOL</li> </ul> </li> </ul>	Receptive vocabulary	Rate Correct Score	31.57	31.72	7.00
	Lexical access	Total Completion Time	51.02	51.42	11.66
Phonological awareness	Phonological awareness	Accuracy: WORD	1.38	1.25	0.56
		Accuracy: PSEUDOWORD	1.22	1.12	0.54
	Orthographic processing	D' : LETTER*	1.98	2.00	0.99
		D' : SYMBOL*	1.43	1.50	1.03

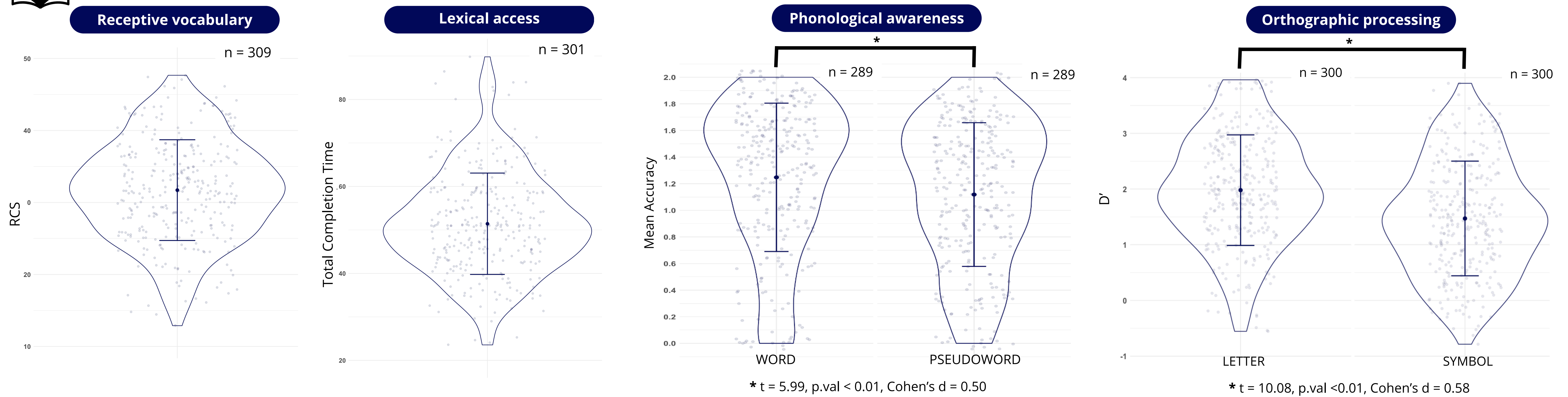
\* Different Correct = Hit, Different Incorrect = Miss

	Ortho SYMBOL	Ortho LETTER	PhonDel PSEUDO	PhonDel WORD	RAN
Vocabulary	0.11 ns	0.11 ns	0.15 *	0.12 ns	0.21 **
RAN	0.10 ns	0.14 *	0.20 **	0.15 *	
PhonDel WORD	0.23 ***	0.30 ***	0.74 ***		
PhonDel PSEUDO	0.19 **	0.19 **			
Ortho LETTER	0.62 ***				

Highest correlations as expected:

- 2 Phoneme deletion measurements
- 2 Visual-ortho measurements
- Visual-ortho with Phoneme deletion
- RAN with PhonDel WORD > PSEUDO
- RAN with Vocabulary

### DISTRIBUTIONS



## CONCLUSION

- Efficiency and Automation:** CRAB overcomes the constraints of resource-intensive, in-person reading assessments by providing an **efficient and automated tool**.
- Cross-Language Research:** It enables **effective research** into the linguistic and cognitive mechanisms underlying reading ability **across different languages**.
- Reliability of Data Collection:** The automated data collection is generally reliable.
  - The Digit Span task, which relies on Automatic Speech Recognition (ASR) during test trials, is an exception.
- Future Improvements:** More work is needed to improve the ASR model or redesign the Digit Span task to enhance overall reliability.



## REFERENCES

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