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

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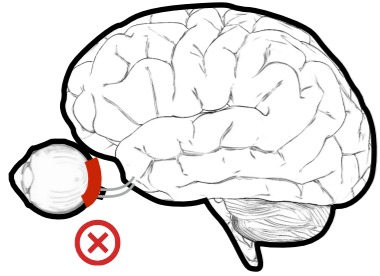
20-21 VHRN Virtual Meetings
January 29th, 2021

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

Aurélie Calabrèse, PhD.

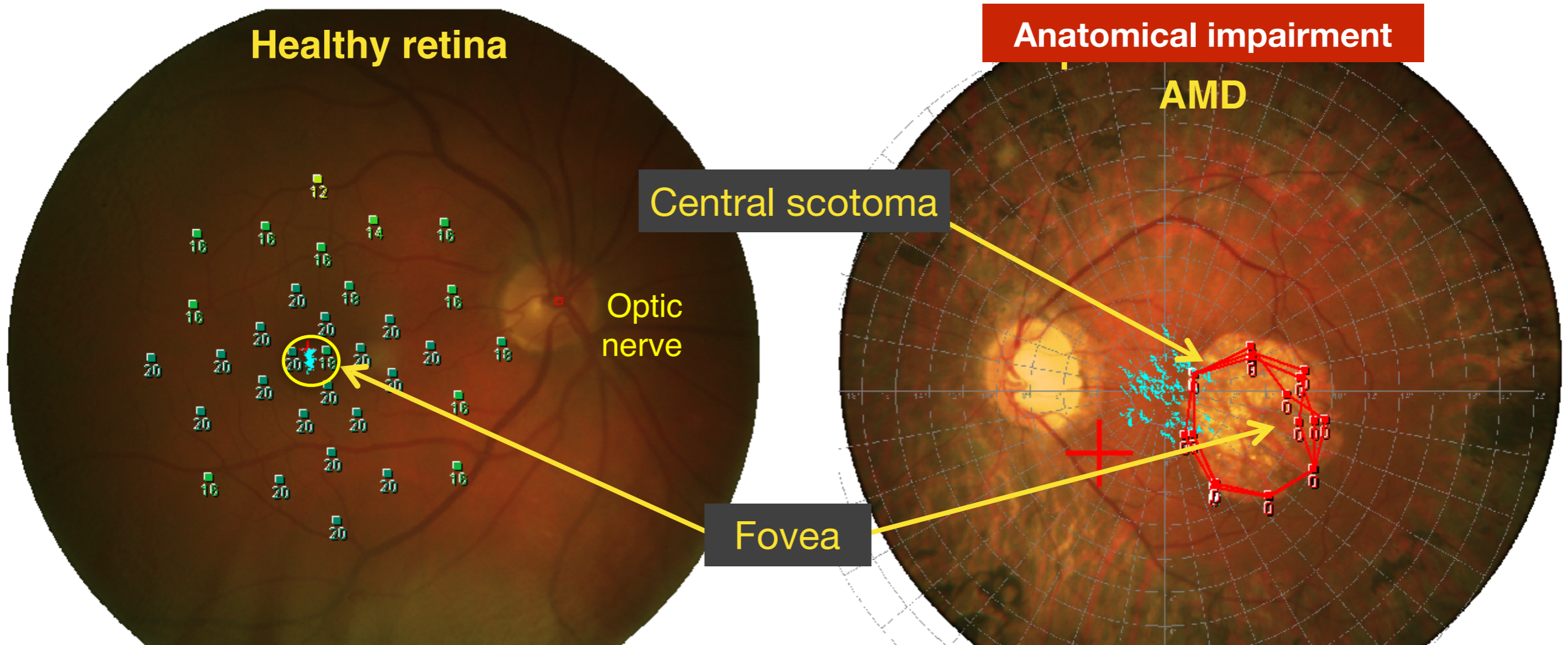


Central Field Loss (CFL)

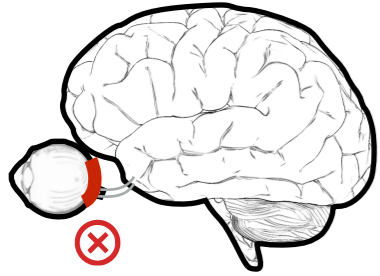


Maculopathies

- 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)



Maculopathies

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

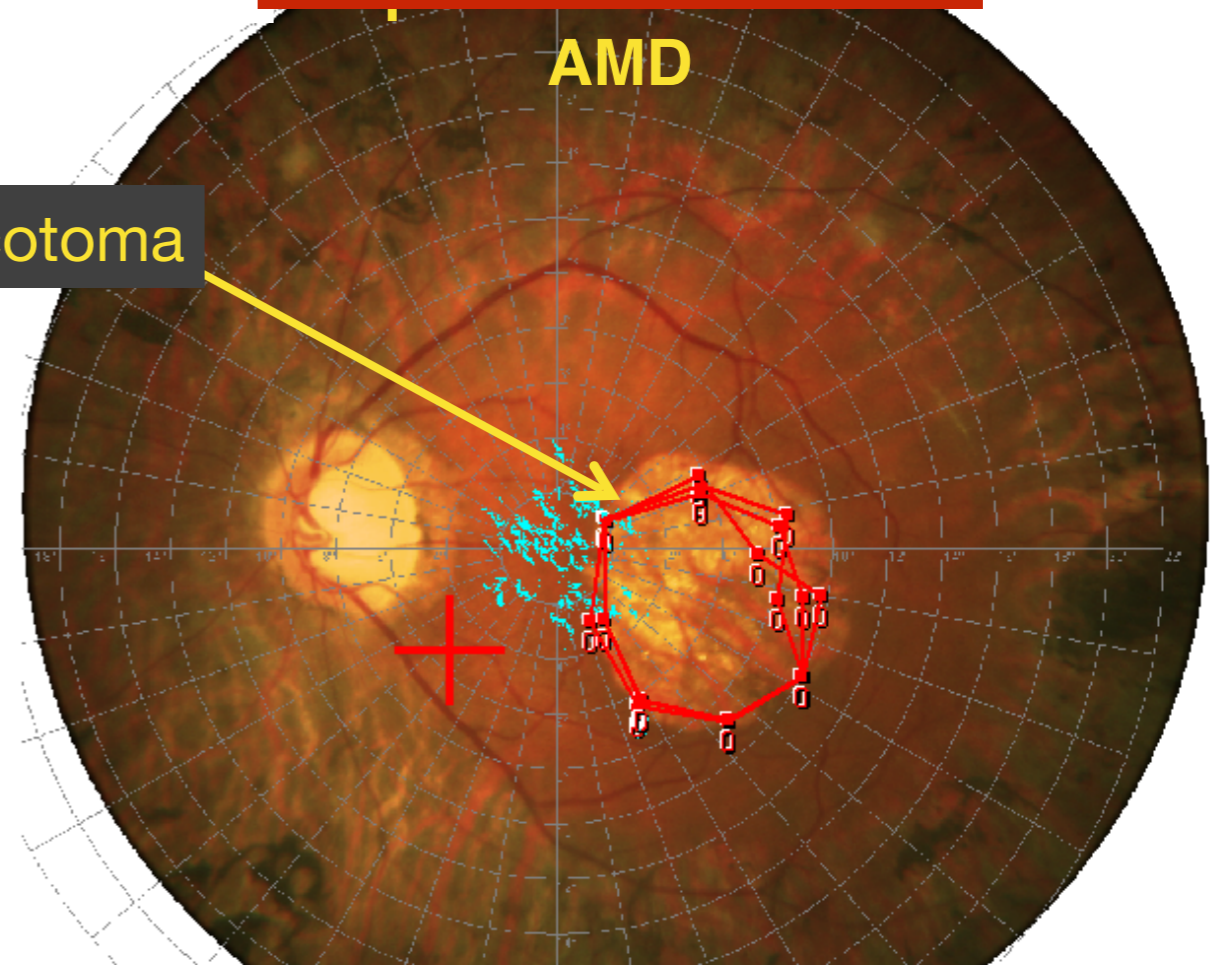
Visual field



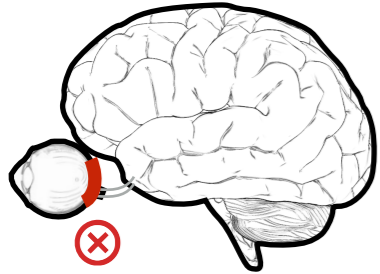
Central scotoma

Anatomical impairment

AMD



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

Functional impairment

Visual field



Reading



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

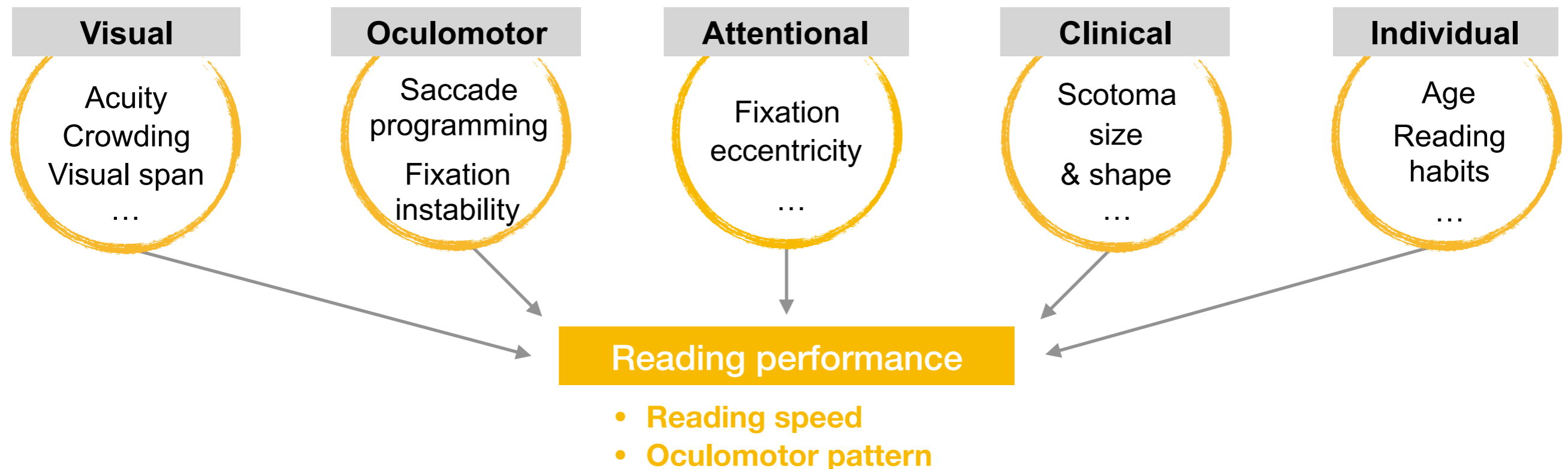
Eccentric vision



*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

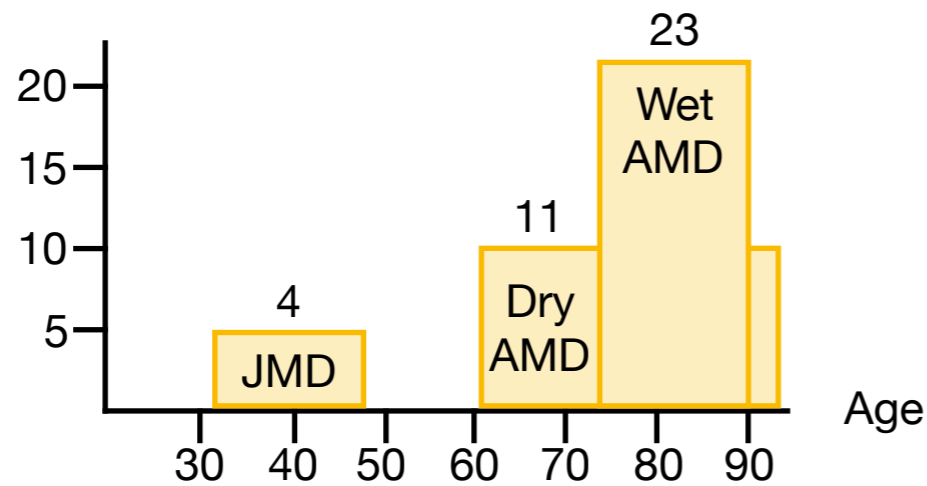
Eye movement pattern when reading with CFL

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.

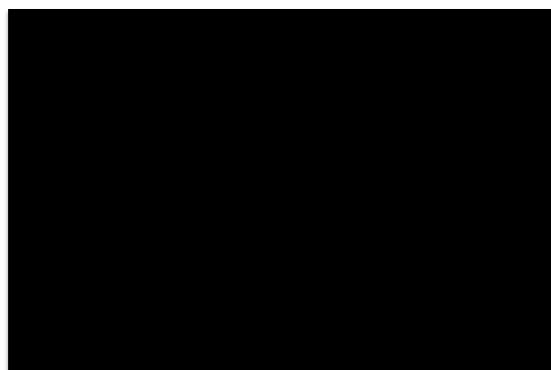
Methods

- 38 patients with binocular CFL



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

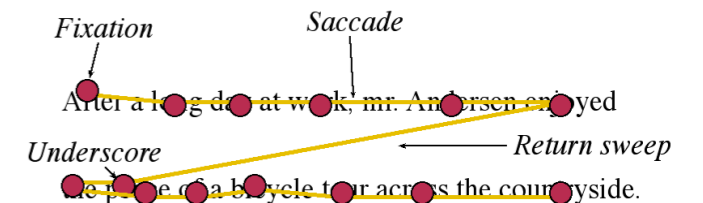
Stimuli



"You open my door"



Eye-tracking

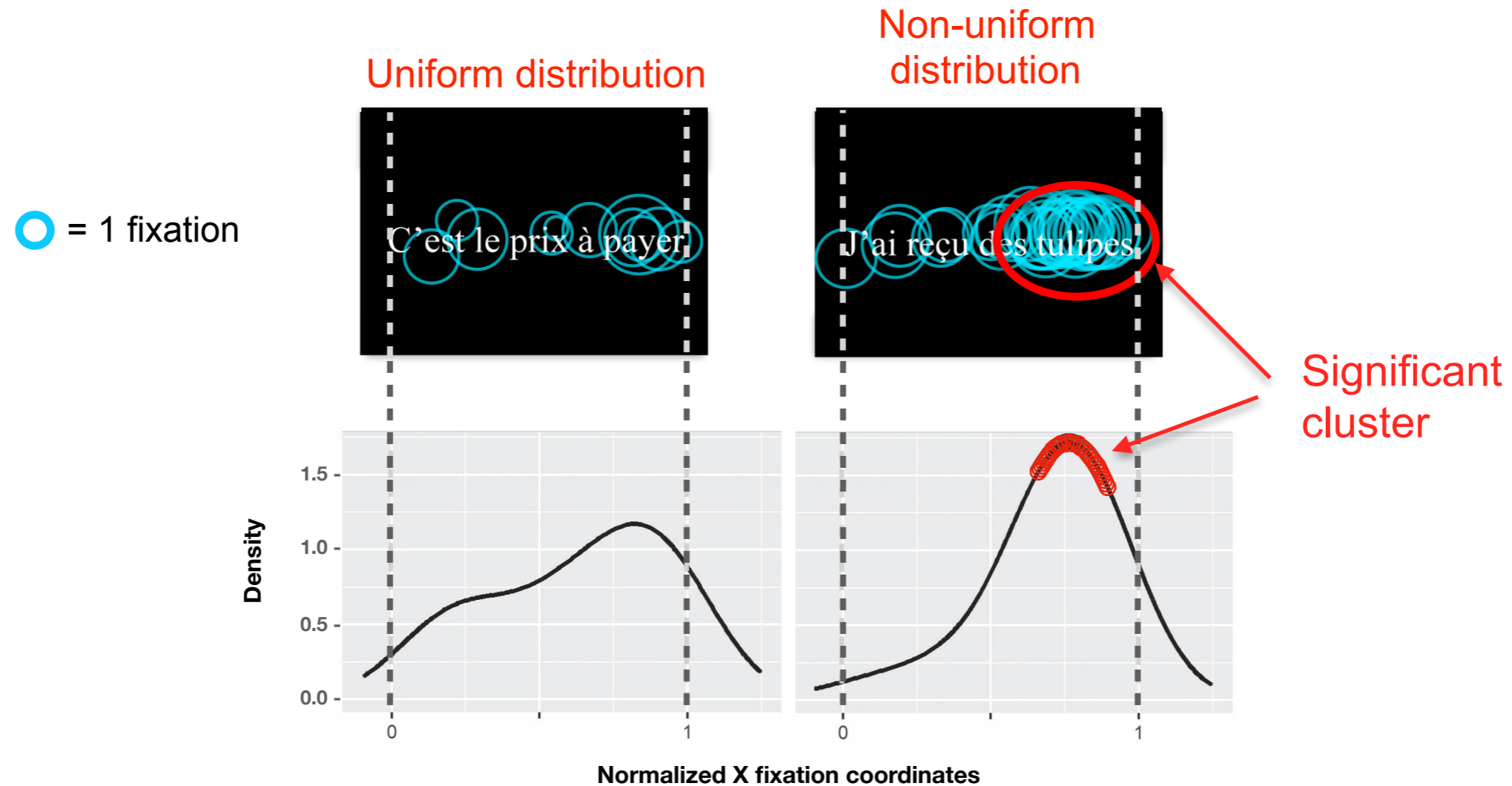


Eye fixation positions

Reading speed (*whole sentence*)

Results

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

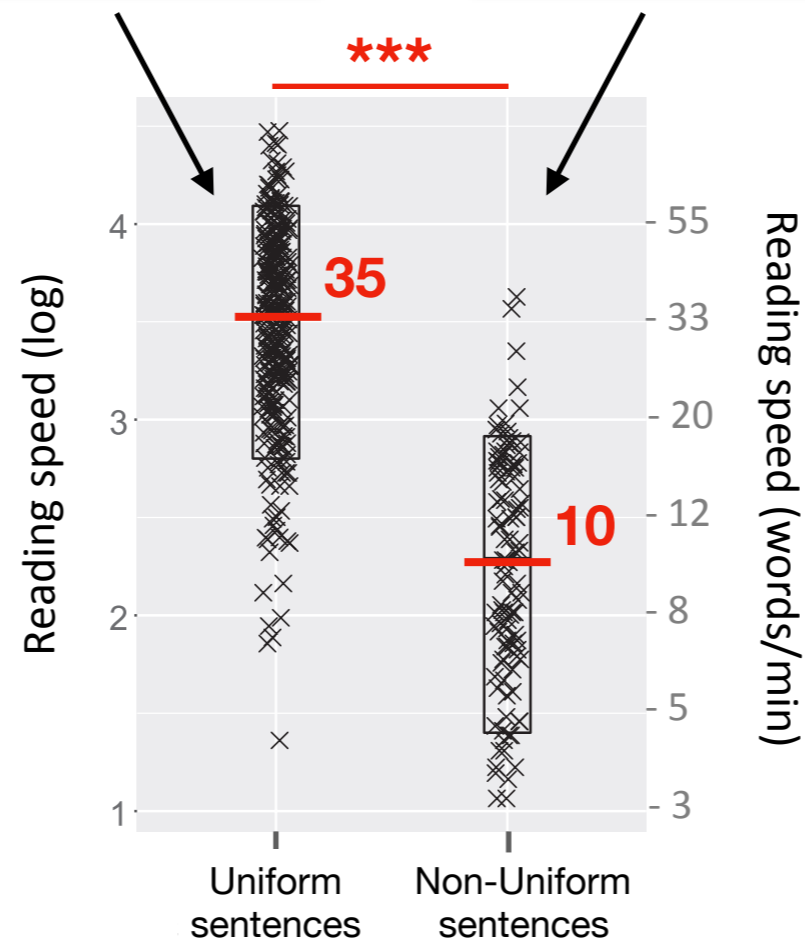
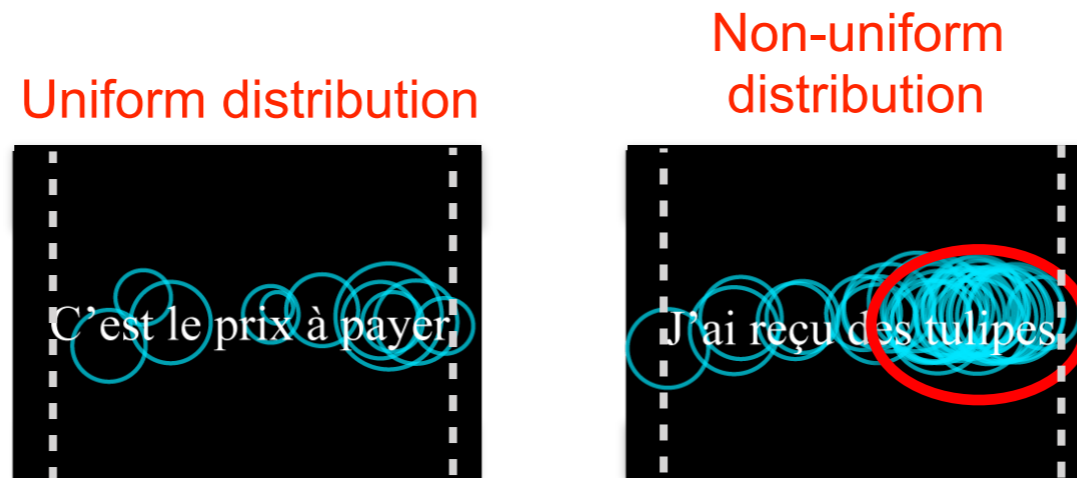


2 very **different distributions** of fixations for the **same patient**

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*

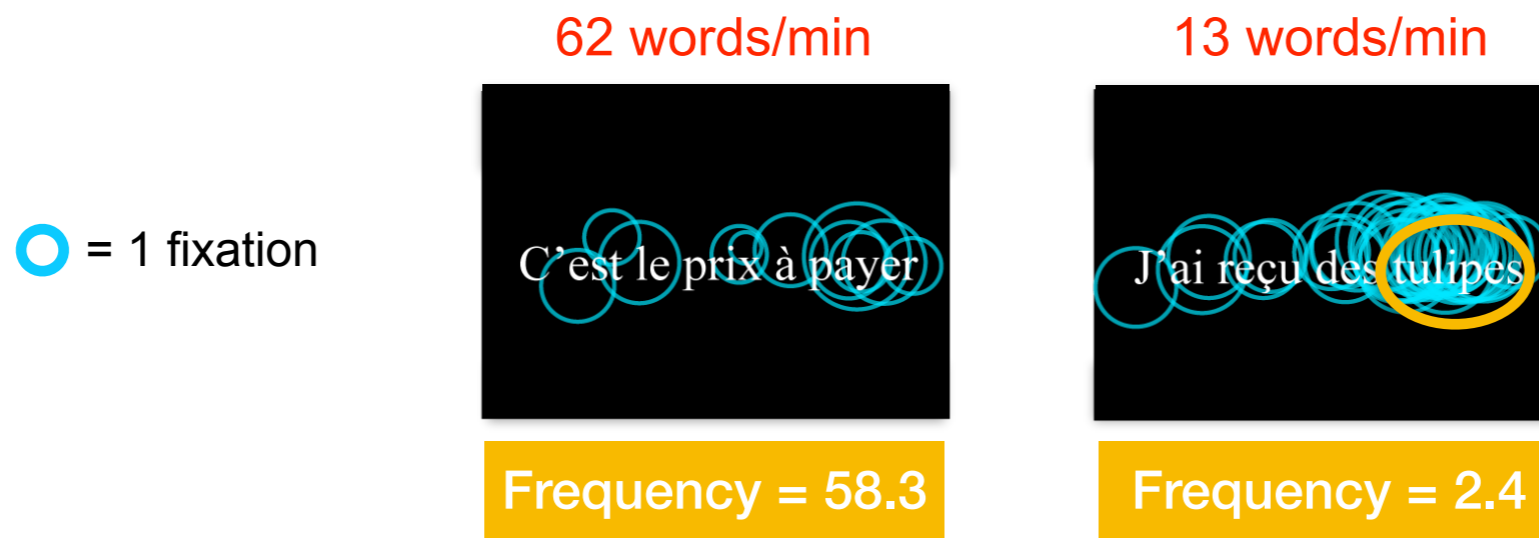
Sentence specific factors:

- 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
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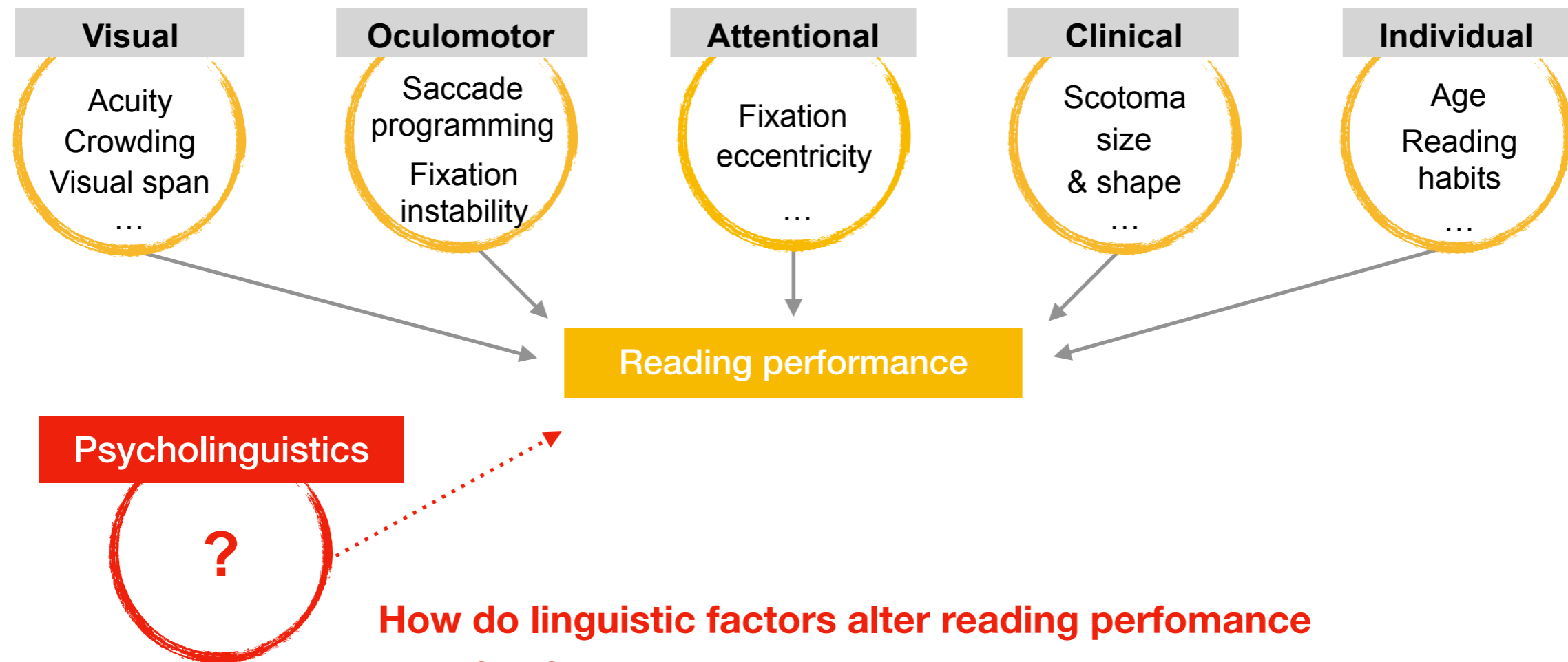
Sentence specific factors:

- 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

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.

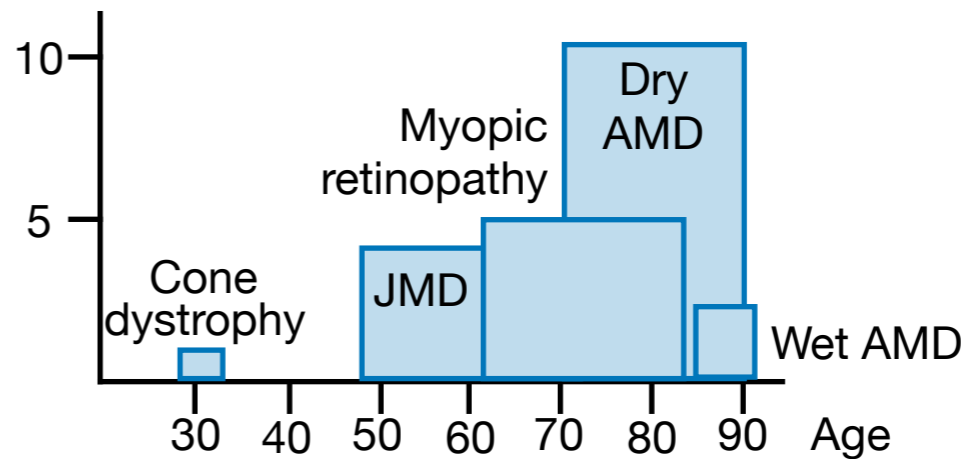
Effect of word frequency when reading with CFL

STUDY 2

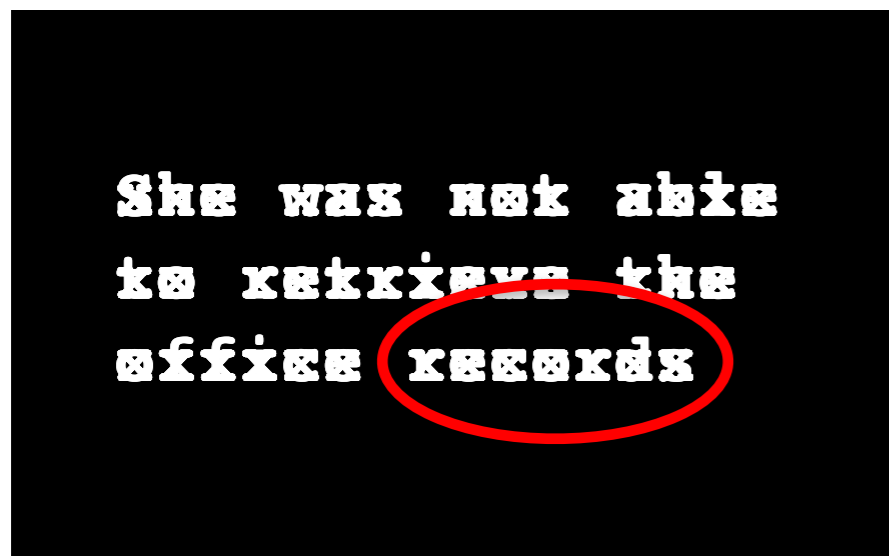
Stolowy, N.*, Calabrèse, A.*, Sauvan, L., Aguilar, C., François, T., Gala, N., et al. (2019) The Influence of Word Frequency on Word Reading Speed when Individuals with Macular Diseases Read Text. *Vision Research*, 155, 1-10 *joint first authors

Methods - participants

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



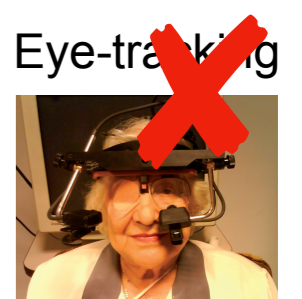
Methods - reading paradigm



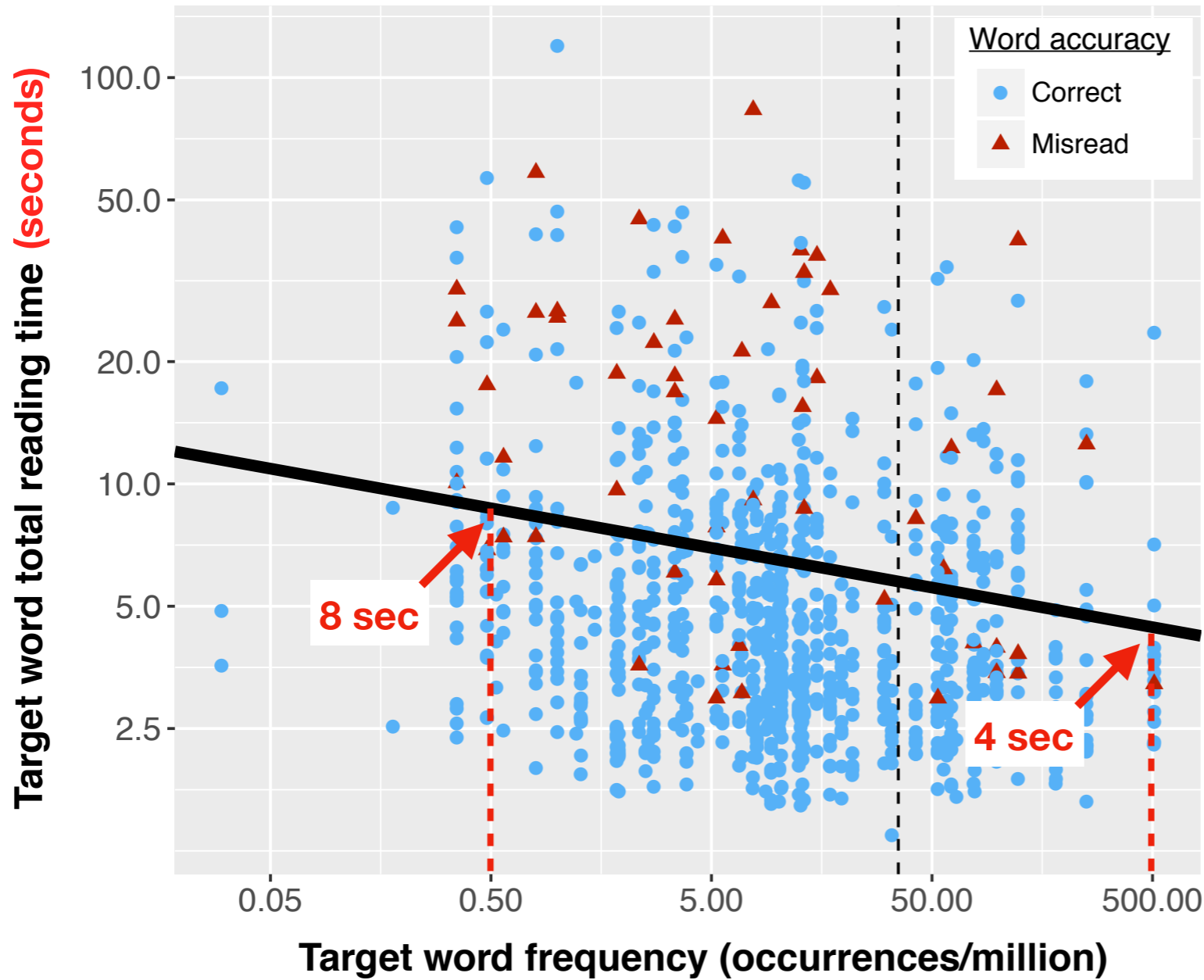
Self-paced reading



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.

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

Effect of word neighborhood size when reading with CFL

STUDY 3

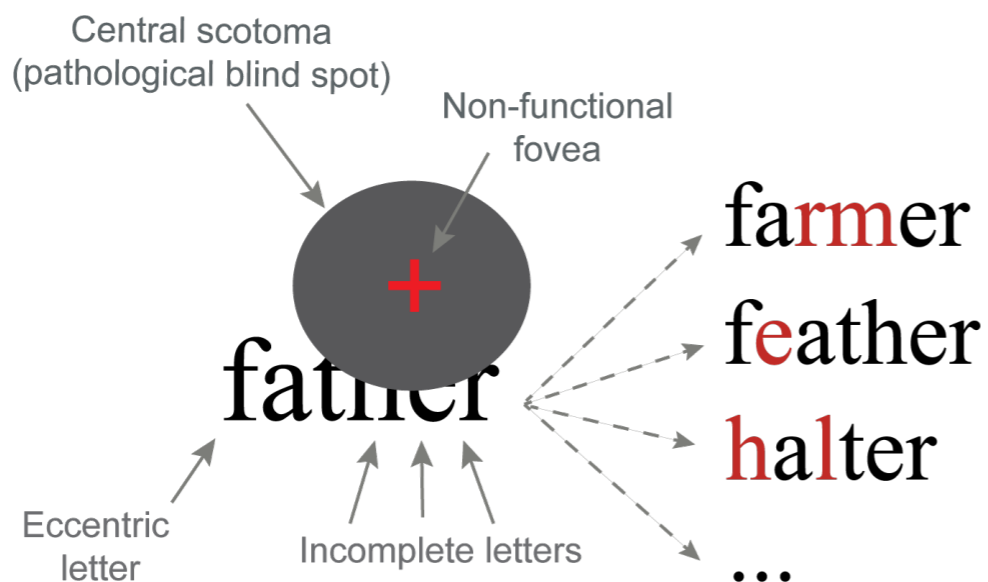
Sauvan, L., Stolowy, N., Aguilar, C., François, T., Gala, N., Matonti, F., et al. (2020) The inhibitory effect of word neighborhood size when reading with central field loss is modulated by word predictability and reading proficiency. *Scientific Reports*, 10, 21792.

Word neighborhood size - definition

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



Hypotheses



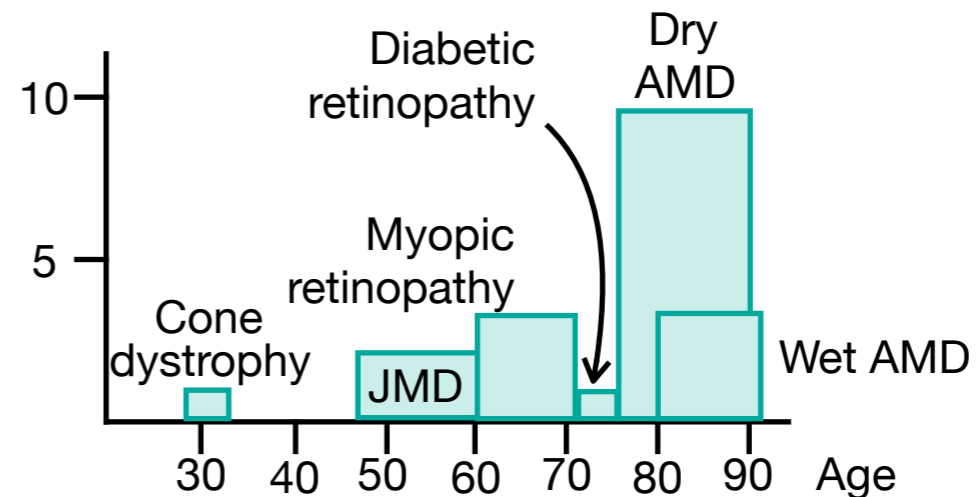
Hyp. 1
Negative effect on reading speed

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

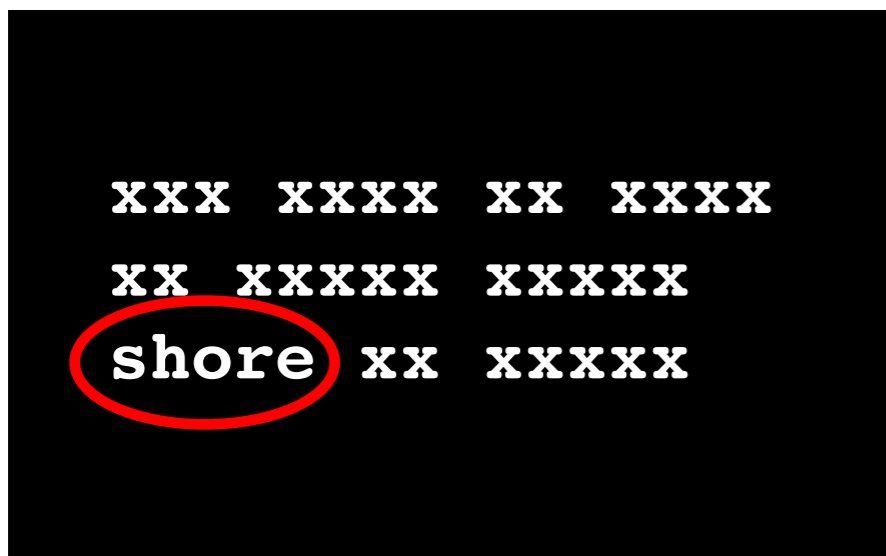
Hyp. 3
The interaction depends on reading proficiency

Methods - *participants*

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



Methods - *reading paradigm*



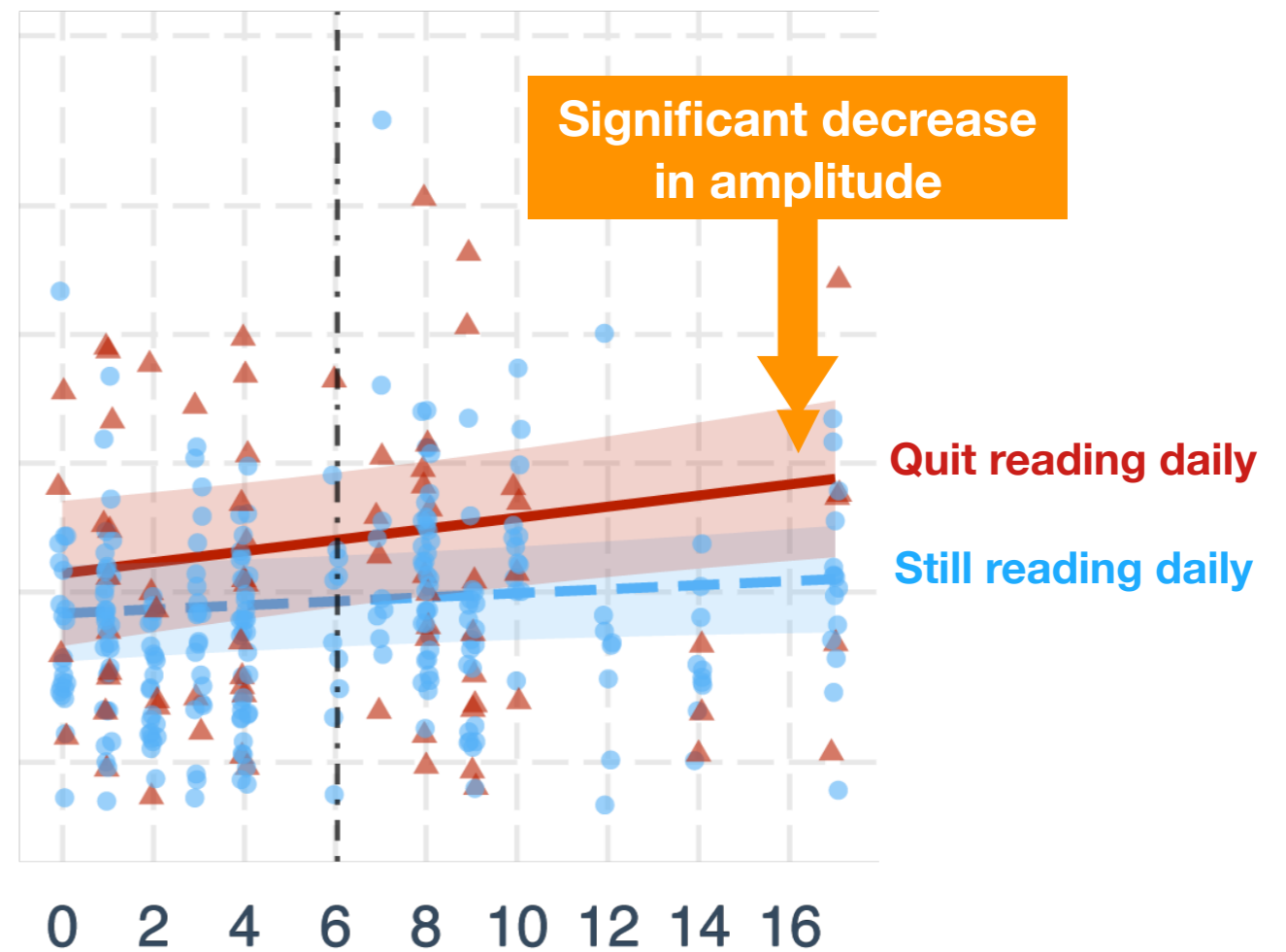
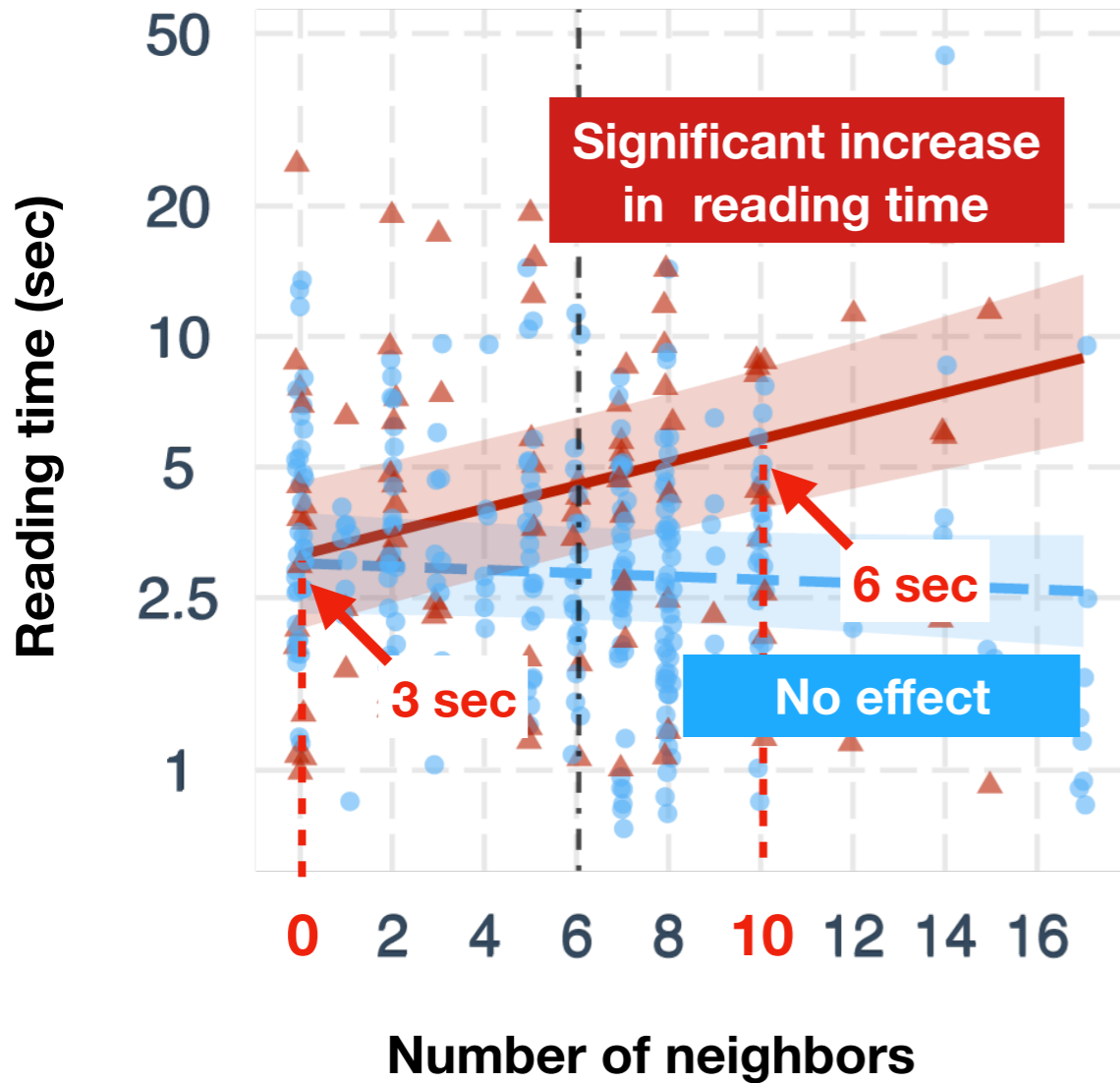
Self-paced reading

→ 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



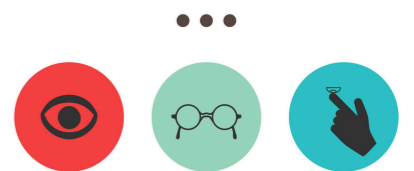
T. François



L. Sauvan



Assistance Publique
Hôpitaux de Marseille



AMD/Low Vision
Awareness
Month

• February •

Thank you