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Orthographic learning of new words: from looking to memorizing

Emilie Ginestet, Sylviane Valdois, Julien Diard and Marie-Line Bosse

INTRODUCTION

Only a few studies have examined eye movements during the repeated reading of new words (Joseph et al., 2014; Joseph et al., 2018) and their implicit memorization. Recently, Nation et al. (2017) suggested that monitoring eye movements during novel word reading might be particularly useful for the real-time study of orthographic learning.

We used eye-tracking to examine the exposure-by-exposure evolution of eye movement patterns while French adults were reading novel words. A spelling task and an orthographic lexical decision task were administered offline to measure orthographic learning. The participants' visual-attention span (VAS) was further assessed.

OBJECTIVES

- Investigate the effect of multiple exposures on eye movements and memorization
- Refine the time line of orthographic learning processing
- Explore whether VAS is a potential predictor of orthographic learning skills

EXPECTED FINDINGS

1. Better memorization performance with increased exposure to novel words
2. Fewer fixations and shorter processing times across exposures during reading
3. Early orthographic learning effects on eye movement patterns
4. Better orthographic learning for participants with higher vs. lower VAS

MATERIAL AND METHOD

Participants

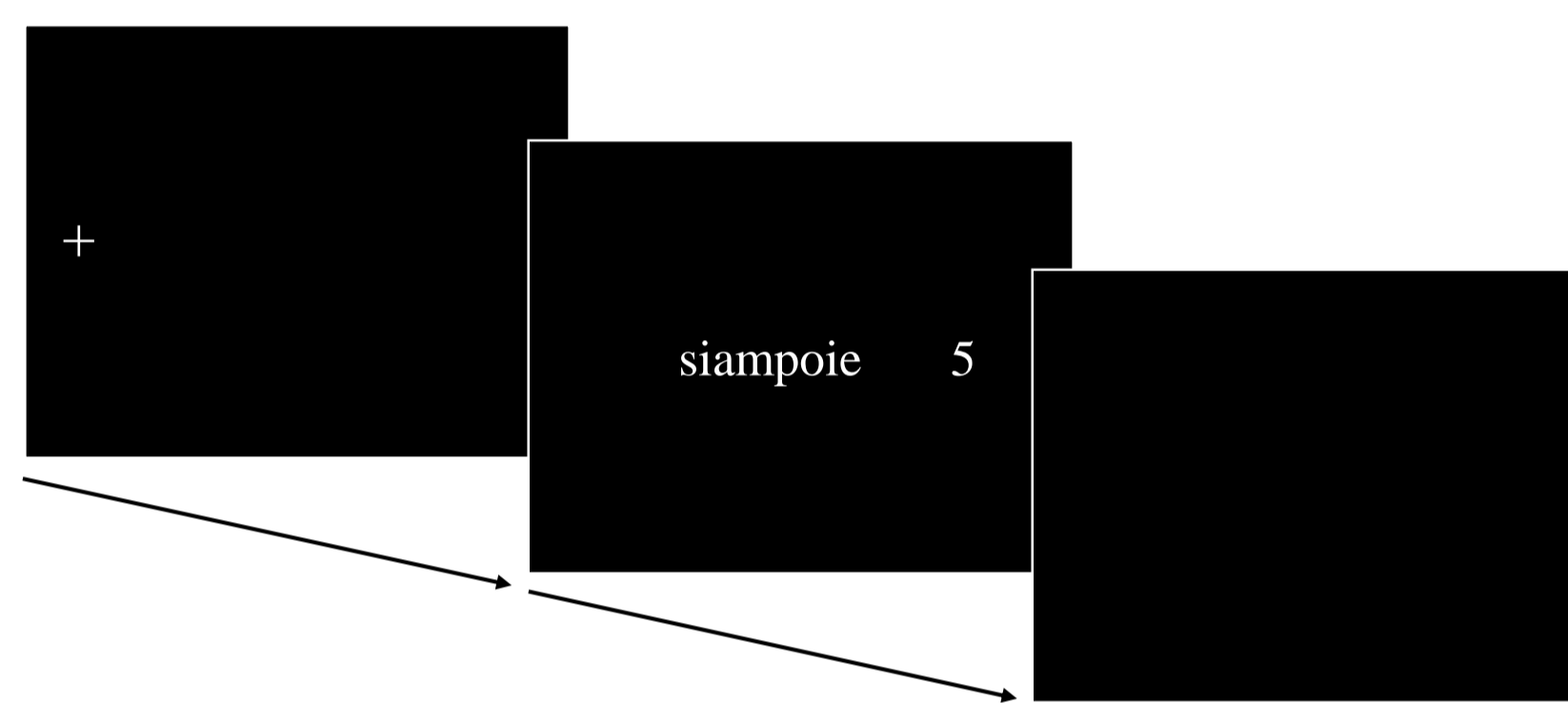
42 French young adults with normal vision and normal reading skills.

Material

- ☐ 30 legal bi-syllabic 8-letter pseudo-words (PW) containing at least two ambiguous graphemes (mean $f_{\text{trigram}} = 1,655$; $SD_{\text{trigram}} = 1,176$; range: 327–2114; $N = 0$)
- ☐ 30 bi- or tri-syllabic 8-letter words that served as controls

➔ Three lists of 10 PWs and 10 control Ws that were randomly mixed

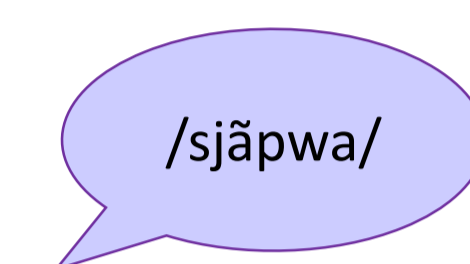
Experimental Reading Task: Exposure Phase



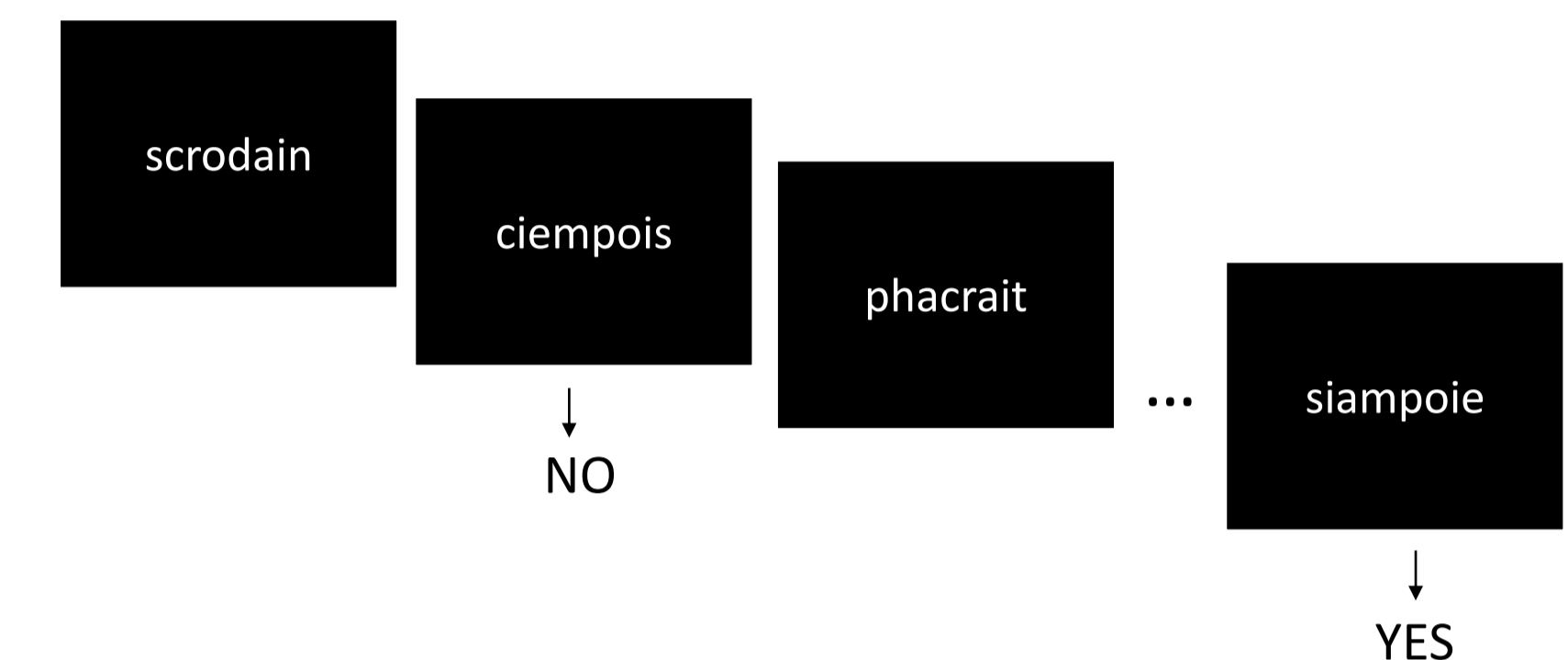
Each item (PW or W) is randomly presented 1, 3 or 5 times (180 trials). Eye movements are monitored.

Orthographic Learning Assessment

Unexpected pseudo-word spelling



Orthographic Decision



Visual-Attention Span Measure

A 6 consonant string is briefly presented for 200 ms.

RFDHST

Participants report either all the letters they have identified in global report or a single postcued letter in partial report. Performance on this task reflects visual attention capacity deployed for multi-element simultaneous processing.

$$\text{Total Score (\%)} = \frac{(\text{Global score} + 2 \times \text{Partial score}) \times 100}{2 \times 144}$$

RESULTS

How well did participants learn?

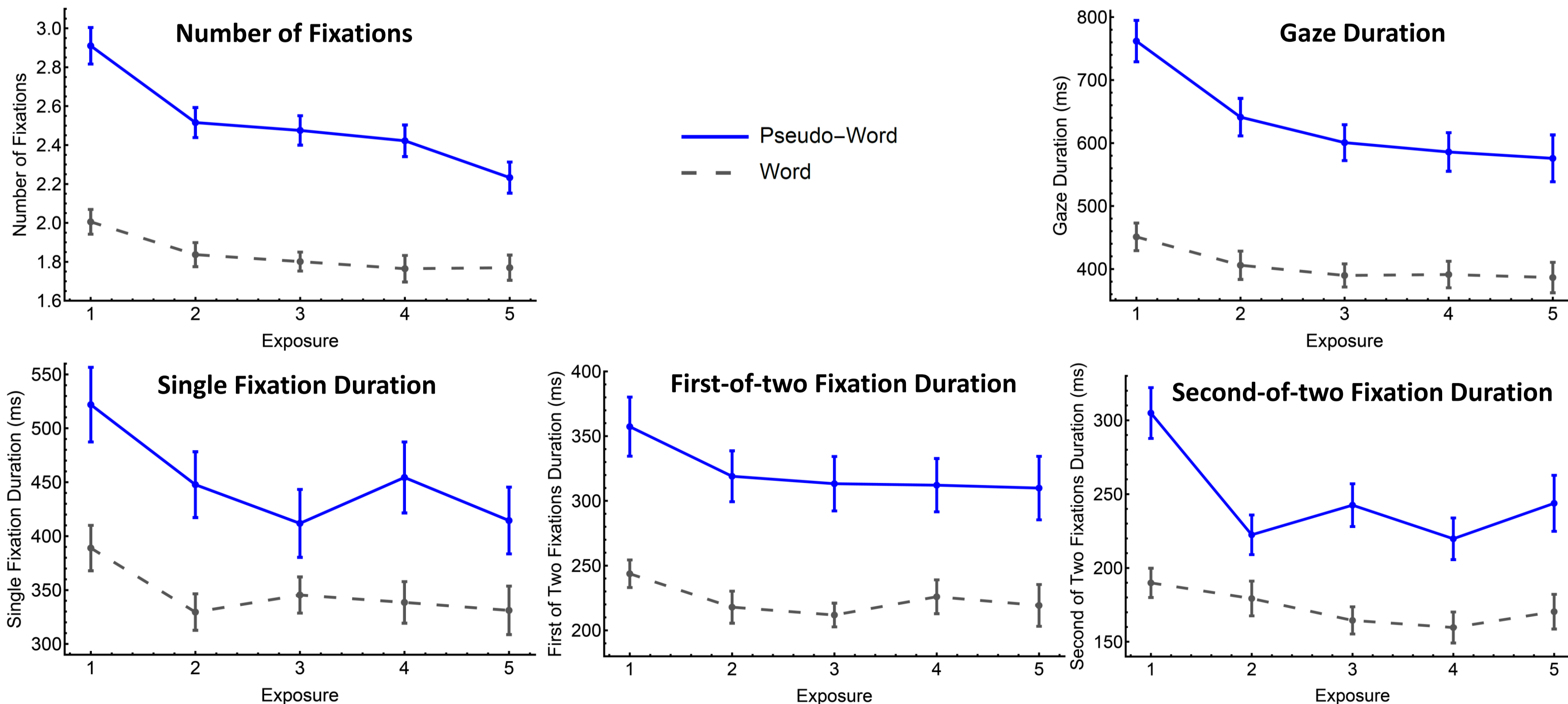
Exposures	PW spelling-to-dictation		Orthographic Decision			
	% correct	RTs	Targets PWs		Homophones	
			% correct YES responses	RTs	% correct NO responses	RTs
1	11.4 (9.0)	1231 (470)	54.4 (15.6)	1284 (492)	58.0 (17.1)	58.0 (17.1)
3	16.4 (15.0)	1114 (419)	72.5 (16.3)	1284 (500)	48.4 (17.5)	48.4 (17.5)
5	21.4 (16.2)	1007 (254)	78.7 (13.3)	1229 (395)	50.6 (16.5)	50.6 (16.5)

Test phase results:

- PWs were spelled more accurately ($p < .001$) across exposures
- PWs were recognized above chance level after 3 and 5 exposures
- PWs were recognized more accurately ($p < .001$) and faster ($p < .001$) across exposures

➔ Orthographic learning did occur during the reading phase

Oculomotor measures during implicit learning



Oculomotor results:

- Main effects of number of exposures and item-type on all oculomotor measures (all $p_s < .001$)
- Faster decrease of number of fixations and gaze duration for PW than for W (resp., $p = .027$ and $p < .001$)

➔ Decrease of processing time across exposures reflects orthographic learning

- Local Performance by Group interaction between the 1st and 2nd exposure for both gaze duration and second-of-two fixation duration (resp., $p = .046$ and $p < .001$)
- Local interaction between the 2nd and 3rd exposure for single fixation duration ($p < .001$)

➔ Orthographic learning occurs during the very early stages of the learning process

Exploratory analysis of VAS Effect

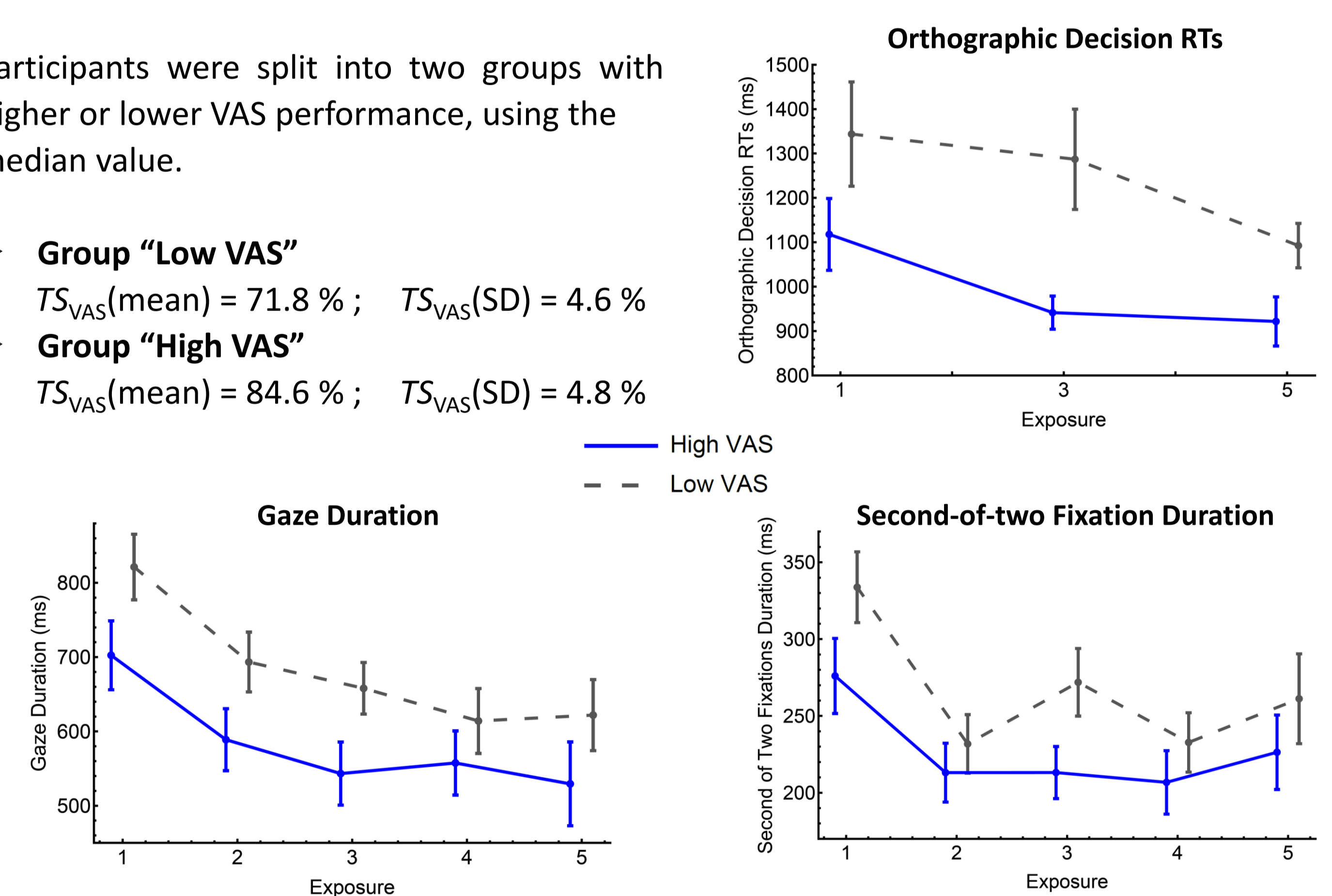
Participants were split into two groups with higher or lower VAS performance, using the median value.

Group "Low VAS"

$TS_{\text{VAS}}(\text{mean}) = 71.8\%$; $TS_{\text{VAS}}(\text{SD}) = 4.6\%$

Group "High VAS"

$TS_{\text{VAS}}(\text{mean}) = 84.6\%$; $TS_{\text{VAS}}(\text{SD}) = 4.8\%$



Results:

- Slower RTs in the orthographic decision task for "Low VAS" group than for "High VAS" group ($p = .003$)
- Longer Gaze duration and Second-of-two fixation duration for the group with lower VAS (resp., $p = .050$ and $p = .021$). Both groups do not significantly differ on any other measures (Number of fixations, Single Fixation Duration, First of Two Fixation Duration).
- Similar decrease of performance with exposures in the two VAS groups

SUMMARY AND DISCUSSION

- ✓ Memorization of new words' orthography increases across exposures
- ✓ Eye movement variations reflect orthographic learning
- ✓ Processing time decreases as a function of exposures
- ✓ Higher visual-attention span induces faster visual processing time

Current findings are accounted for by BRAID-Learn, our model of orthographic learning of new words. This allows interpreting results observed here; for instance, processing time decreases thanks to the top-down influence from the newly acquired orthographic representation

The role of VA span in orthographic learning requires further investigations