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► **To cite this version:**

Stéphanie Bellocchi, Delphine Massendari, Jonathan Grainger, Stéphanie Ducrot. Investigating the impact of inter-letter spacing on saccade computation in developmental dyslexia. International Workshop on Reading and Developmental Dyslexia, May 2016, Bilbao, Spain. hal-01462174

HAL Id: hal-01462174

<https://hal.science/hal-01462174v1>

Submitted on 1 Feb 2022

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Investigating the impact of inter-letter spacing on saccade computation in developmental dyslexia

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Supported by Brain and Language Research Institute, LABEX, Aix Marseille Université

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Introduction

A small increase in inter-letter spacing improves legibility of texts, especially for individuals with dyslexia (e.g. Perea et al., 2012; Zorzi et al., 2012).

Possible sources of this improvement are:

- ✓ reduced crowding;
- ✓ reduced perceptual uncertainty on a letter's position within a word (Tydgat & Grainger, 2009).

The main purpose of this study was to determine whether this improvement might also be linked to greater inter-letter spacing leading to more precise saccade computation (Experiment 1).

Experiment 1

Method

Participants

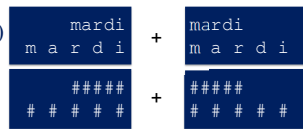
24 dyslexic children (D) (CA: mean=125.29; SD=7.80 months; RA: mean=90.29; SD=5.53 months)

28 unimpaired reading-level controls (RL) (CA: mean=86.82 ; SD=6.7 months; RA: mean= 87.64; SD= 7.33 months)

15 unimpaired chronological-age controls (CA) (CA: m=122.27; SD=3.77 months; RA: m=116.07; SD=18.38 months)

Materials: 96 stimuli (5 or 6 characters)

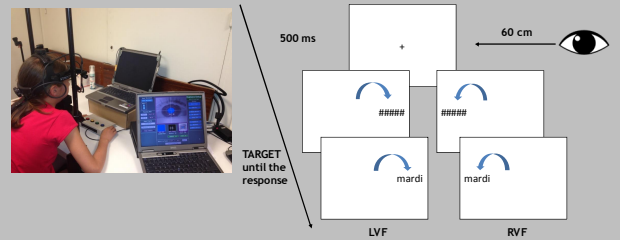
- ✓ Type of stimulus: strings of hashes (48) or words (48); non-proportional font (courier new)
- ✓ Visual field (VF): left or right
- ✓ Spacing: spaced or non-spaced



General method

EYE TRACKING SYSTEM: mobile infrared head mounted eye tracker (EYELINK II, SR Research Ltd.)

OCULOMOTOR BISECTION TASK: participants were asked to move their eyes as quickly as possible to a position they thought to be the middle of the stimulus and to validate this position by pressing a button.



Discussion

Main results showed that:

1. In non-spaced condition : weaker left/right asymmetrical landing position pattern for beginning readers and dyslexics than for expert readers (Bellocchi et al., 2013; Ducrot et al., 2013).
 2. Extra inter-letter spacing modulates saccade computation :
 - ✓ It makes initial landing positions closer to the beginning of the stimulus (e.g. Perea et al., 2012).
 - ✓ It leads to a reduced left/right asymmetry in landing-position distributions, in particular for RL children.
 - ✓ It increases saccade latencies. [This effect could be explained by the fact that spaced condition is characterized by lower luminance than non-spaced condition. In that condition, dyslexics are less sensitive (see Ahmadi et al., 2015)] .
 - ✓ It increases initial fixation durations. There was a consistent relationship between the initial-fixation location and the initial-fixation duration for all children, with initial- fixation durations being the shortest for initial fixations far from the PVL (preferred viewing location) of the word (like an inverted-OVP effect). This effect was modulated by VF only in the non-spaced condition, thus suggesting more difficulties to target the PVL in the spaced condition.
- To sum up, for all groups, extra spacing seems to lead to less accurate saccade computation.

However, increased inter-letter spacing increases eccentricity which is known to affect saccade programming (Hautala & Loberg, 2015). A second experiment was run to disentangle the role of inter-letter spacing and spatial width.

Experiment 2

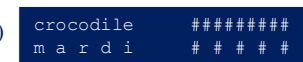
Method

Participants

23 unimpaired chronological-age controls (CA) (CA: m=129.04; SD=3.77 months; RA: m=128.70; SD=20.04 months)

Materials: 96 stimuli

- ✓ Type of stimulus: strings of hashes (48) or words (48); non-proportional font (courier new)
- ✓ Visual field (VF): left or right
- ✓ 5 spaced ch. vs 9 non-spaced ch. → same spatial width



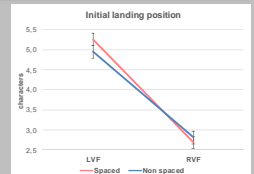
Results

INITIAL LANDING POSITION:

VF x spacing: $F(1,22)=16.09$; $p<.05$:

RVF: no diff. between 5 spaced ch. and 9 non-spaced ch.

LVF: stronger left/right asymmetry for 9 non-spaced ch.



Discussion

Saccade computation was slightly influenced by the number of characters of the stimuli, when controlling for spatial width. The initial landing position shifted to the word beginning in the LVF for the 9 characters stimuli, thus suggesting that the number of characters of the upcoming word may be used to fine-tune saccade targeting.

General conclusion

The present study showed that extra spacing impacts saccade computation and this effect remains even when spatial width is controlled. However extra spacing doesn't lead to more precise eye-movement control. On the contrary, it seems to lead to less accurate saccade computation affecting both *where* and *when* to move the eyes. Given its negative impact on eye-movement control, increased inter-letter spacing is therefore unlikely to help reading.

References

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