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An Investigation of Eye Movement Dysfunctions in Children with Neurofibromatosis type 1

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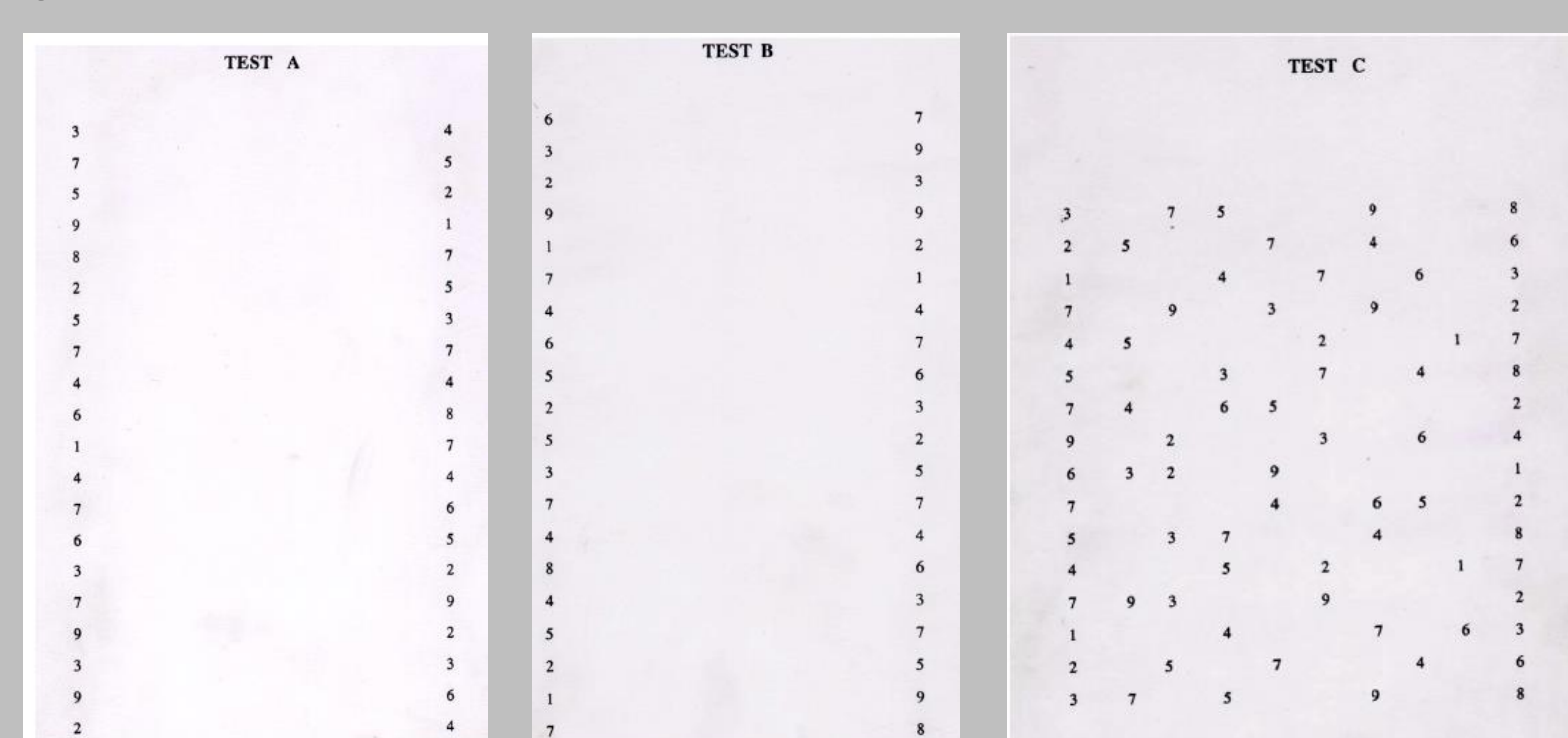
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Background

Today's estimates indicate that 30-60% of Neurofibromatosis type 1 (NF1) children suffer from learning disorder, including reading disabilities, secondary to language and/or visuospatial deficits (Chaix et al., 2017) with a profound impact on their academic achievement (Krab et al., 2008). Some studies suggest a delay in the maturation of low-level vision processes in children with NF1 (e.g. saccadic system, Lasker et al., 2003; magnocellular processing, Ribeiro et al., 2012). The findings from typically developing readers suggest a strong relationship between reading ability and visual processing (Leibnitz, et al., 2017). The main goal of this study was to investigate the occurrence of perceptual, visuo-attentional and oculomotor deficits in NF1 children and their potential to explain reading behavior and reading problems in this population.

Method

Forty-two children with NF1 ($9,8 \pm 1,5$ years, 26 girls) and forty-two control children (TD, $10 \pm 1,1$ years, 20 girls) participated in the study. Parents and children gave their informed consent prior to the experiment, approved by the local ethics committee. Reading and visual processing skills were respectively evaluated with the Alouette test (Lefavrais, 2005) and the DEM test (Garzia et al., 1990). We also recorded eye movements while a subgroup of 17 NF1 children ($9;8 \pm 1;4$ years, 10 girls) and 21 control children ($9;4 \pm 0;9$ years, 10 girls) performed an oculomotor lateralized bisection task on words, strings of hash marks and solid lines.



DEM test : digit reading tasks

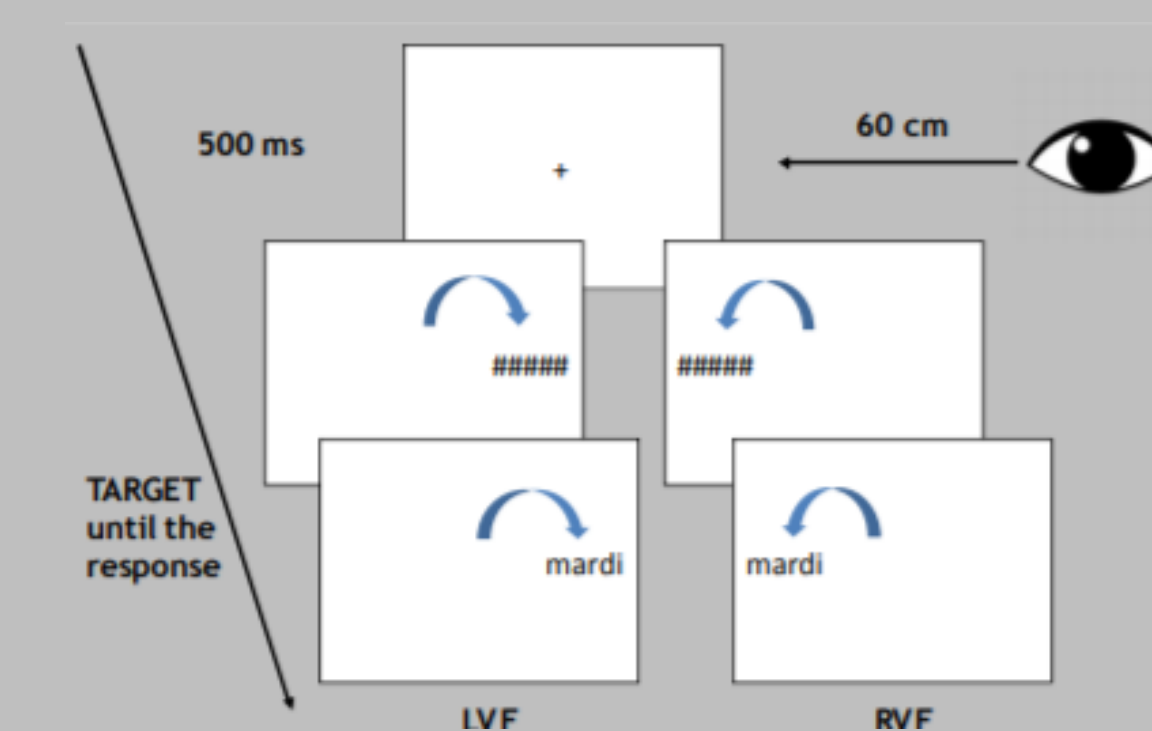
BEHAVIOUR TYPE	VERTICAL TIME	HORIZONTAL TIME	RATIO
Type 1	Normal	Normal	Normal
Type 2	Normal	High	High
Type 3	High	High	Normal
Type 4	High	High	High

BEHAVIOUR TYPE	CHARACTERISTICS
Type 1	Normal automaticity and oculomotor skills
Type 2	Oculomotor dysfunction
Type 3	Deficiencies in automaticity/number calling skills
Type 4	Deficiencies in automaticity and oculomotor skills

DEM test : type of oculomotor behavior

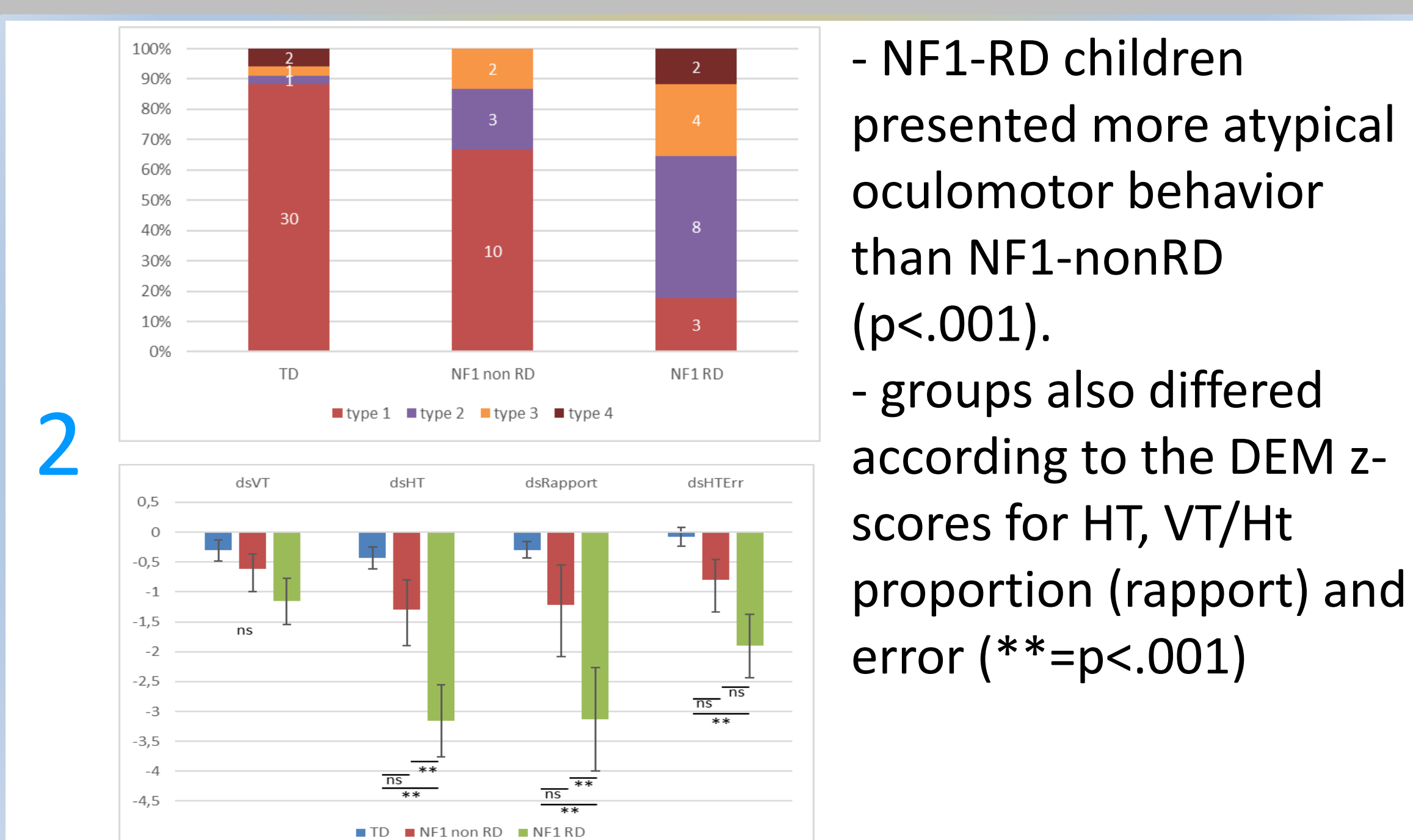
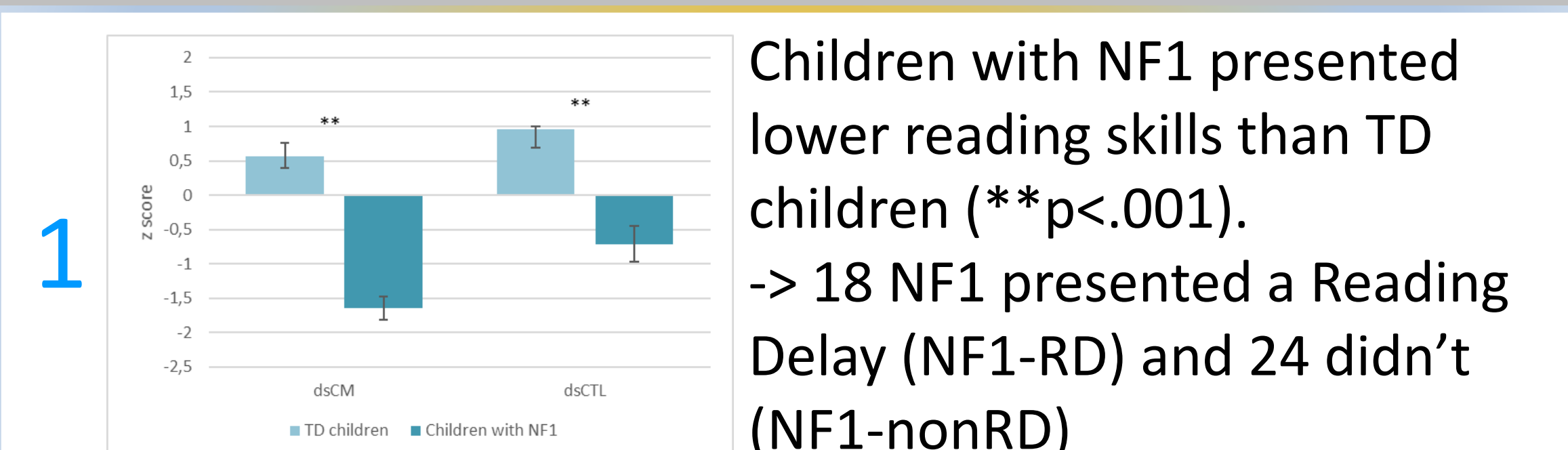


Mobile infrared head mounted eye tracker (EYELINK II, SR Research Ltd).

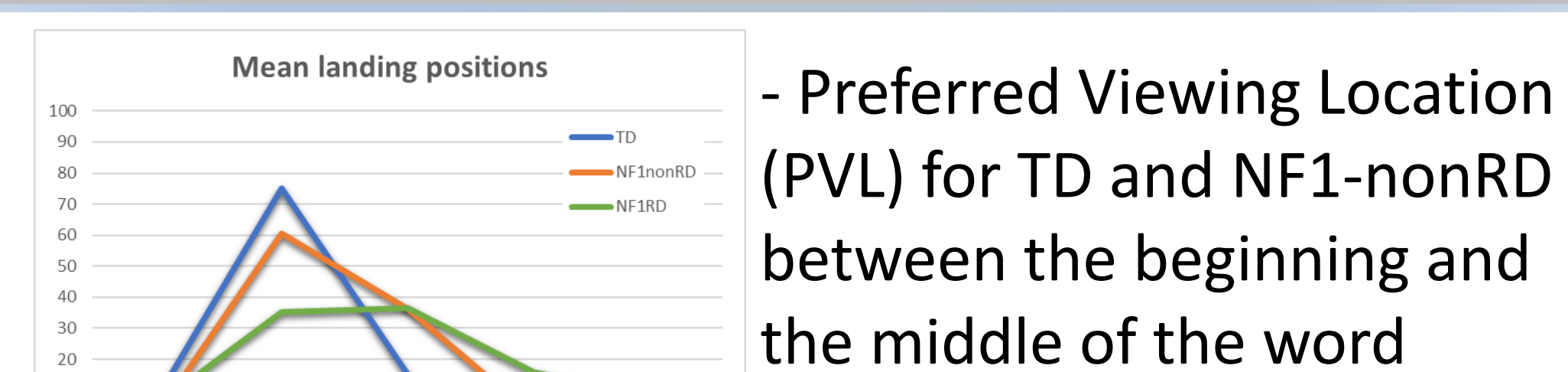


Oculomotor bisection task : participants were asked to move their eyes as quickly as possible to a position they thought to be the middle of the stimulus and to validate this position by pressing a button

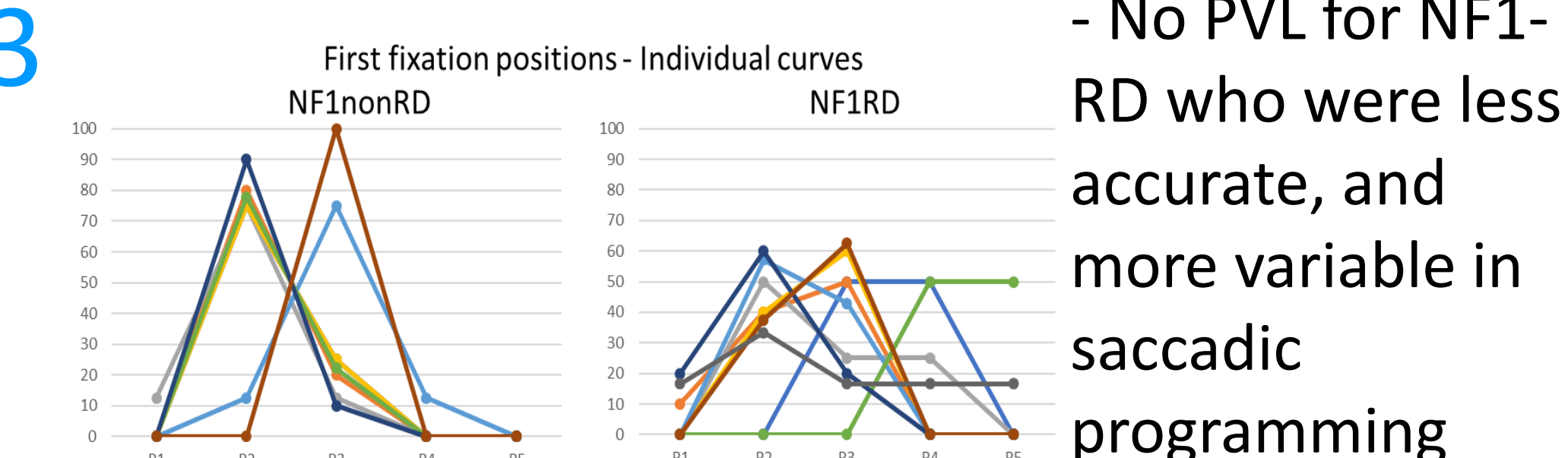
Results



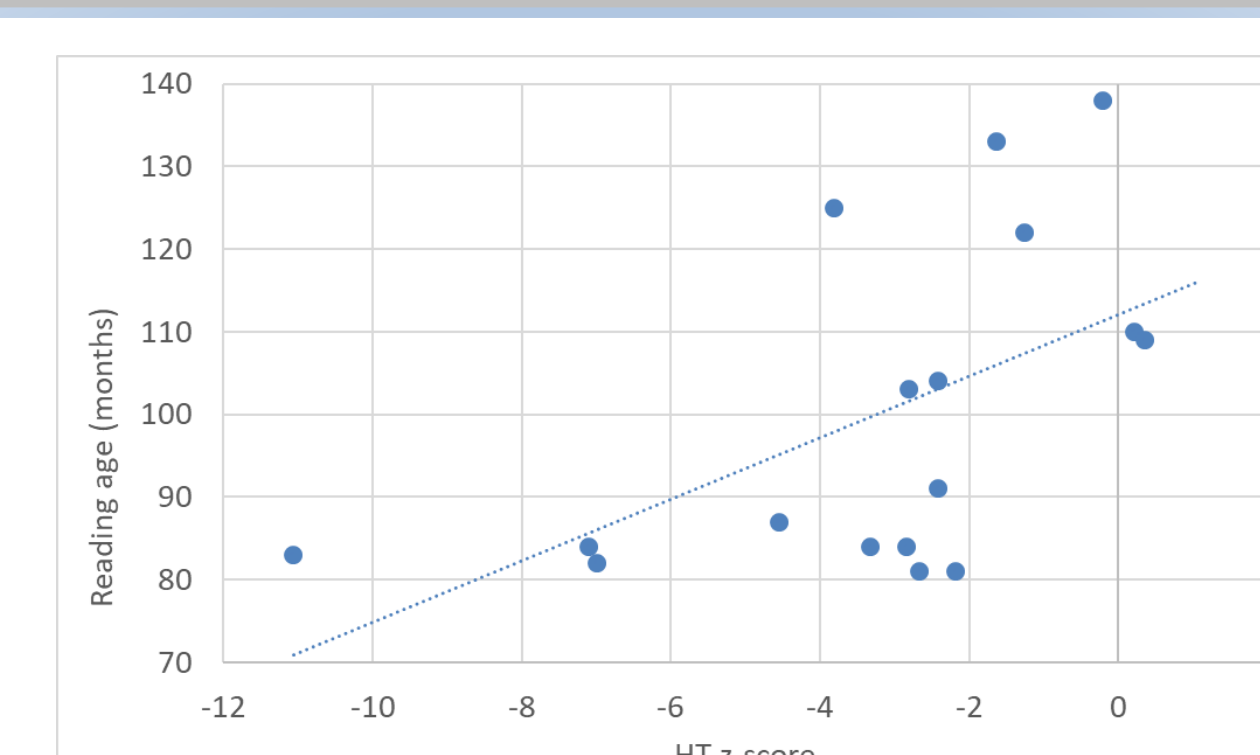
5 No significant correlations were found between DEM parameters and the density of landing positions ($r = -0.368$ and $r = -0.011$, for VT/density in P2-P3 and HT/density in P2-P3)



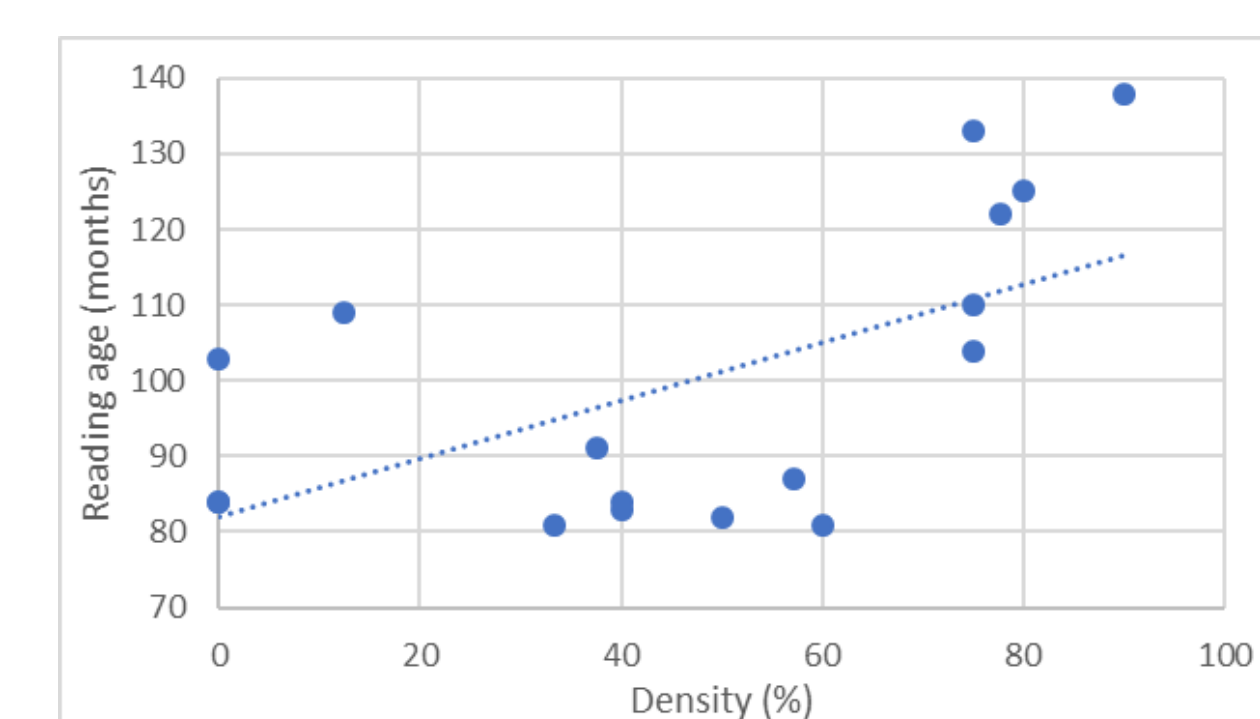
- No PVL for NF1-RD who were less accurate, and more variable in saccadic programming



-> NF1-RD displayed poor results in visual attention and generation of saccadic processing (e.g., less accurate, more variability, no sensibility to the discreteness of the stimuli).



4 A link between reading age and performance in both tasks : DEM test ($r = .55$, $p < .05$) and ocular bisection task ($r = .59$, $p < .05$) was evidenced in NF1 children.



Conclusions

DEM test (especially the HT) can be used clinically to distinguish NF1 with RD from NF1 without RD. Analysis of eye movement patterns represents a potential way to identify differences in the cognitive processing and visuo-attentional mechanisms underlying reading in NF1 children before the occurrence of school failure. Both language and visual aspects of reading should be targeted in intervention programs.