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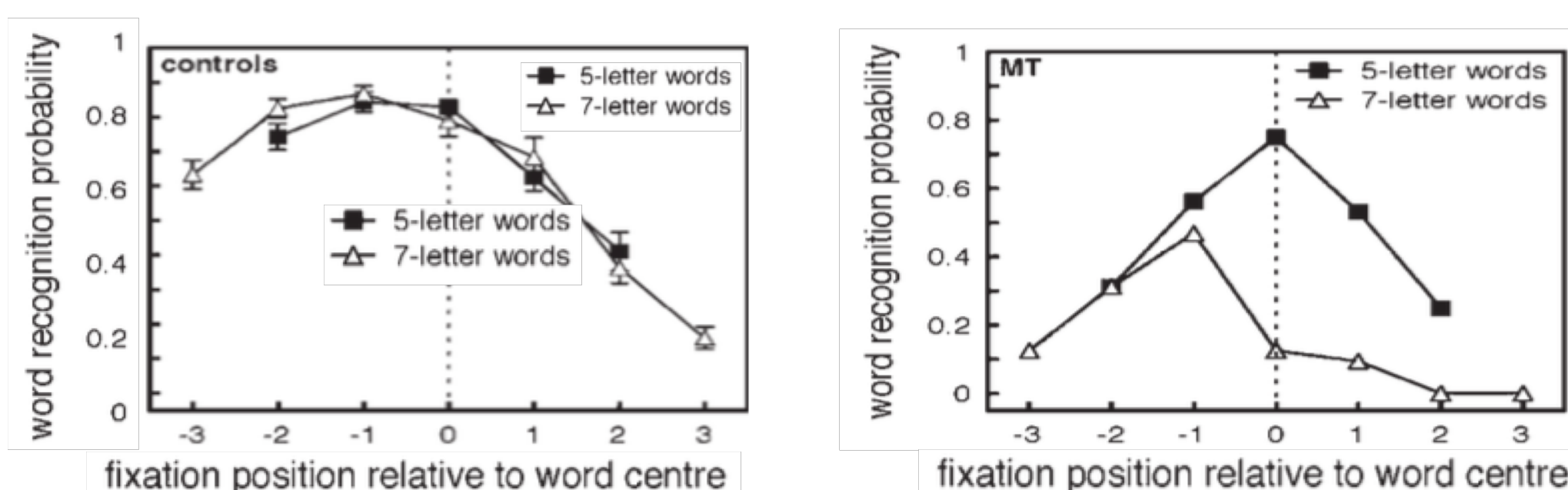
Simulation of the Atypical Viewing Position Curves of Dyslexic Children

Sylviane VALDOIS, Thierry PHÉNIX, Mathilde FORT and Julien DIARD

The Optimal Viewing Position Effect in Developmental Dyslexia

The probability of recognizing a word depends on the position of fixation during processing. The **Optimal Viewing Position (OVP)** for word recognition is located **slightly left of the word center**. Performance decreases when the eyes deviates from the OVP, producing an inverted J-shaped curve (O'Regan & Jacobs, 1992; Brysbaert & Nazir, 2005). **A few studies report atypical viewing position curves in dyslexic individuals** (Aghababian & Nazir, 2000; Dubois et al., 2007; Ducrot et al., 2003).

The viewing position curves in typical (left) and dyslexic (right) individuals

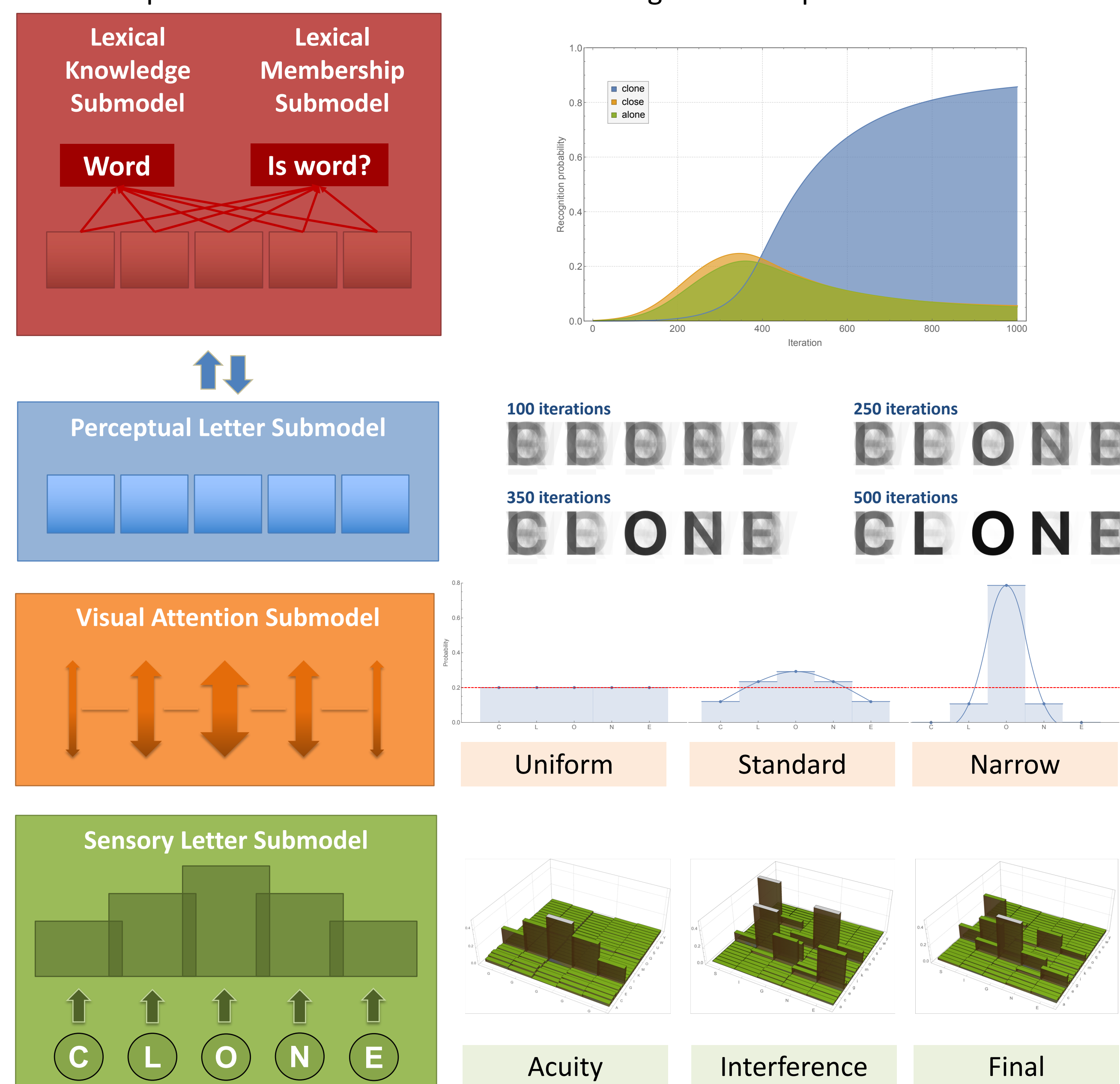


Goals:

- We report new data on the OVP effect in developmental dyslexia
- We simulate the observed viewing position curves with BRAID, a new Bayesian word Recognition model with Attention, Interference and Dynamics

The BRAID model

BRAID is a probabilistic model of visual word recognition composed of 5 sub-models.



Empirical Findings: Atypical viewing position curves in dyslexic children

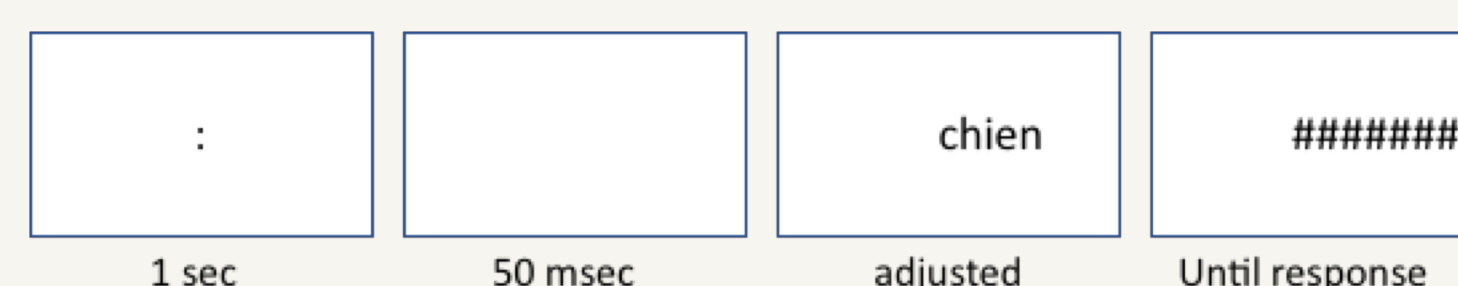
Behavioral Experiment

Population:

- 23 dyslexic children (11 girls); Mean chronological age = 10.9 years; 4th-6th grade
- Native French speakers; normal IQ; normal or corrected vision / audition
- Free from any neurological or psychiatric history, no medical treatment
- Reading deficit: 71 words correctly read per minute (CTLs: m=136.8, SD=30.9)
- Written consent from the legal tutor of each child

Method:

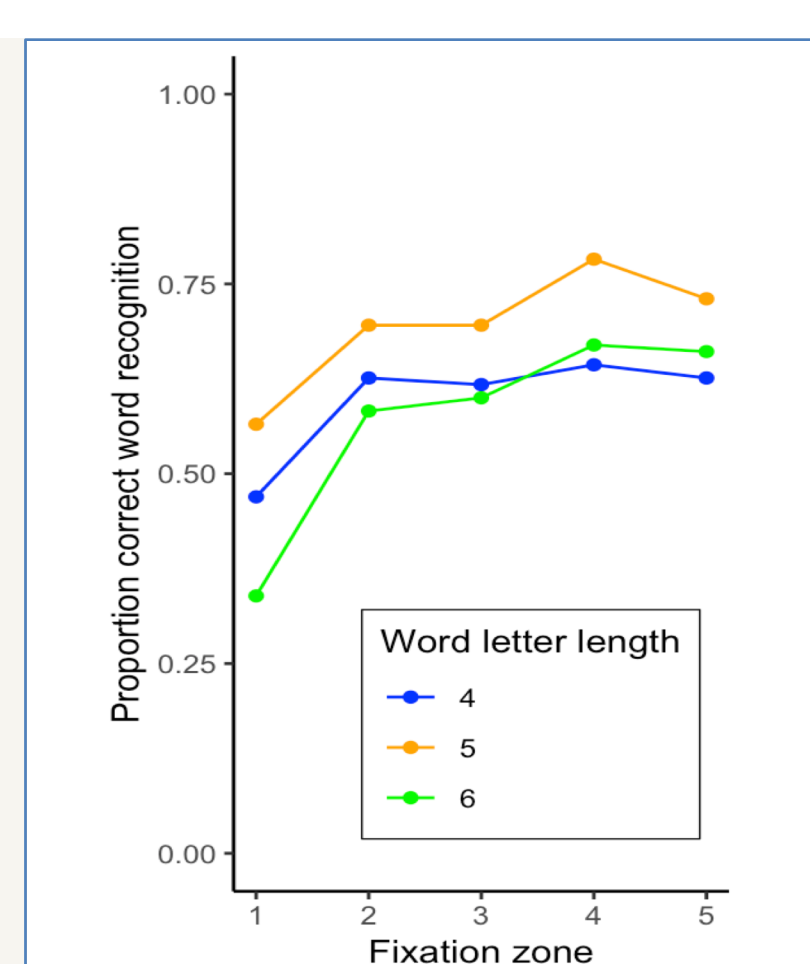
- Stimuli:** 75 4-, 5- and 6-letter words (25 per length) matched in frequency; words of high frequency (mean=200; Manulex database, Lété et al., 2004); matched in age of spelling acquisition (EOLE database, Pothier & Pothier, 2003).
- Design:** Each word was divided into five zones of one fifth of the width of the total word length. The center of each zone was designated as a potential fixation point. Words were presented in blocks of the same length. Exposure duration was adjusted for each child until the percentage of accurate recognition exceeded 50%.
- Procedure:**



Empirical curves:

Atypical viewing position curves: better word recognition when fixating the **right** than the left half of the word: $\chi^2(1)=27.4, p<.001$.

A significant **Position effect:** $\chi^2(4)=50.21, p<.001$
A significant but atypical **Length effect:** $\chi^2(4)=21.99, p<.001$. Five-letter words are better identified than 4- or 6- letter words. No Length by Position interaction.



Conclusion:

- As in typical readers, word recognition performance in developmental dyslexia differs depending on fixation location.
- Children with dyslexia show atypical viewing position curves: words are better identified when fixated to the right of word center instead of the left as in controls.
- Similar viewing position curves have been reported in a letter-by-letter brain damaged reader (Montant & Nazir, 1998).

References

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Simulation Results

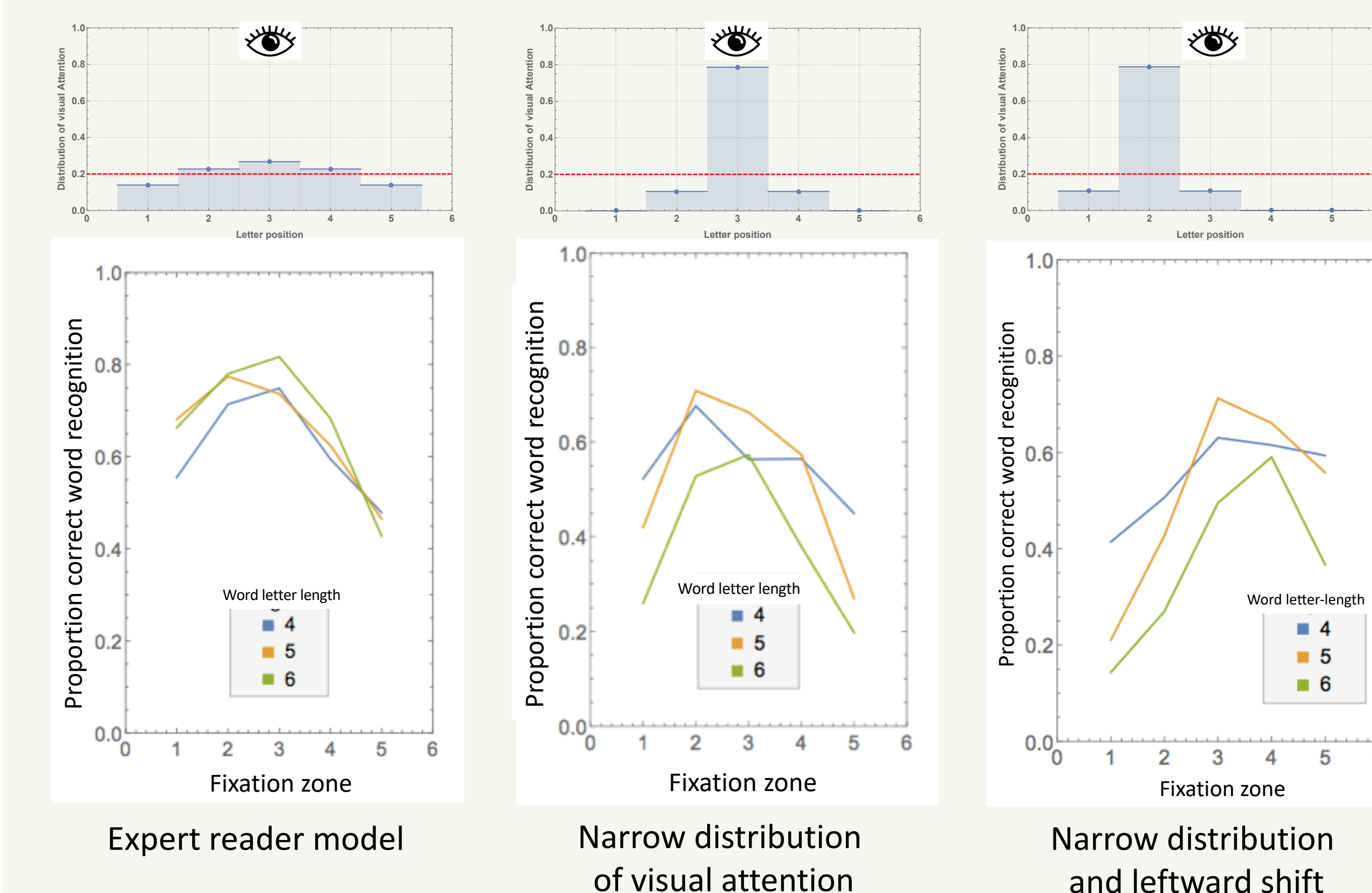
Simulations with the BRAID model

Purpose:

The dyslexic participants show atypical viewing position curves when asked to identify words of 4-to-6 letters.

- First, we simulate word recognition curves depending on fixation location with the BRAID model using the same set of words and the model default parameters (expert reader model).
- Second, we explore whether and how a narrow distribution of visual attention affects the shape of the viewing position curves (simulation of visual attention span deficit (Dubois et al., 2007; Aghababian & Nazir, 2000).
- Last, we combine narrow visual attention distribution and leftward shift of attention to simulate the empirical curves observed in the dyslexic participants.

Simulation Results:



- Typical optimal viewing position curves are generated when using the BRAID model default parameters (expert reader model).
- Lower word recognition performance follows from narrowing the visual attention distribution, with a tendency towards reversed V-shaped curves.
- Asymmetric (better to the right) OVP curves are simulated following narrow visual attention distribution and a leftward shift of visual attention.

Conclusion:

- For the first time, an optimal rightward viewing position is reported in children with dyslexia, mimicking patterns found in letter-by-letter readers.
- BRAID can successfully simulate the atypical viewing position curves observed in the dyslexic participants following a double dysfunction: abnormally narrow visual attention distribution and atypical leftward shift of attention.