VISUOSPATIAL ATTENTION AND READING PERFORMANCE

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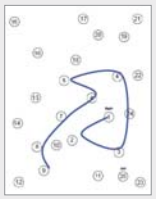
Although reading is a uniquely human cognitive activity involving a number of distinct visual responses during which a series of short eye movements – saccades – are performed, approximately 10% of children will experience reading difficulties.

This study explores visuospatial attention in children and its role in reading processes. Empirical data reveals visuospatial attention (TMT test), reading speed, and oculomotor mechanisms (DEM test) in 2671 children (aged 7-18 years).

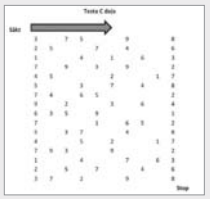
Children who had been identified as having learning difficulties often exhibited results below 1SD, including visuospatial attention below 1 SD in 12% of such children; reading speed below 1 SD in 48%, and eye movements below 1 SD in 29%. Only children who had been diagnosed with learning difficulties comprised the entirety of the 4% of the study participants who exhibited results below 1 SD for all three testing measures: visuospatial attention, reading speed, and eye movements. Good readers had significantly better results in visuospatial attention and eye saccades.

The average z-score in reading speed in poor readers with sub par TMT results was significantly worse (z=-1,74; p=0.05) than in poor readers with good TMT results.

We conclude that there are similar cognitive mechanisms involved in visuospatial attention, reading and oculomotor processes, because poor readers also display poor results in attention and generation of saccadic processing. A plausible interpretation of the results of this study indicates a crucial and necessary developmental relationship between visual attention and reading processes.

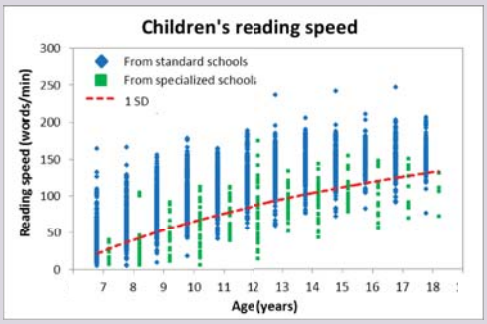


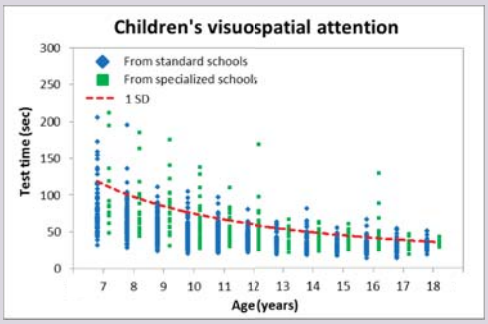
TMT test

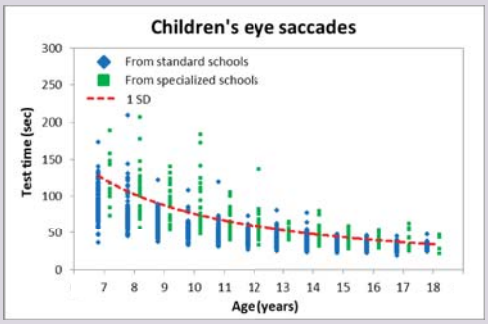


DEM test

General overview: reading speed, attention, and saccades





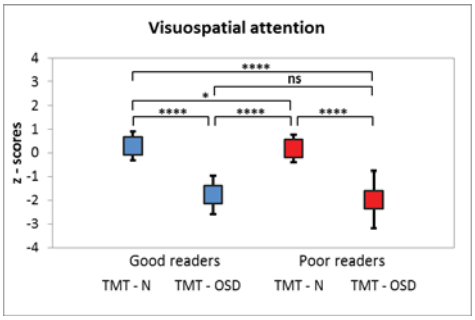


INTRODUCTION

Although reading is a uniquely human cognitive ability, approximately 10% of children will experience reading difficulties. Reading is a complex cognitive activity involving a number of distinct visual responses, during which a series of short eye movements – saccades – are performed. The main function of saccades is to bring a new region of the text into the center of one's vision. Many studies suggest **that visuospatial attention might play a causal role in the generation of saccades** (Hoffman & Subramaniam, 1995; Inhoff, Pollatsek, Posner, & Rayner, 1989). Other studies have also indicated that the ability to perform a visual search task is weaker in poor readers and in dyslexics (Facoetti, Paganoni, Turatto, Marzola, & Mascetti, 2000). Facoetti, Corradi, Ruffino, Gori, & Zorzi (2010) and Vidyasagar & Pammer (2010) have presented studies supporting the thesis that a deficiency in visuospatial attention may be closely linked to dyslexia. The present study focuses on visuospatial attention in school-aged children with both stronger and weaker reading abilities.

METHODS

Our study participants included 2671 school-aged children. We evaluated the study participants' levels of visuospatial attention with a paper-based trail making test (TMT), their abilities to produce saccades with the eye developmental test (DEM) and their reading speeds with a modified text (average word length – 5 letters). While we evaluated the reading speed of all of the study participants, it was not possible to have all of the children participate in the TMT and DEM testing. Therefore, all of the study participants' results were divided into two categories and analyzed separately. The first group of results was comprised of the data of 2393 children from typical (non-special education) schools and 278 children who had been identified as having learning difficulties and were attending schools within the special educational system. The second group of results was comprised of the data of 2257 strong readers and 414 weak readers (by identified those study participants with results either above or below 1SD).



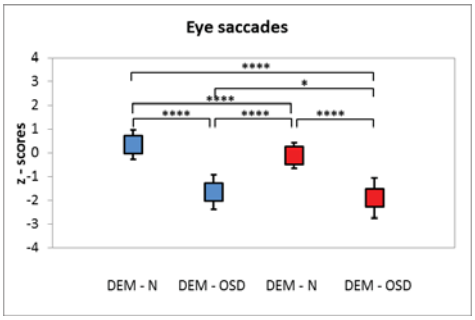
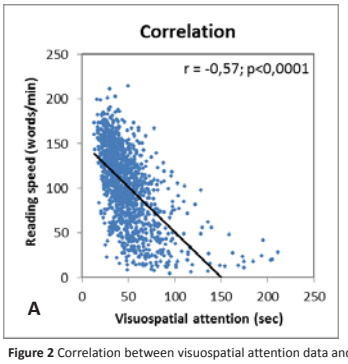


Figure 1 Visuospatial attention data analysis and saccade levels in strong and weak readers. All children were divided into two groups according to reading speed. N (results falling within one standard deviation; OSD (results falling outside of one standard deviation – on the lower end). Each group's average z-score and standard deviation are displayed.



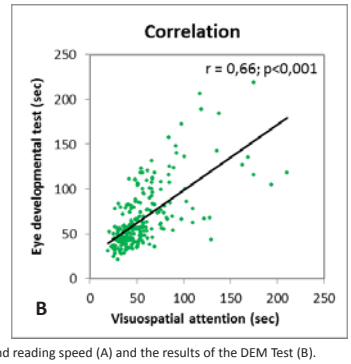


Figure 2 Correlation between visuospatial attention data and reading speed (A) and the results of the DEM Test (B).

RESULTS

Visuospatial attention below 1 SD was exhibited by 12% of the children who were attending schools within the special education, because they had been identified as having learning difficulties, while only 2,4% of children attending typical (non-special education) schools exhibited such results. Reading speeds below 1 SD were exhibited by 48% of children with learning difficulties, in contrast to only 12% of children from typical (non-special education) schools.

DEM test results below 1 SD were displayed by 29% of the study participants with learning difficulties, and only 5,4% in the case of those study participants attending typical (non-special education) schools. Levels of visuospatial attention and saccadic processing tend to stabilize around the age of 12 or 13, which mirrors the correlation between reading speed and age (ANOVA and Tuckey's method). Next, we analyzed the visuospatial attention and eye saccades z-scores.

Strong readers had significantly better levels of visuospatial attention and eye saccades (see **Fig.1**).

The average reading speed z-score amongst weak readers with sub par TMT results was significantly worse (z=-1,74; p<0.05) than in weak readers with strong TMT results.

Only 5% of children with strong reading skills displayed visuospatial attention results below 1 SD, 7% of such children displayed eye saccade levels below 1 SD, and the 4% who exhibited results below 1 SD for all testing parameters may have dyslexia. Our data (see **Fig.2**) demonstrates the relationship between visuospatial attention and reading speed (a negative correlation exists), as well as eye movements processing (a positive correlation exists).

DISCUSSION

The study reveals weak visuospatial attention and eye saccades in children with poor reading skills. Reading at a typical level requires that each word is viewed fully to achieve the highest spatial resolution. This is usually accomplished by shifting to and focusing attention on each word for as long as necessary. It follows that the ability to orient the focus of one's visual attention, as well as the ability to control the field of one's visual attention, are cognitive processes that are assumed to be deeply involved in reading (Morris & Rayner, 1991). Casco, Tressoldi, & Dellantonio (1998) produced a study on children with the weakest performances in a visual search task and pointed out that this difference could be due to a deficiency in selective visual attention.

CONCLUSION

The present study reveals that **poor visuospatial attention correlates with poor reading ability and defective eye saccade mechanisms**. Of our study participants, only 4% of the school-aged children displayed poor results in visuospatial attention and reading processing.

A plausible interpretation of the results of this study indicates **a crucial and necessary developmental relationship between visual attention and reading processes**. Further, we might hypothesize that the development of visuospatial attention plays a causal role in the development of phonological awareness.

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