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# Automated Text Simplification as a reading aid for low-vision individuals

Aurelie Calabrese

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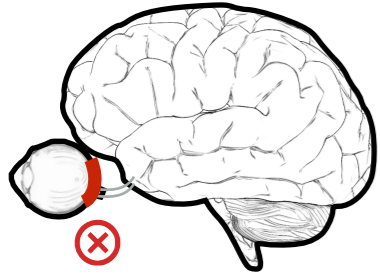
**20-21 VHRN Virtual Meetings**  
**January 29th, 2021**

# **Automated Text Simplification** **as a reading aid for** **low-vision individuals**

**Aurélie Calabrèse, PhD.**

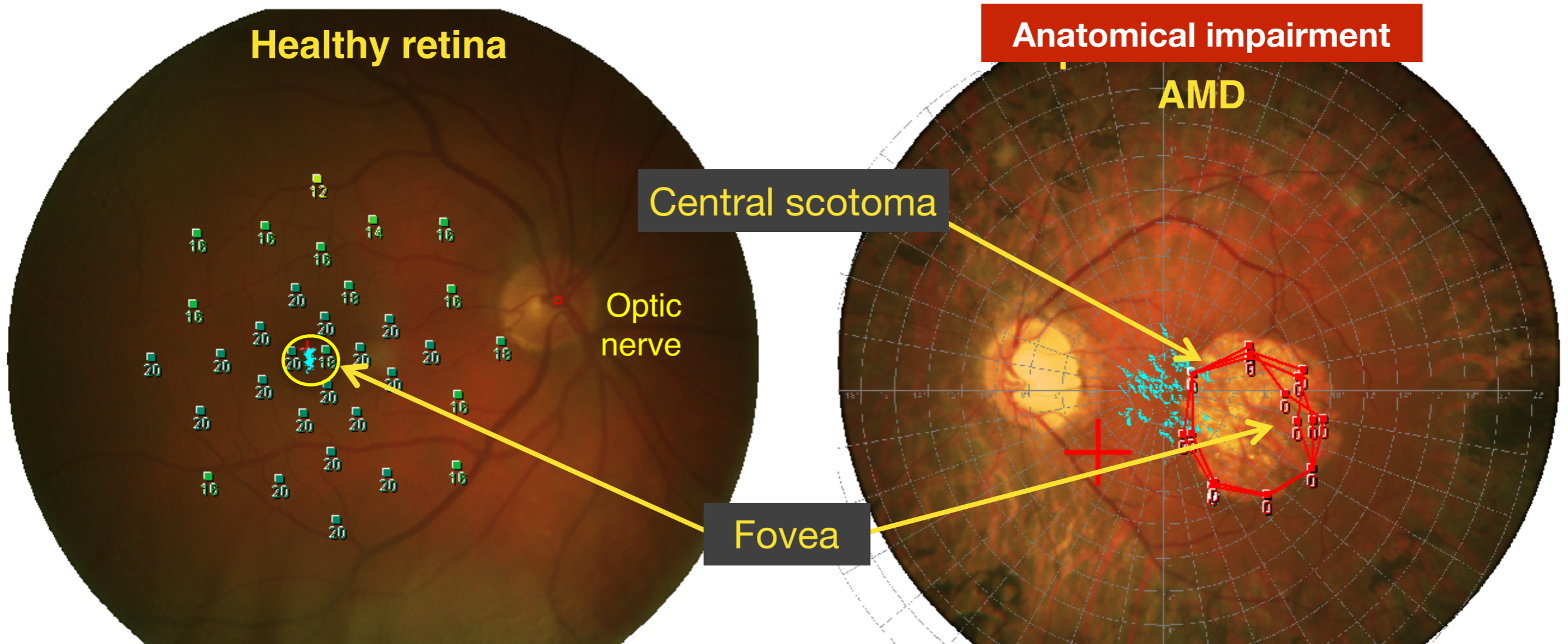


## Central Field Loss (CFL)



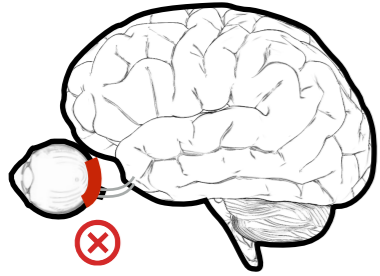
### Maculopathies

- Age-related Macular Degeneration (AMD) → 1st cause of visual impairment > 50 years old
- Diabetic retinopathy
- Myopic retinopathy
- Cone dystrophy
- Stargardt's disease





## Central Field Loss (CFL)



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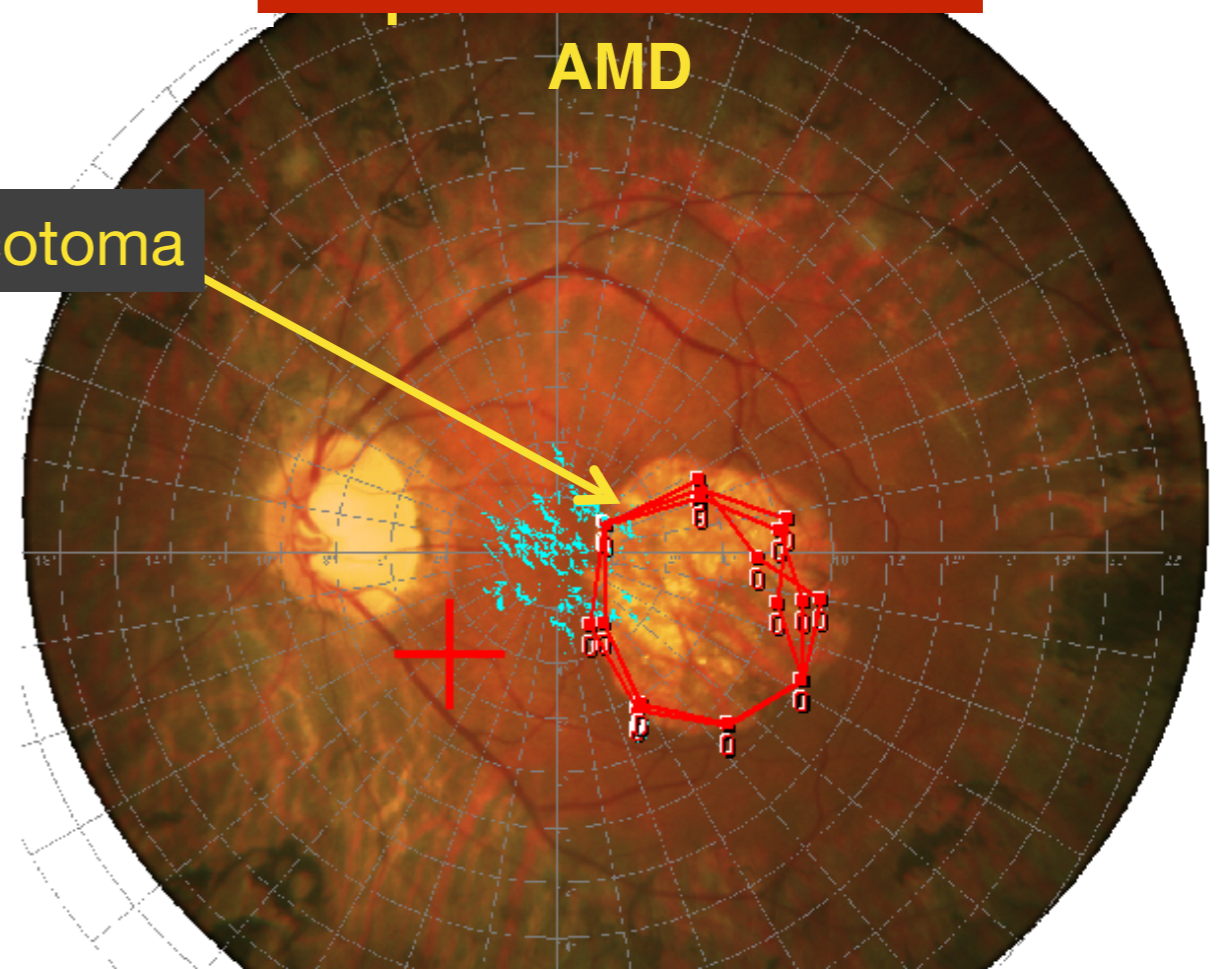
### Functional impairment

Visual field

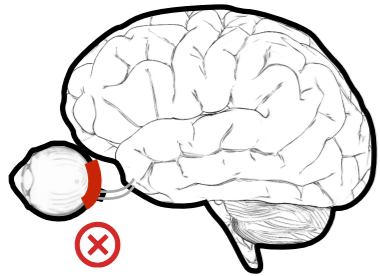


Central scotoma

### Anatomical impairment



## Central Field Loss (CFL)



### Maculopathies

- Age-related Macular Degeneration (AMD) → 1st cause of visual impairment > 50 years old
- Diabetic retinopathy
- Myopic retinopathy
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## Functional impairment

Visual field



## Reading



J'ai offert de jolies  
roses **rouges** à ma  
maman pour sa fête

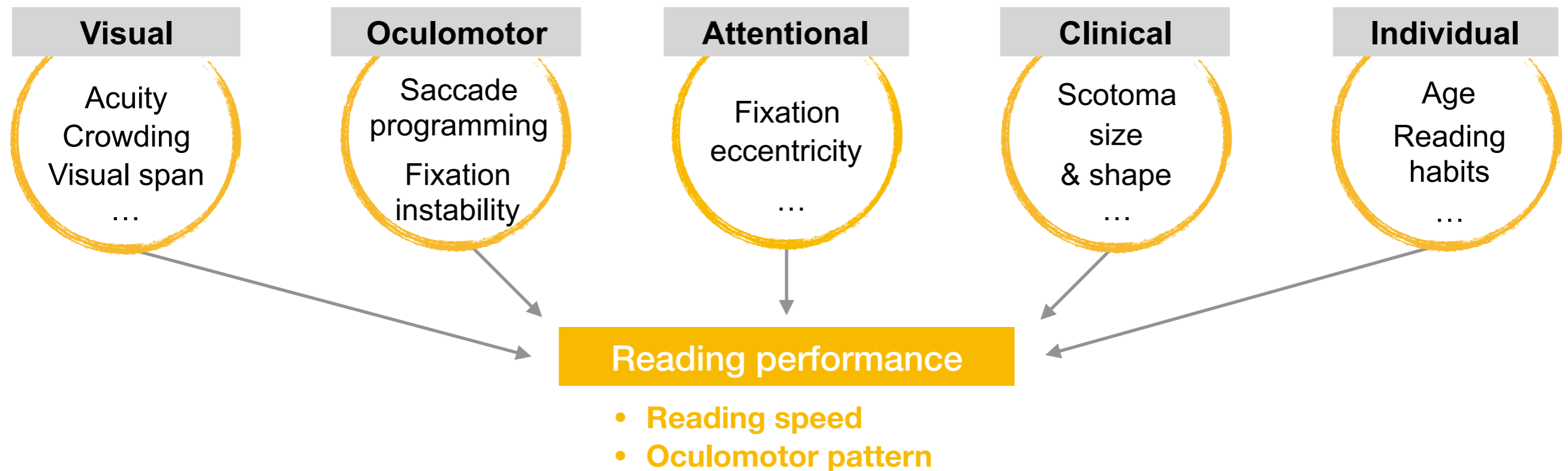
*Eccentric vision*



*Personalised  
rehabilitation  
protocols*

*Personalised  
visual aids*

## What are the underlying factors of poor reading performance with central field loss?



# Outline

**STUDY 1**

**STUDY 2**

**STUDY 3**

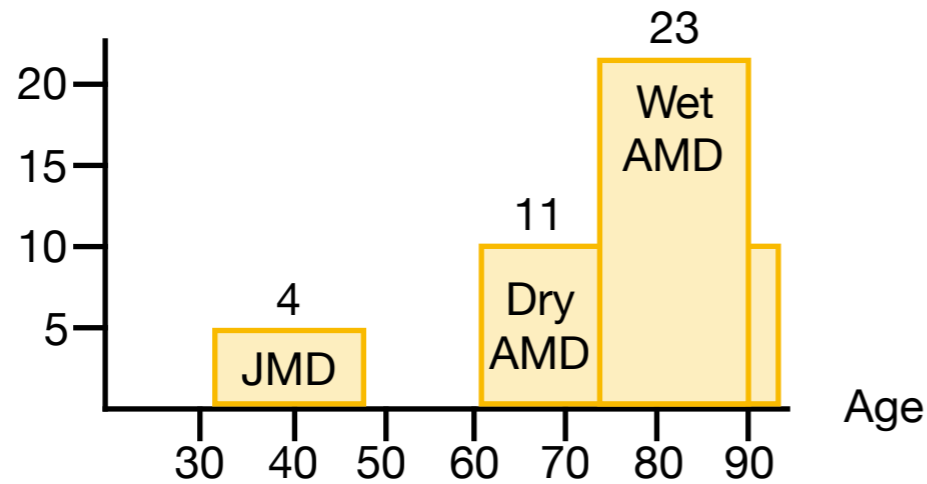
## Eye movement pattern when reading with CFL

### STUDY 1

Calabrèse, A., Bernard, J.-B., Faure, G., Hoffart, L., & Castet, E. (2016). Clustering of Eye Fixations: A New Oculomotor Determinant of Reading Speed in Maculopathy. *Investigative Ophthalmology & Visual Science*, 57(7), 3192-3202.

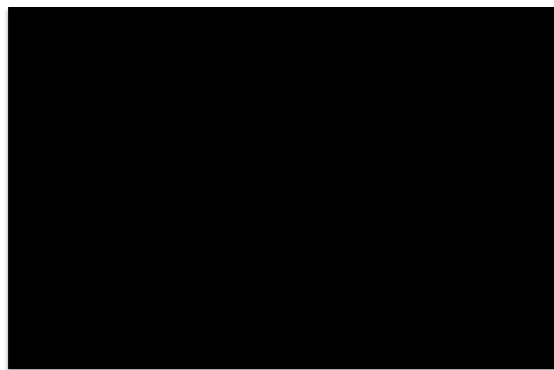
Methods

- 38 patients with binocular CFL



- Acuity from 20/250 to 20/63 (better eye)
- Only **absolute binocular scotoma**

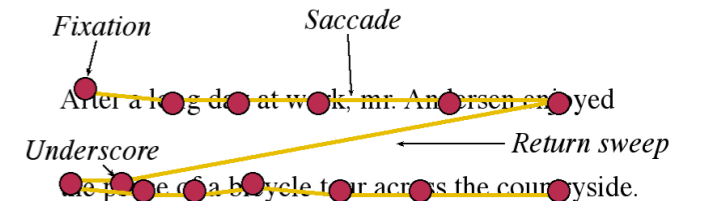
Stimuli



"You open my door"



Eye-tracking



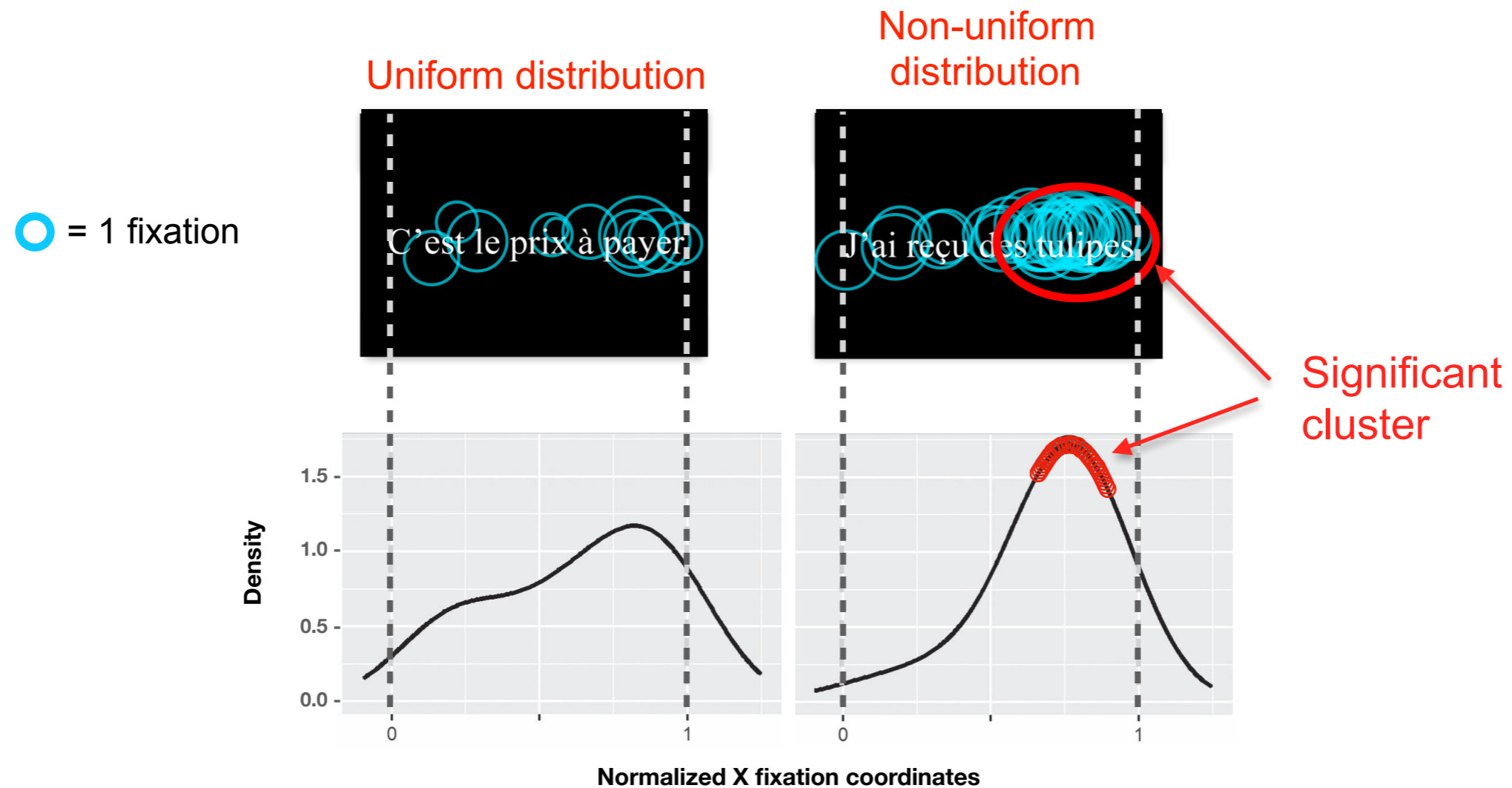
Eye fixation positions

Reading speed (*whole sentence*)



## Results

1- We defined a new oculomotor factor: the **non-uniformity of fixations**

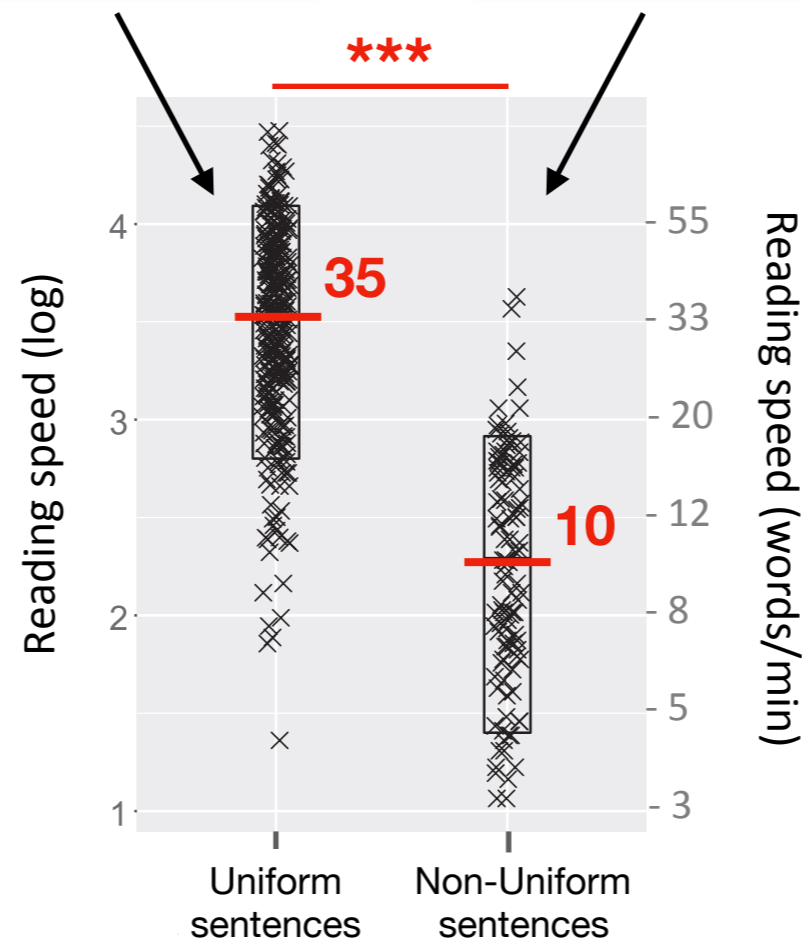
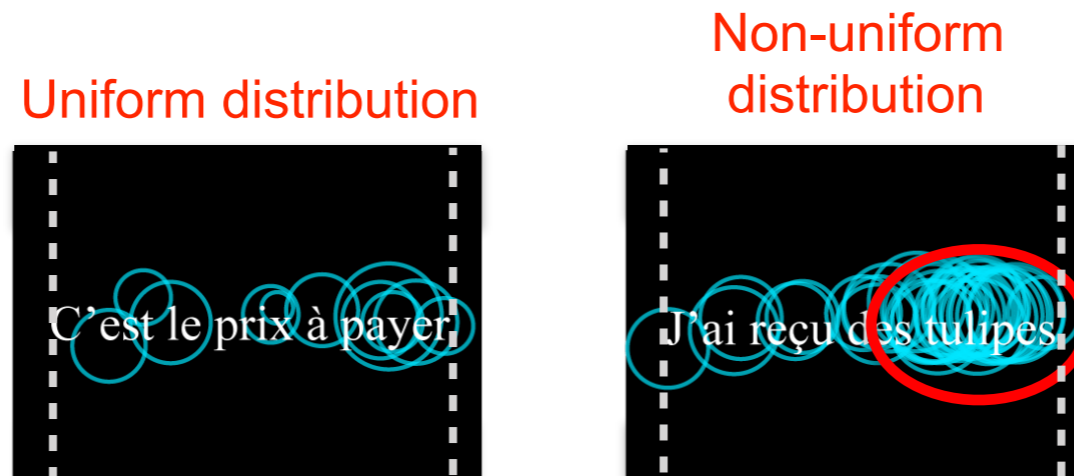


2 very **different distributions** of fixations for the **same patient**

## Results

- 1- We defined a new oculomotor factor: the non-uniformity of fixations
- 2- We measured the effect of this new factor on reading speed

○ = 1 fixation



Reading speed is significantly **reduced** when the pattern of fixations is **non-uniform** ( $p < 0.0001$ )

## Results

- 1- We defined a new oculomotor factor: the non-uniformity of fixations
- 2- We measured the effect of this new factor on reading speed
- 3- We investigated factors that could explain the non-uniformity

### Patient specific factors:

- Fixation instability → *no effect*
- Scotoma size → *no effect*
- Visual acuity → *no effect*
- Pathology → *no effect*
- Age → *no effect*

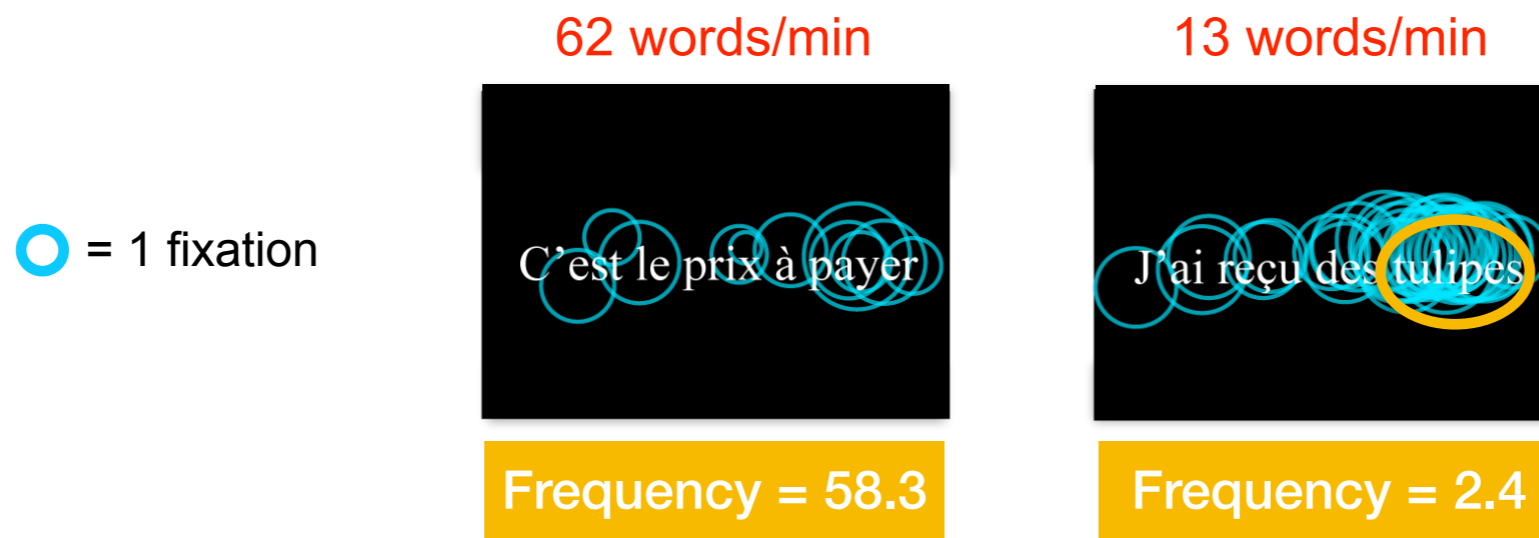
### Sentence specific factors:

- Word frequency → *significant effect*

*The probability to find a fixation cluster within a sentence increases when the frequency of the lowest-frequency word decreases*

## Results

- 1- We defined a new oculomotor factor: the non-uniformity of fixations
- 2- We measured the effect of this new factor on reading speed
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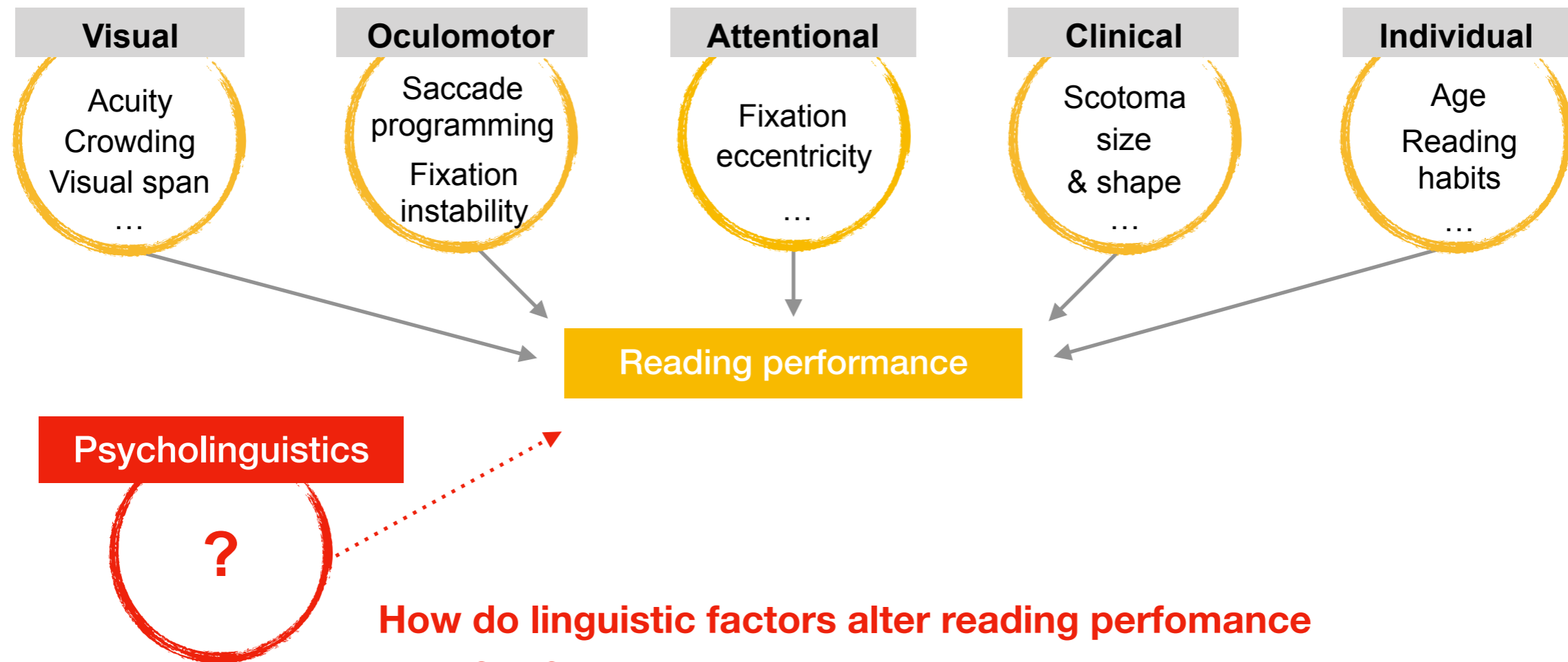
### Sentence specific factors:

- Word frequency → *significant effect*

*The probability to find a fixation cluster within a sentence increases when the frequency of the lowest-frequency word decreases*

## Conclusions

Underlying factors of poor reading performance with central field loss...



**How do linguistic factors alter reading performance with CFL?**

*Could we modify the text itself to make it more accessible to CFL?*

## Eye movement pattern when reading with CFL

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Calabrèse, A., Bernard, J.-B., Faure, G., Hoffart, L., & Castet, E. (2016). Clustering of Eye Fixations: A New Oculomotor Determinant of Reading Speed in Maculopathy. *Investigative Ophthalmology & Visual Science*, 57(7), 3192-3202.

## Effect of word frequency when reading with CFL

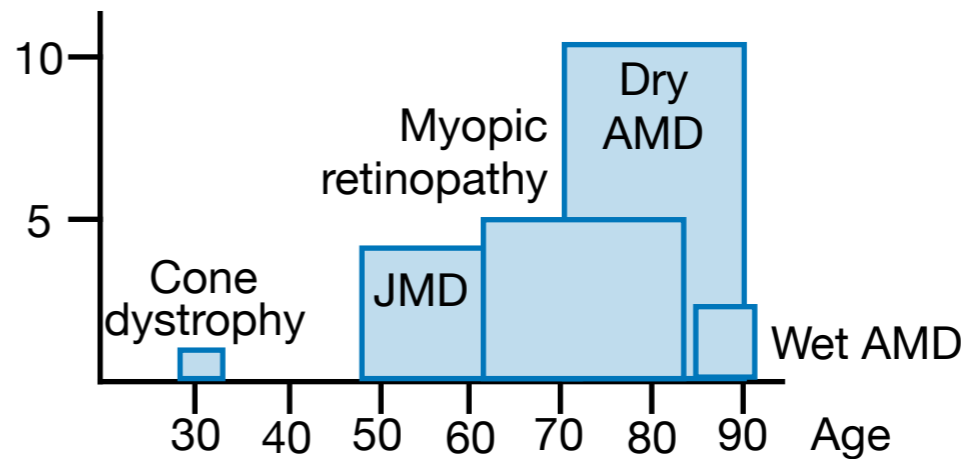
### STUDY 2

Stolowy, N.\*, Calabrèse, A.\*, Sauvan, L., Aguilar, C., François, T., Gala, N., et al. (2019) The Influence of Word Frequency on Word Reading Speed when Individuals with Macular Diseases Read Text. *Vision Research*, 155, 1-10 \*joint first authors

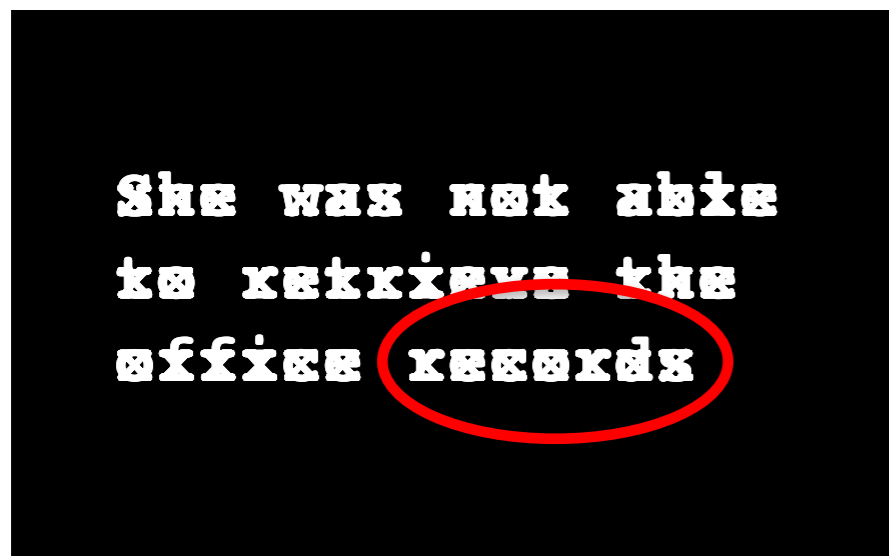


Methods - *participants*

- **23 patients** with binocular CFL
- Acuity from 20/400 to 20/63 (better eye)
- Only **absolute binocular scotoma**



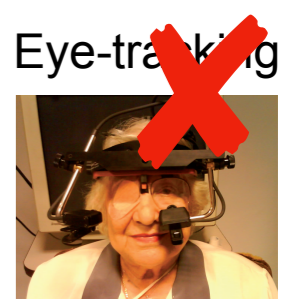
Methods - *reading paradigm*



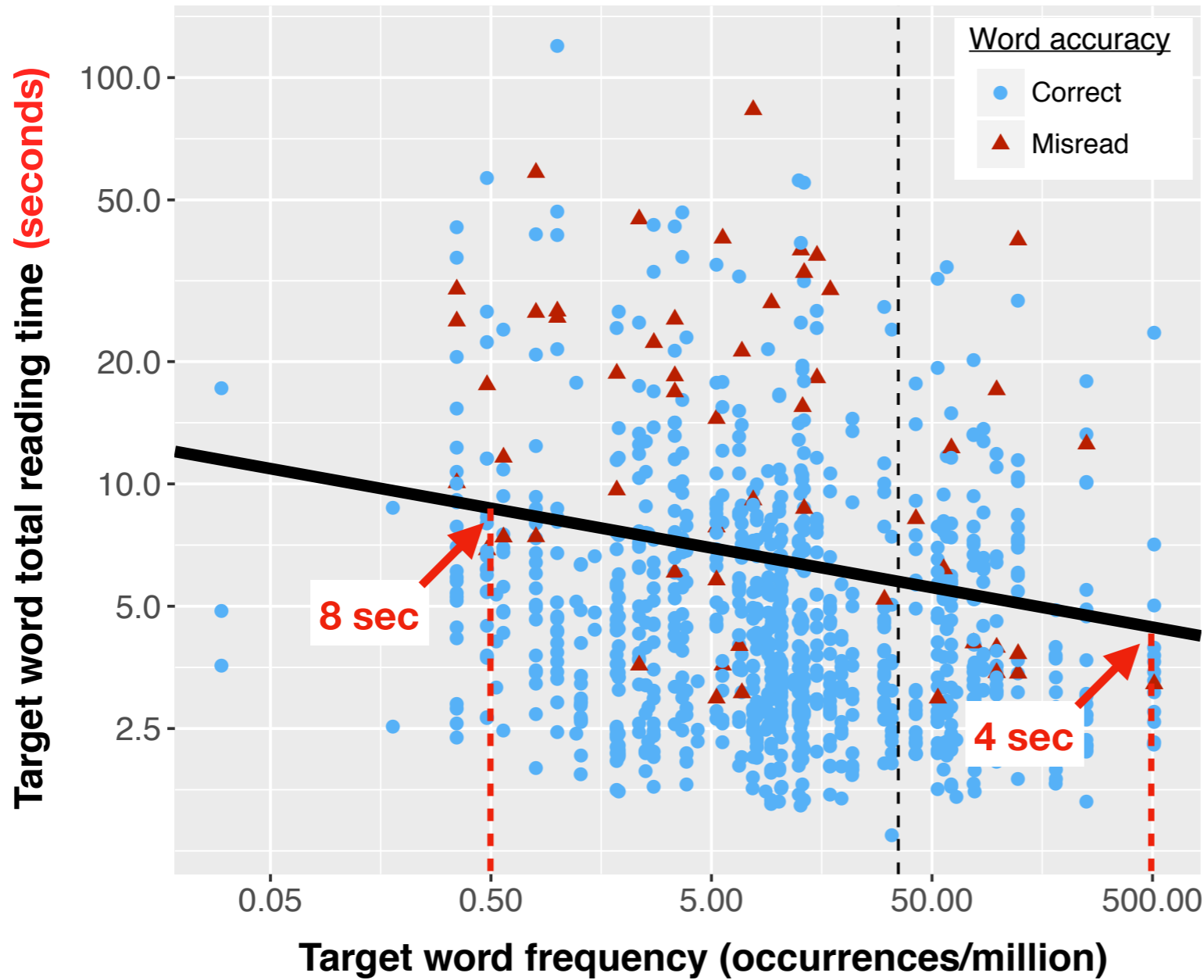
Self-paced reading



Reading time (*individual words*)



Results



Reading time decrease

=

Reading speed increase

Facilitator effect of frequency

Multiplying frequency by 1000 decreases reading time by 50%

## Eye movement pattern when reading with CFL

### STUDY 1

Calabrèse, A., Bernard, J.-B., Faure, G., Hoffart, L., & Castet, E. (2016). Clustering of Eye Fixations: A New Oculomotor Determinant of Reading Speed in Maculopathy. *Investigative Ophthalmology & Visual Science*, 57(7), 3192-3202.

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## Effect of word neighborhood size when reading with CFL

### STUDY 3

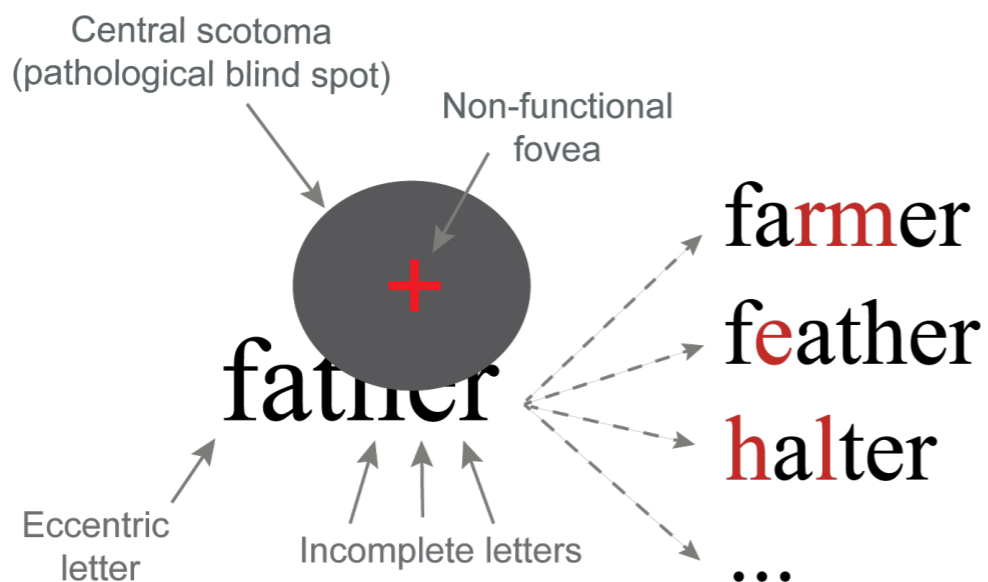
Sauvan, L., Stolowy, N., Aguilar, C., François, T., Gala, N., Matonti, F., et al. (2020) The inhibitory effect of word neighborhood size when reading with central field loss is modulated by word predictability and reading proficiency. *Scientific Reports*, 10, 21792.

**Word neighborhood size - definition**

**N = Number of words that can be formed from a single word by changing only one letter**



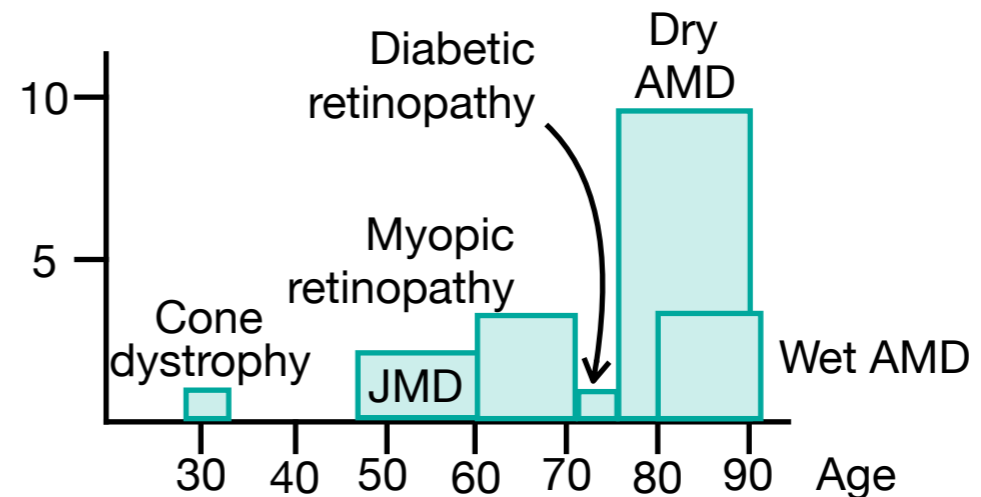
**Hypotheses**



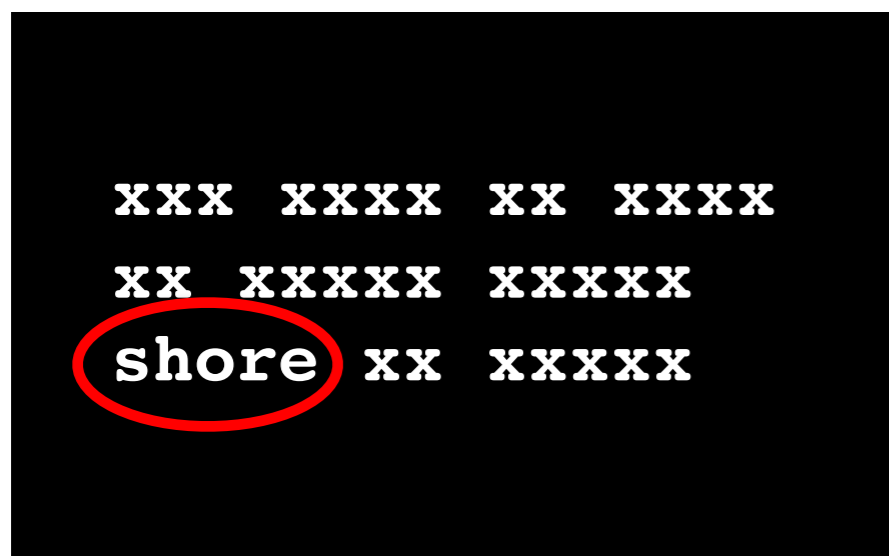
- Hyp. 1**  
Negative effect on reading speed
- Hyp. 2**  
The more predictable a word is the smaller the effect
- Hyp. 3**  
The interaction depends on reading proficiency

Methods - *participants*

- **19 patients** with binocular CFL
- Acuity from 20/400 to 20/50 (better eye)
- Only **absolute binocular scotoma**

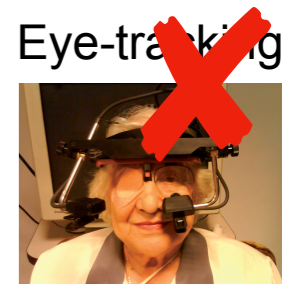


Methods - *reading paradigm*



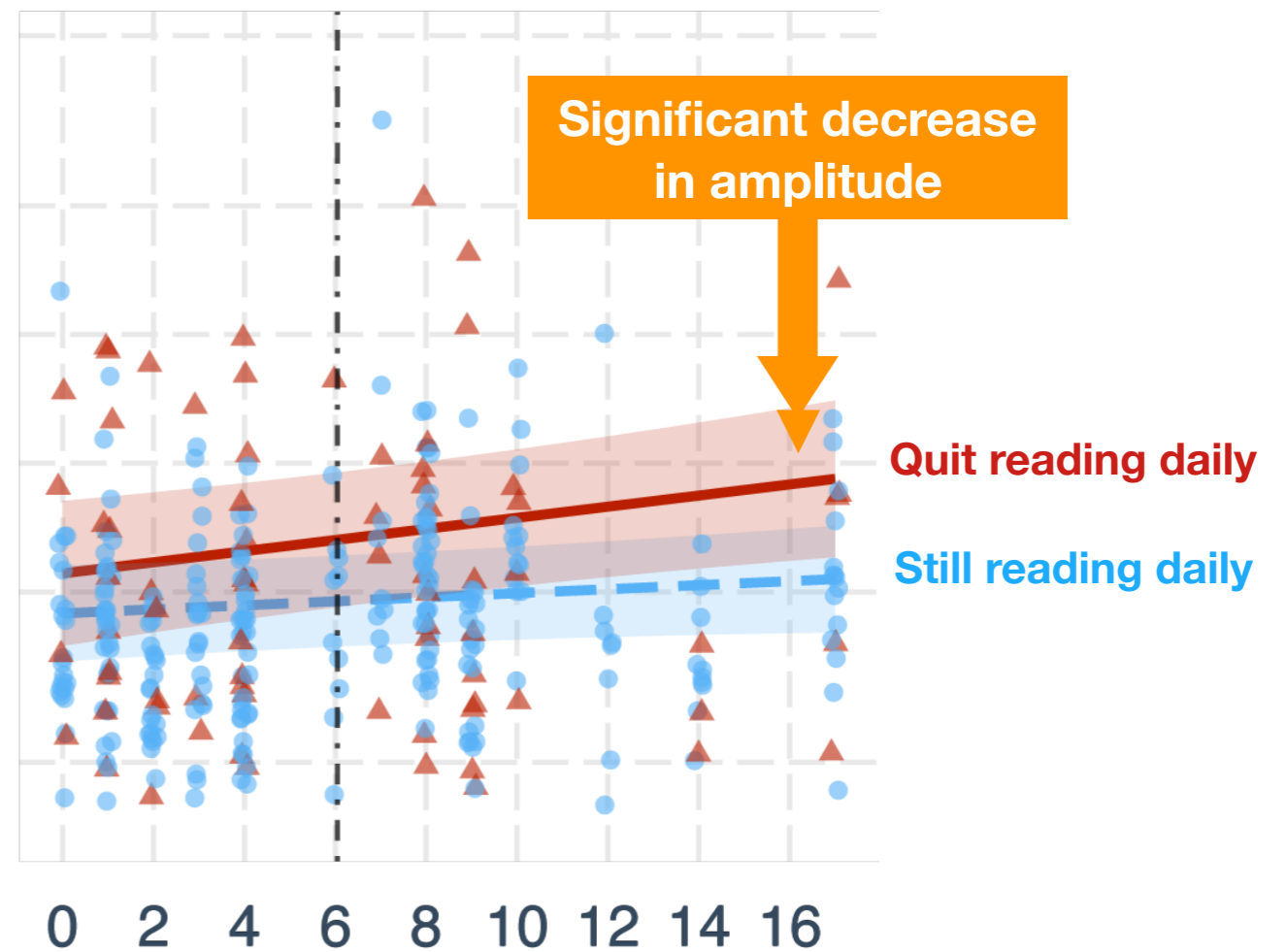
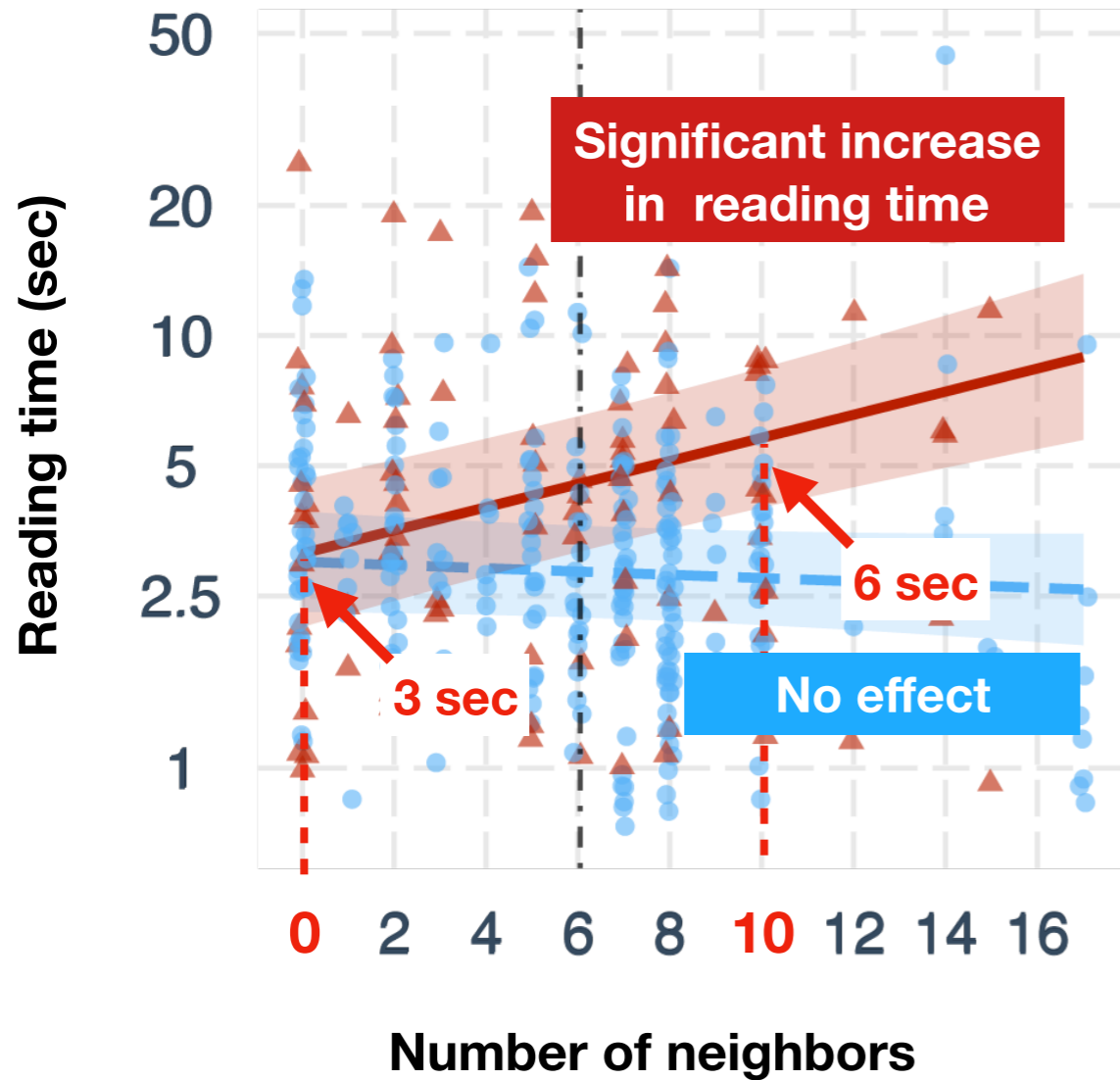
Self-paced reading

→ Reading time (*individual words*)



**Results**

Predictability ..... ⊖ ..... ⊕ ⊕



**Hyp. 1** ✓  
 Negative effect on reading speed

**Hyp. 2** ✓  
 The more predictable a word is the smaller the effect

**Hyp. 3** ✓  
 The interaction depends on reading proficiency



- ★ **The linguistic properties of a text do influence reading performance differently in the presence of CFL.**

*Psycholinguistic properties of a text must be investigated in the context of low vision (e.g., lexical, syntactic, discursive).*

- ★ **Reading habits and proficiency seem to reduce text complexity in the presence of CFL.**

*Reinforce the need to provide patients with individualised rehabilitative care of functional vision to help maintain daily reading practice.*

- ★ **Text simplification should be considered as a potential rehabilitation tool and daily reading assistive technology.**

*Automated text simplification software could be developed in the form of tablet apps or web browser.*

*By increasing reading accessibility, it would foster overall reading ability and fluency through increased practice.*

Happy faces!

Fondation  
de  
France

N. Gala



E. Castet



F. Matonti



C. Aguilar



N. Stolowy



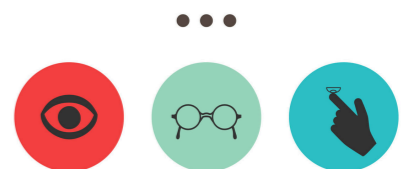
T. François



L. Sauvan



Assistance Publique  
Hôpitaux de Marseille



AMD/Low Vision  
Awareness  
Month

• February •

**Thank you**