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# Modeling Optimal Viewing Position with BRAID: The Role of Visual Attention

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► **To cite this version:**

Thierry Phénix, Sylviane Valdois, Julien Diard. Modeling Optimal Viewing Position with BRAID: The Role of Visual Attention. Annual Meeting of the Psychonomic Society, Nov 2018, New-Orleans, United States. hal-02004121

**HAL Id: hal-02004121**

**<https://hal.science/hal-02004121>**

Submitted on 1 Feb 2019

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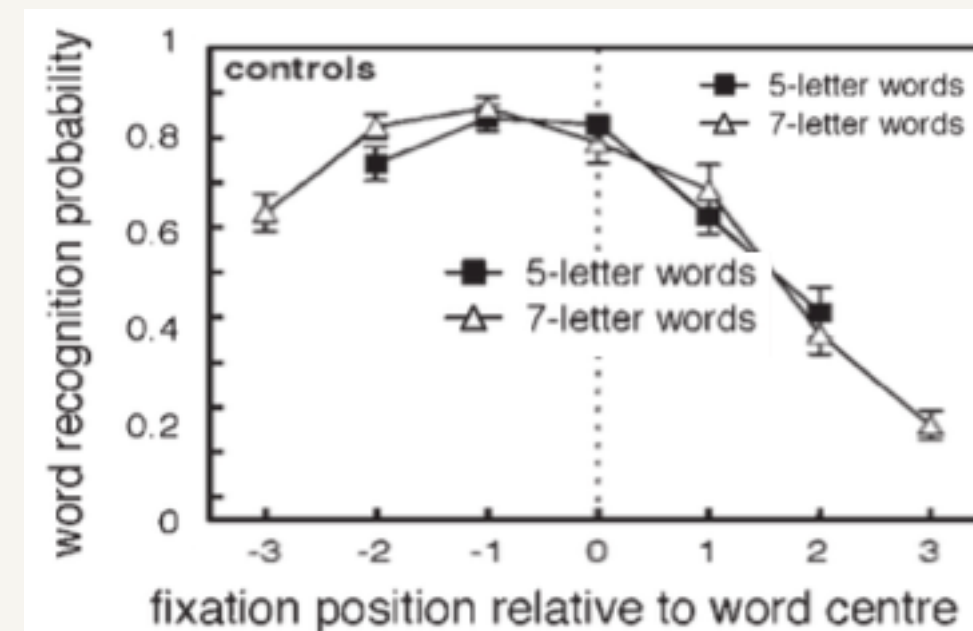
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## The Optimal Viewing Position Effect in typical readers

### Background

Word recognition depends on the position of fixation within the word letter string.

The fixation position that is optimal for word identification (the **Optimal Viewing Position** or **OVP**) is located slightly left of the word center. Performance declines asymmetrically when deviating from the OVP, thus resulting in an inverted J-shaped curve of word recognition.

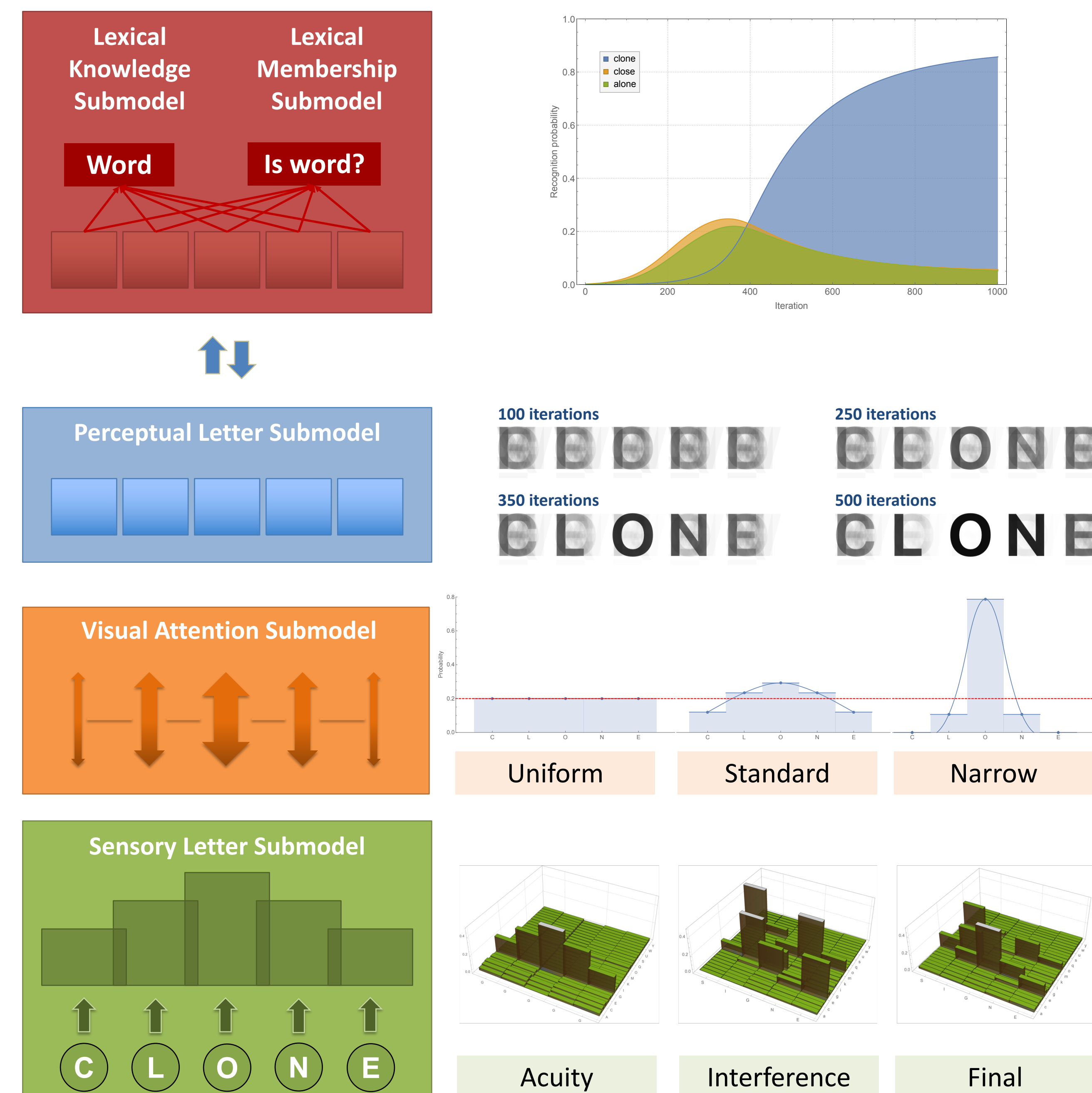


Despite being a well-documented and very robust effect in visual word recognition (Brysbart & Nazir, 2005; O'Regan & Jacobs, 1992), the OVP effect was largely ignored by previous word recognition models.

Our aim was here to assess the capacity of **BRAID**, a new **Bayesian model of word Recognition with Attention, lateral Interference between adjacent letters and Dynamics** to simulate the OVP effect and word recognition curves for words of different lengths.

### The BRAID model

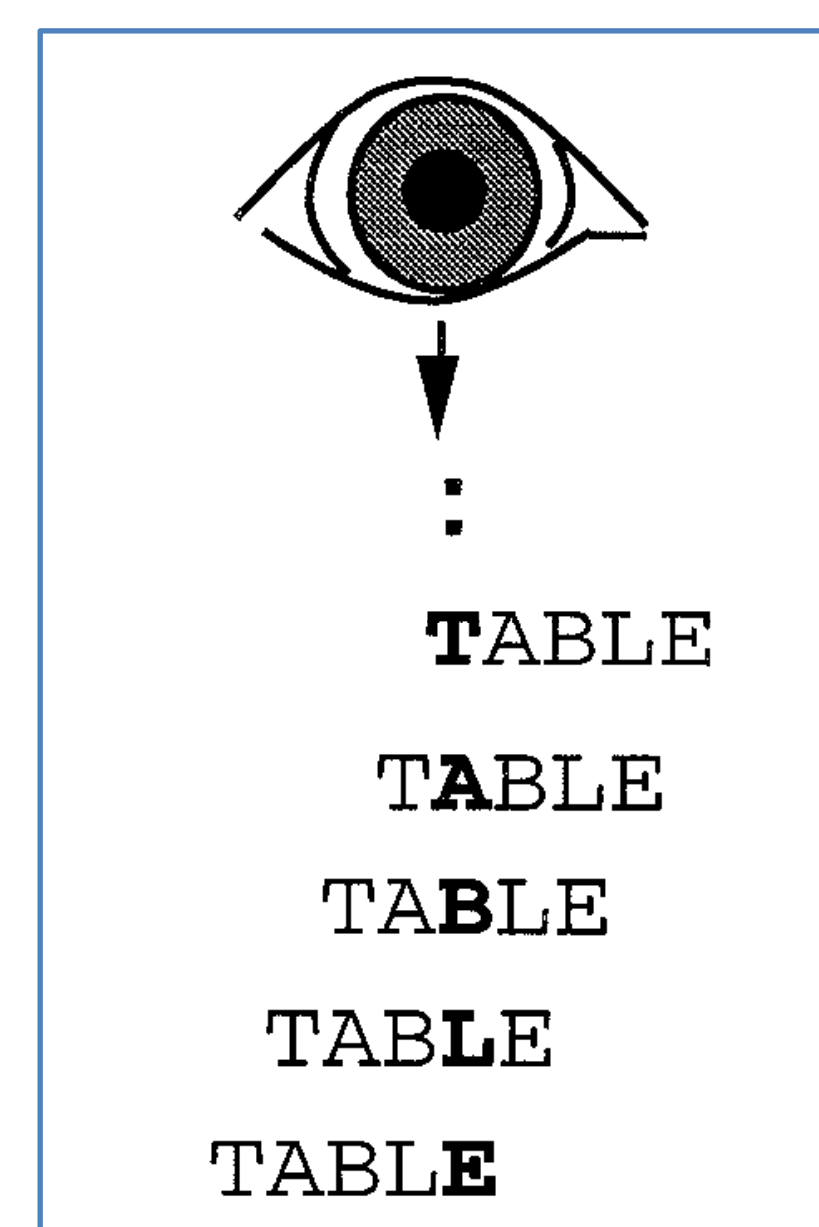
BRAID is a probabilistic model of visual word recognition composed of 5 sub-models.



## Behavioral Task and Simulation Methodology

### Behavioral Experiment

Word recognition task with variable viewing position



Empirical data from Montant, Nazir & Poncet (1998)

- Word length varies from 5 to 9 letters, 250 words (50 per length)
- Short duration presentation (33 ms), avoiding any eye movement

#### Behavioral results:

- The OVP is slightly left of the word center
- Performance drops with eccentricity
- Asymmetry between first and last position
- Length effect: mean performance decreases with word length

### Simulation with BRAID

#### Material:

- List of 5-to-9 letter words of Montant et al. (1998)
- Definition of five fixation zones for each word length
- Gaze position is successively set at the center of the five fixation zones for each word

#### Method: grid search

- The variance of visual attention ( $\sigma_A$ ) varies between 0.5 and 3.0
- Word identification probability is recorded for the first 500 iterations
- Each word length is evaluated separately
- The mean square error (MSE) between simulated and observed performance was computed (see left column of the main Figure of simulation results)

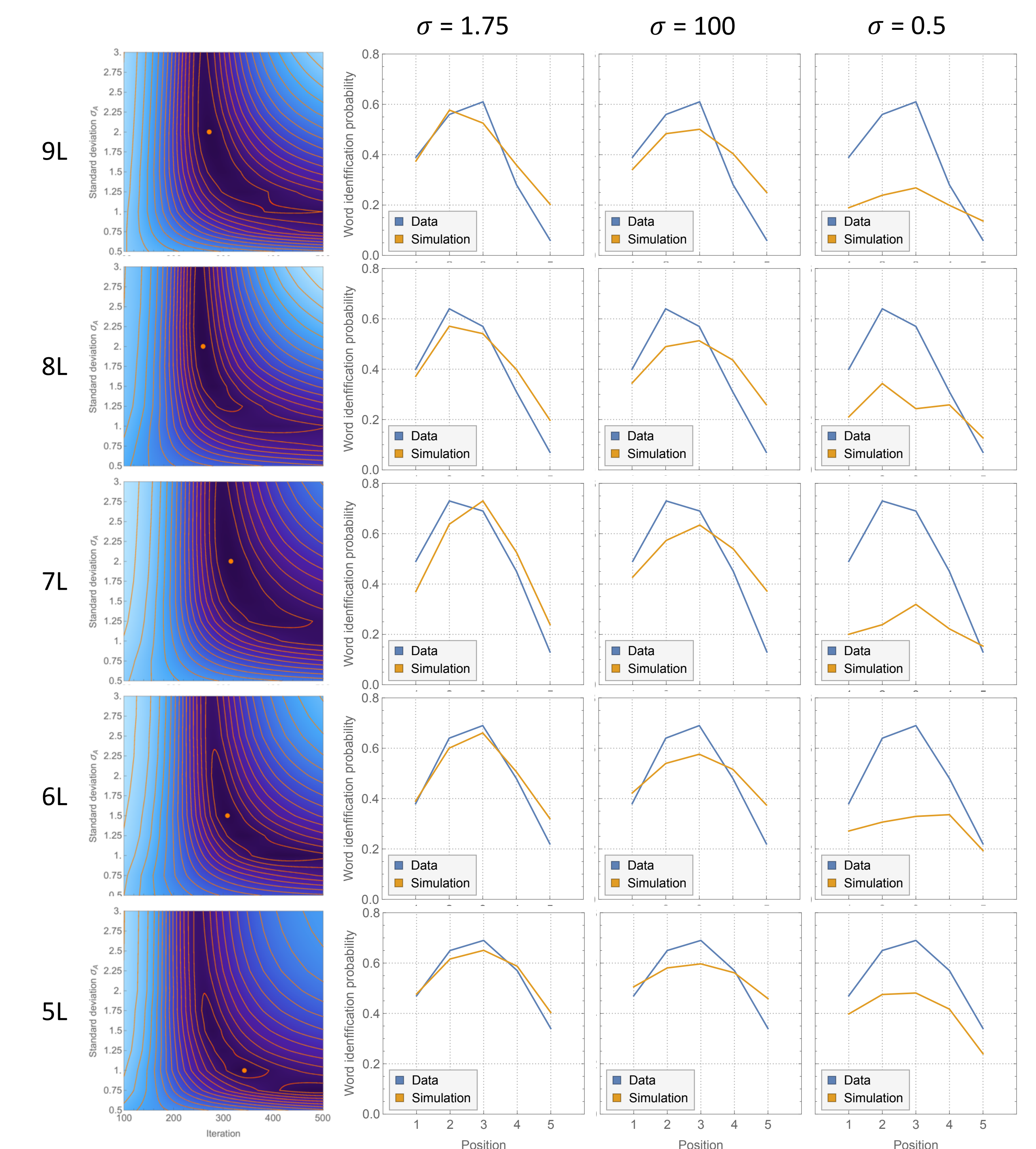
#### Simulation results:

- The best fit is obtained for  $\sigma_A$  values of 1, 1.5 and 2 for words of lengths 5, 6 and 7 or more, respectively
- The model is not sensitive to parameter values for  $\sigma_A$  and thus captures human data in a robust fashion
- With a  $\sigma_A$  value of 1.75, we simulate all the features of the empirical curves for all word lengths
- In contrast, uniform or narrow distributions fail to account for behavioral results

#### References

Aghababian, V. & Nazir, T. (2000). J. of Exp Child Psych, 76, 123-150. • Dubois, M., Lafaye de Micheaux, P., Noël, M.P. & Valdois, S. (2007). Cog Neuropsych, 6(1), 623-660 • Ducrot, S., Lété, B., Sprenger-Charolles, L. & Billard, C. (2003). Current Psych Letters, 10, 1 • Ginestet, E., Phenix, T., Diard, J., & Valdois, S. (submitted). Modelling length effect for words in lexical decision: the role of visual attention. • Phénix, T., Valdois, S., & Diard, J. (submitted). Bayesian word recognition with attention, interference and dynamics. • Phénix, T. (2018). Modélisation bayésienne algorithmique de la reconnaissance visuelle de mots et de l'attention visuelle. Université Grenoble Alpes.

## Simulation Results



Left column: Contour plots of the MSEs between simulated and empirical data as a function of iterations and variance of attention distribution (the darker the color, the better the fit). Orange dots = best fit parameter values. Three other columns: Simulated word identification probability curves (in orange) as a function of fixation position and attention distribution: "standard" ( $\sigma = 1.75$ , 2<sup>nd</sup> column), uniform-like ( $\sigma = 100$ , 3<sup>rd</sup> column) and narrow ( $\sigma = .5$ , 4<sup>th</sup> column). In blue, the empirical curves.

### Conclusion

- Varying the attention distribution affects the shape of the word recognition curves for all word lengths.
- **BRAID can successfully account for the optimal viewing position effect** reported in word recognition as a function of fixation position.
- The almost symmetrical curves obtained for a uniform attention distribution reinforce the idea that visual attention acts as an attentional filter, modeled in BRAID by a Gaussian distribution.
- The low recognition rate and atypical curve shapes that result from a narrow attention distribution mimic the behavioral data reported in some poor and / or dyslexic readers (Dubois et al., 2007; Aghababian & Nazir, 2000; Ducrot, Lété, Sprenger-Charolles, Pynte, & Billard, 2003).