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# Improving reading through visual saliency: A remedial tool for neurodevelopmental disorders

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## OCULOMOTOR CONTROL IN READING

Presence of a **preferred viewing location (PVL)** as an empirical signature of reading expertise (Rayner, 1979)

- Located halfway between the beginning and the middle of the word
- ↳ reading time, refixation probability and saccade's numbers / ↗ reading accuracy

Grade 1 to Grade 3 = stabilization period of the initial fixation position towards the PVL (Ducrot et al., 2013)

## Study 1 - DD children

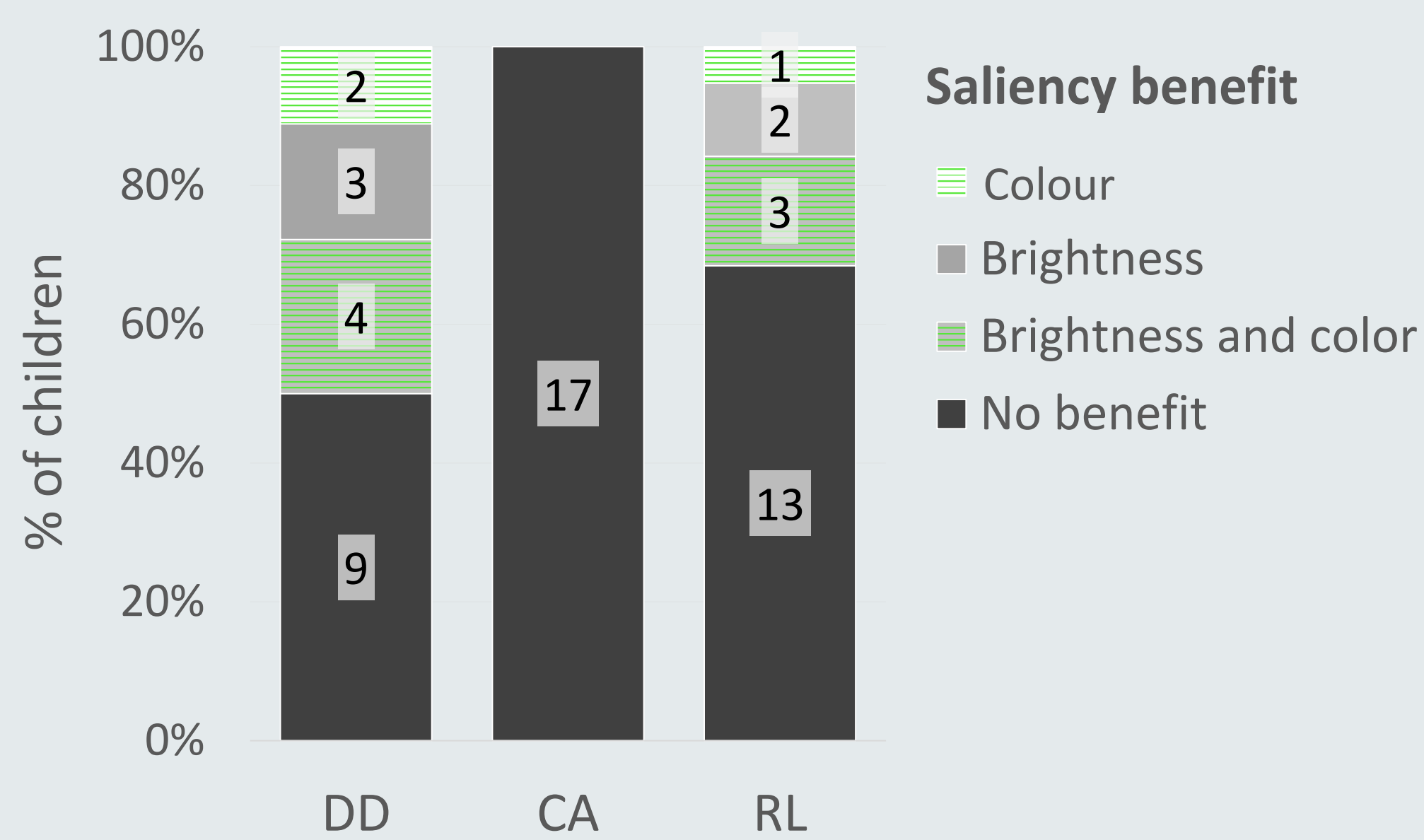
Dyslexic children demonstrate **immature or more variable initial landing positions in word** (Hawelka et al., 2010; Vernet et al., 2023)

### Participants

- Children with developmental dyslexia (DD)
- Chronological-age controls (CA)
- Reading-level controls (RL)

	DD	CA	RL
N	18	17	19
Age (in months)	136.5(10.7)	136.9(12.7)	101.9(8.4)
Sex ratio (F/M)	13/5	13/4	16/3

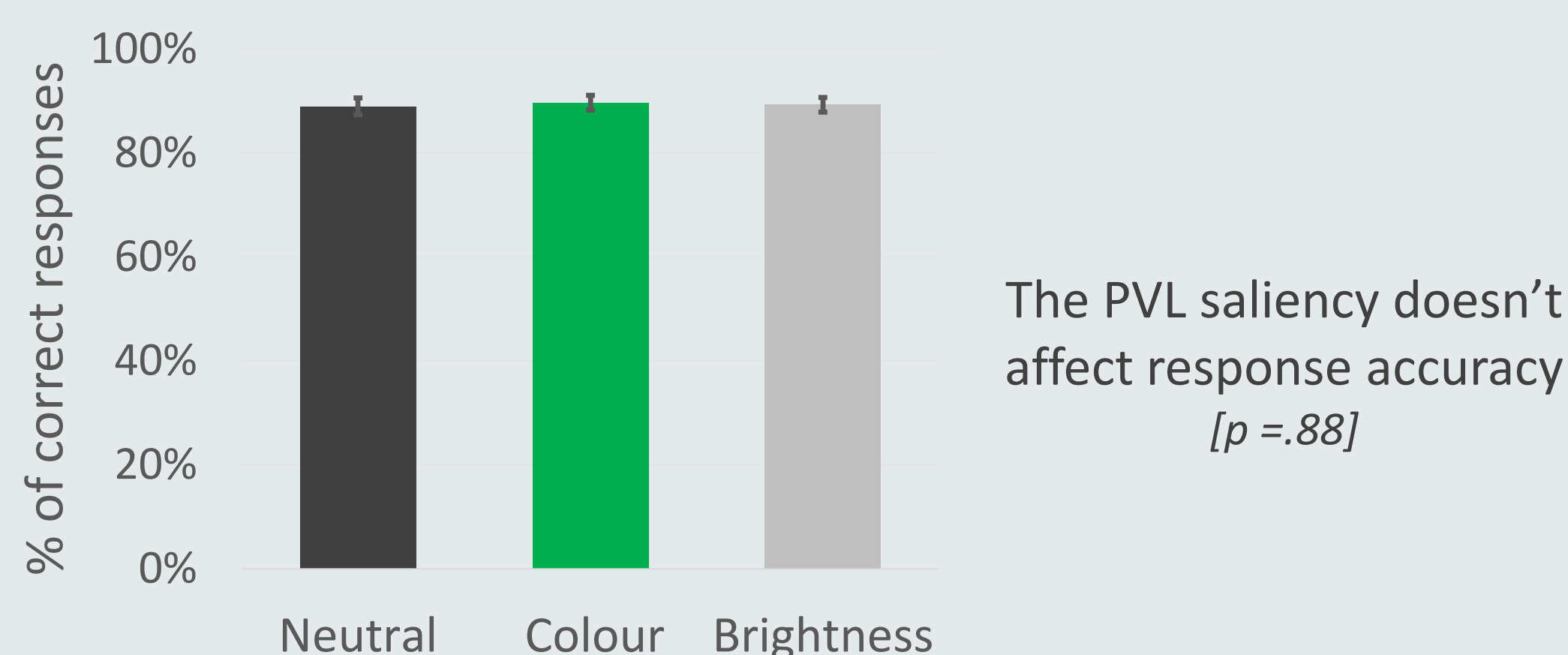
### Results



- Salient PVL : only beneficial for non-expert readers
- Both types of saliency can improve the RTs

Is the benefit in the TR reflected in the response accuracy?

ANOVA between the 3 conditions of saliency in children with benefit in their RT



The PVL saliency doesn't affect response accuracy [p = .88]

## DEVELOPING AN OCULOMOTOR READING AID

Possible improvement of saccadic computation to the PVL with training in young readers (Lehtimäki et Reilly, 2005)

Reduction of oculomotor errors with increased visual saliency of parafoveal information (Van Zoest & Donk, 2005)

**Aim: examine the usefulness of a tool enhancing the PVL saliency in reading deficits**

A brighter/coloured letter in a word could act as a salient signal for launching the saccade and optimize the location of the ILPs

Increased visual saliency (colour/brightness) of the letter at the PVL improves the eye-movement parameters' accuracy in poorer readers (see Ducrot et al., 2023, Poster 66)

## Study 2 - NF1 children

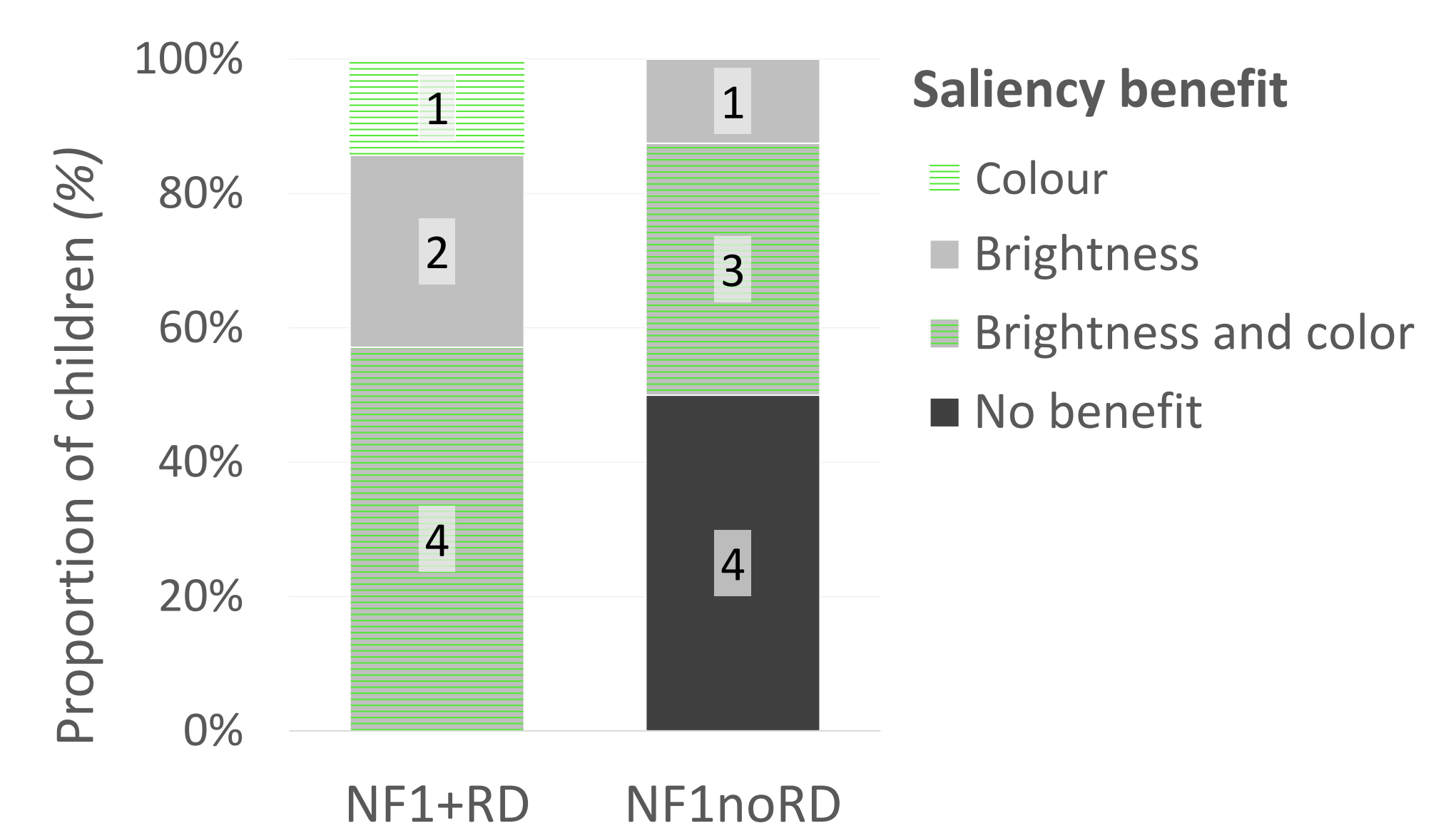
- NF1 = neurogenetic disease with a 50% risk of reading difficulties (Chaix et al., 2017)
- NF1+RD mirrored the dyslexic eye-movement behaviour (Vernet et al., 2023)

### Participants

- NF1 children with reading difficulties (NF1+RD)
- NF1 children without reading difficulties (NF1noRD)

	NF1+RD	NF1noRD
N	7	8
Age (in months)	94.0(6.4)	94.0(9.1)
Sex ratio (F/M)	1/6	5/3

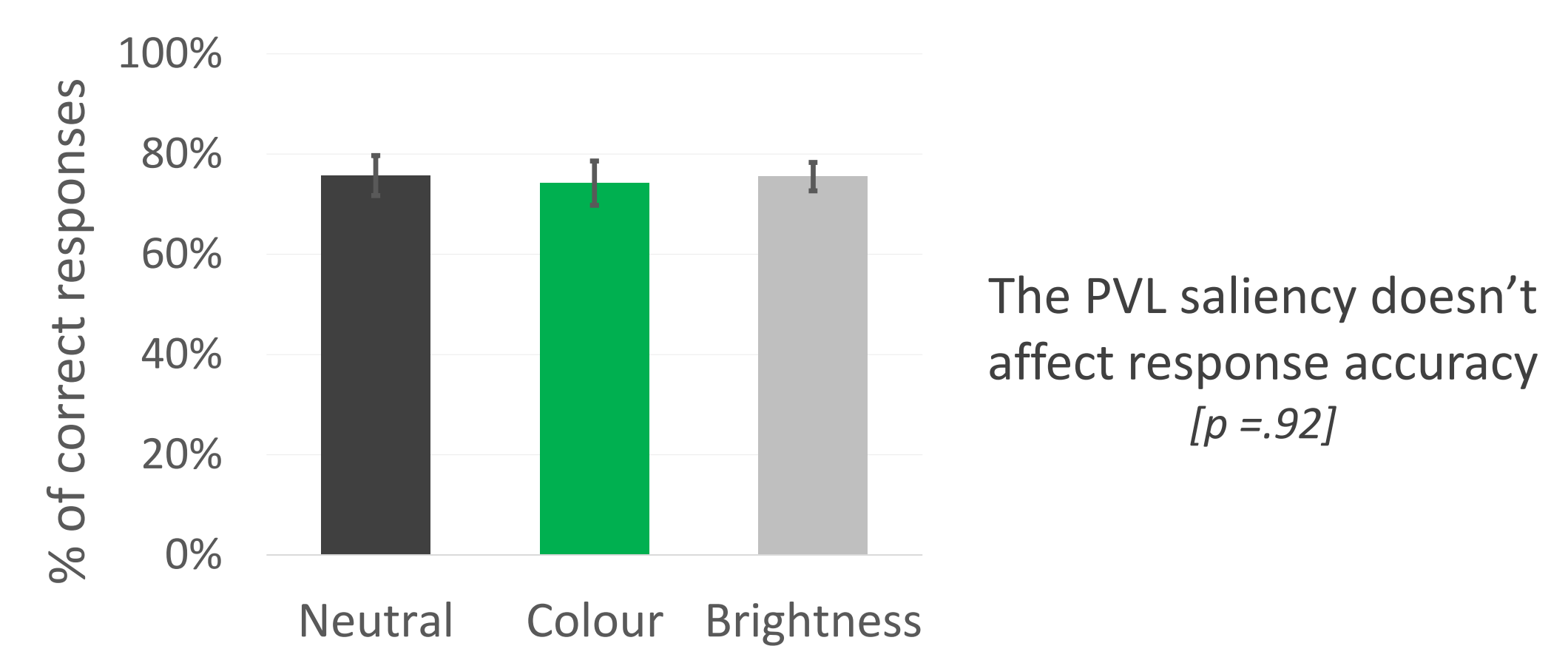
### Results



- Salient PVL : beneficial for all NF1+RD and half of the NF1noRD
- Both types of saliency can improve the RTs

Is the benefit in the TR reflected in the response accuracy?

ANOVA between the 3 conditions of saliency in children with benefit in their RT



The PVL saliency doesn't affect response accuracy [p = .92]

### Common procedure



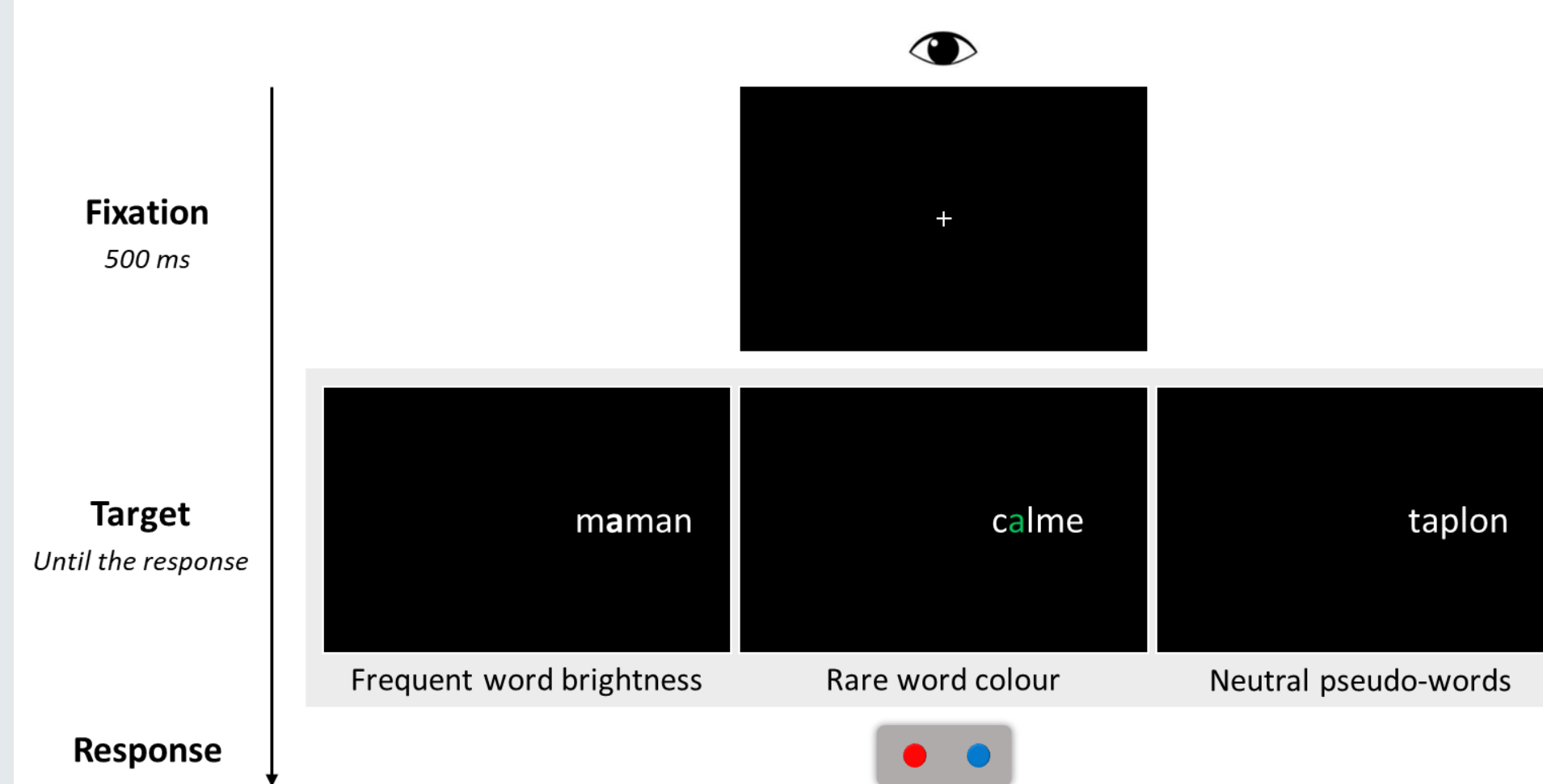
\* Words extracted from the Manulex lexical database; Lété et al. (2004)

### Stimuli

Divided into 3 lists according to the PVL saliency:

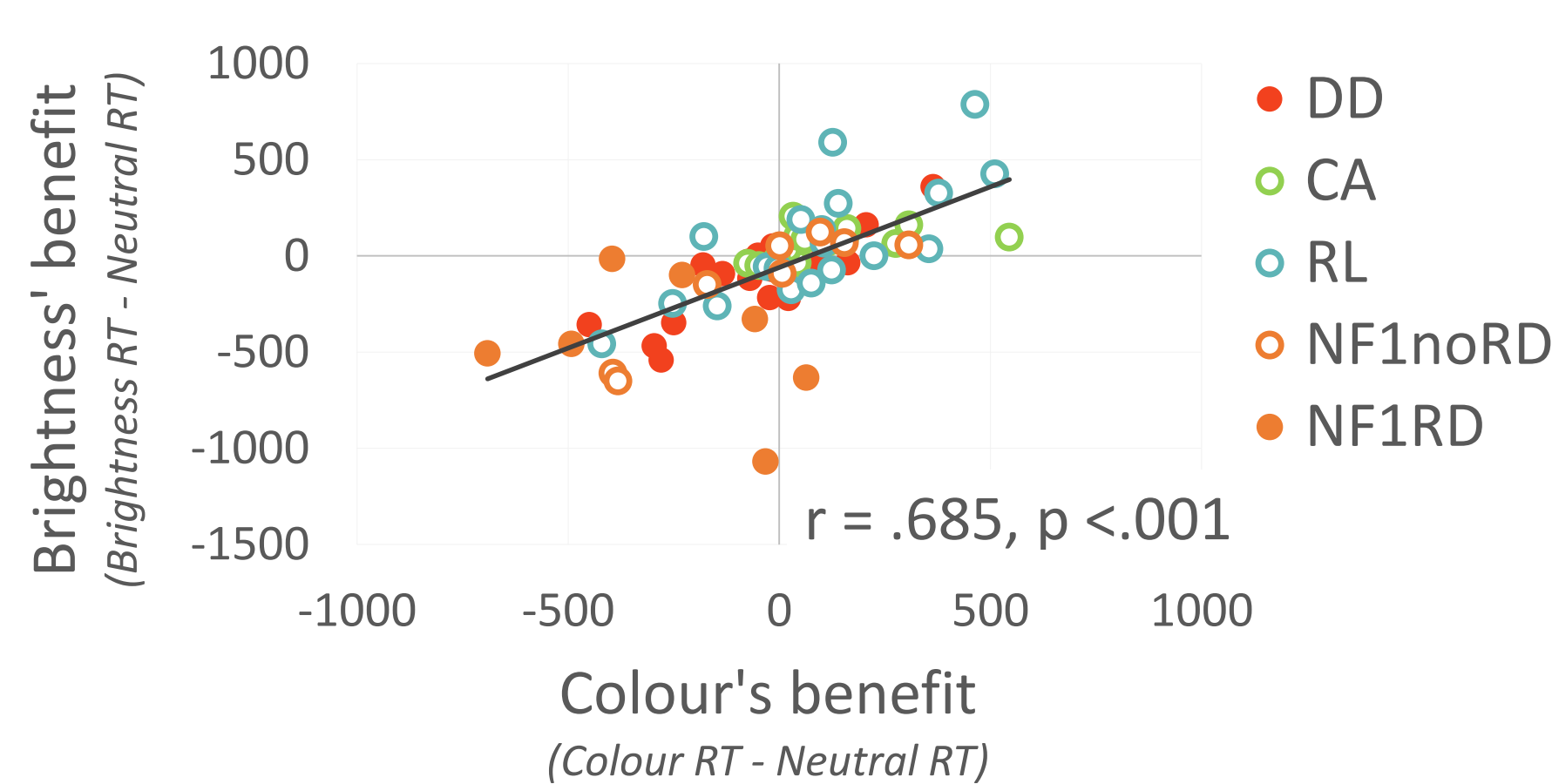
- Colour
- Brightness
- Neutral

### Lateralized lexical decision task



- Response time (RT)
- Saliency benefit (from 100 ms of gain compared to the neutral condition)
- % of correct responses

### Common result



The more a child benefits from the brightness of the PVL letter, the more he/she also benefits from the colour.

## Discussion

### PROCESS INVOLVED

Improved RTs but not % of correct responses

No impact on the encoding of the lexicon, but rather on its speed of access by optimizing the fixation location (see Ducrot et al., 2023, Poster 66)

### USEFULNESS IN READING DEFICIT

Performance improvement for young readers and children with reading deficit

→ this manipulation can encourage the systematic use of the lexical route for non-expert readers

### NATURE OF THE SALIENCY

Involve different visual pathways:

- colour = parvocellular
- brightness = magnocellular

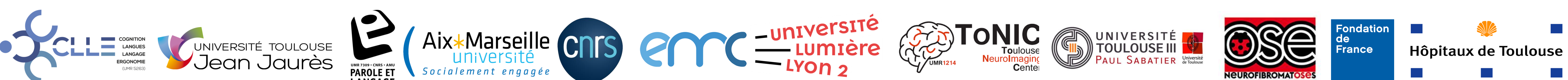
However, there is no specific impact of any of the saliency conditions

### SENSITIVITY DIFFERENCES

2 hypothesis

- Colour: too intense, can break the structure of the word and disturb some readers
- Different visual pathways impaired in the same disease (for NF1, see Robeiro et al., 2012)?

New approach to the remediation of reading deficits, with an adapted saliency to what works best for each child



Chaix, Y., Lion-François, L., Kemlin, I., Faure-Marie, N., Castelnaud, P., Barbarot, S., ... Schweitzer, E. (2017). Deficit in phonological processes: a characteristic of the neuropsychological profile of children with NF1. *Child Neuropsychology*, 24(4), 558–574. Ducrot, S., Pynte, J., Ghio, A., & Lété, B. (2013). Visual and linguistic determinants of the eyes' initial fixation position in reading development. *Acta Psychologica*, 142, 287–298. Hawelka, S., Gagl, B., & Wimmer, H. (2010). A dual-route perspective on eye movements of dyslexic readers. *Cognition*, 115(3), 367–379. Lehtimäki, T. M., & Reilly, R. G. (2005). Improving eye movement control in young readers. *Artificial Intelligence Review*, 24(3–4), 477–488. Lété, B., Sprenger-Charolles, L., & Colé, P. (2004). Manulex: A grade-level lexical database from French elementary-school readers. *Behavior Research Methods, Instruments & Computers*, 36, 156–166. Rayner, K. (1979). Eye guidance in reading: fixation locations within words. *Perception*, 8, 21–30. Ribeiro, M. J., Violante, I. R., Ribeiro, I., Bernardino, I., Ramos, F., Saraiva, J., ... Castelo-Branco, M. (2012). Abnormal achromatic and chromatic contrast sensitivity in neurofibromatosis type 1. *Investigative Ophthalmology and Visual Science*, 53(1), 287–293. Van Zoest, W., & Donk, M. (2005). The effects of saliency on saccadic target selection. *Visual Cognition*, 12(2), 353–375. Vernet, M., Bellocchi, S., Danna, J., Massendari, D., Jover, M., Chaix, Y., & Ducrot, S. (2023). The determinants of saccade targeting strategy in neurodevelopmental disorders: The influence of suboptimal reading experience. *Vision Research*, 204, 1–14.