Reading difficulties as a result of weakness in stereopsis

Gunta Krumina*, Jurgis Skilters**

UNIVERSITY OF LATVIA

*Department of Optometry and Vision Science

**Department of Communication Science/ Center of Cognitive Sciences and Semantics

e-mail: Gunta.Krumina@lu.lv

Introduction

Reading is a complex process involving coordination of real time psychological systems associated with vision, oculomotor control, and linguistic processing. Stereoacuity refers to the ability of depth perception from disparate binocular images, a process that further requires coordinated binocular vision and enables efficient text scanning. Adjustment of small-scale visual stimuli is therefore a crucial component of reading (Schotter et al., 2012).

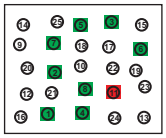
Some children with low literacy have normal intelligence and opportunity to learn and to read yet experience reading difficulties. Subtle neurological deficits may give rise to multiple correlated abnormalities affecting sensory processing and cognition (Ponsonby et al., 2013). Stereoacuity refers to the ability to assess depth from disparate binocular images, a process that requires coordinated binocular vision. Binocular vision is used for depth perception and text scanning.

Buzzelli (1991) could not found difference in stereovision between 13 children with dyslexia and 13 children from control groups using Random dot test. Mean stereoacuity did not differ significantly between the poor readers and controls using Randot stereotest (Palomo-Alvarez & Puell, 2010). Absent stereoacuity in children with ADHD was found in 4%, while 33% children were unable to perform the Titmus test (Mezer & Wygnanski-Jaffe, 2012). The prevalence of poor stereoacuity among this population-based sample of children with low literacy was estimated to be 16.8% (Ponsonby et al., 2013). Lower testability of the stereoacuity test in children with learning disabilities compared to children in mainstream classes was found to be due to communication problems and uncooperative children who refused to use the Polaroid filter (Abu Bakar & Chen, 2014).

Method

A comparative study was conducted to test reading speed, stereo acuity (using TNO (global) stereotest), and visuo-spatial attention (using TMT A and B). Participants were 2561 school children (age range from 7 to 15; 2358 children from standard schools and 203 from schools where children with learning difficulties are taught).

TNO stereotest



TMT test

Results

According to our general results children with learning difficulties indicate significantly weaker results in stereopsis perception (157±114 arc sec) in contrast to children without learning difficulties (96±85 arc sec; p<0,0001).

Differences in stereopsis (see **Fig.1**) and reading speed (see **Fig.2**) measures can be observed in all age groups. Absent of global stereopsis are more in cases of children from specialized schools (see **Fig.3**).

Decreased reading speed, measures indicating slower attentional processes and weaker stereopsis were observed in children with learning difficulties. In case of a weaker (≥ 240 arc sec) or absent stereopsis, reading speed is significantly higher (accordingly z=-0,34 and z=-0,22) than in case of good stereopsis (z=0,09; p<0,0001) (see **Fig.4**).

Also in case of a weaker or absent stereopsis, results of visual attention tests are significantly longer (accordingly z=0,07 and z=-0,09) than in case of good stereopsis (z=0,24; p<0,001 (see **Fig.5**).

Poor readers have worse results of stereopsis and visual attention (see **Fig.6**).

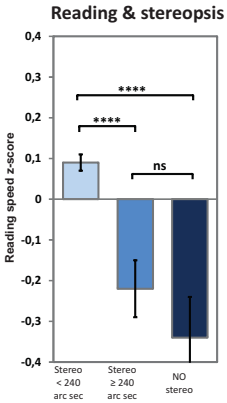


Figure 4 Reading speed in different cases of stereopsis.

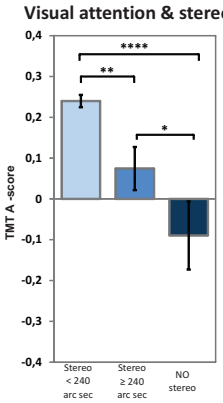


Figure 5 TMT part A data in different cases of stereopsis.

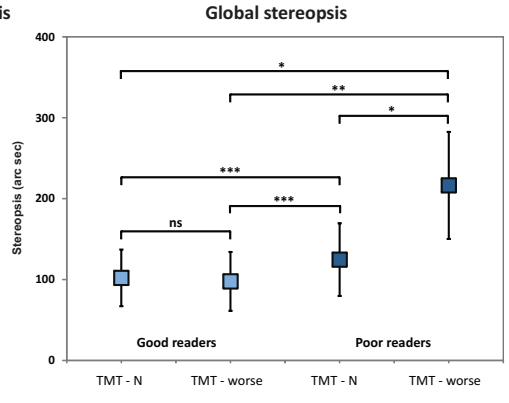


Figure 6 Poor readers have worse global stereopsis that could be the one of factor of slow reading process.

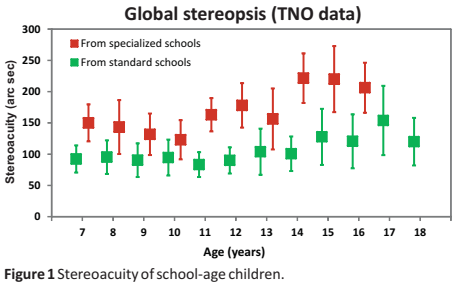


Figure 1 Stereoacuity of school-age children.

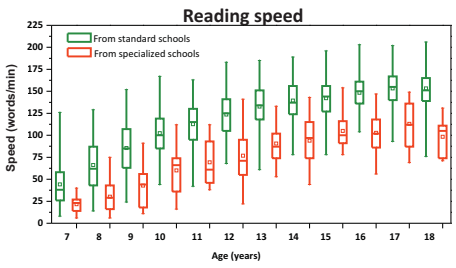


Figure 2 Reading speed of school-age children increases with the age.

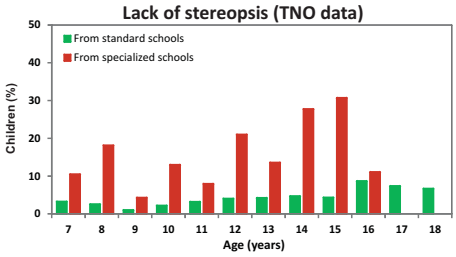


Figure 3 The absent of stereopsis is more evaluated in cases of specialized school children.

Conclusion

We conclude that weaker results in stereopsis refer to weaker development of reading skills and learning quality.

Our generalization is that stereopsis is a critical small-scale spatial factor that contributes to the quality of learning.

References

ABU BAKAR, N.F., & CHEN, A.H. (2014). Comparison on Testability of Visual Acuity, Stereo Acuity and Colour Vision tests between Children with Learning Disabilities and Children without Learning Disabilities in Government Primary Schools. Indian Journal of Ophthalmology, 62(2), 141-144.

BUZZELLI, A.R. (1991). Stereopsis, Accommodative and Vergence Facility: Do They Relate to Dyslexia? Optometry and Vision Science, 68(11), 842-846.

MEZER, E., & WYGNANSKI-JAFFE, T. (2012). Do Children and Adolescents with Attention Deficit Hyperactivity Disorder have Ocular Abnormalities? European Journal of Ophthalmology, Apr 2:0, doi: 10.5301/ejo.5000145.

PALOMO-ALVAREZ, C., & PUELL, M.C. (2010). Binocular Function in School Children with Reading Difficulties. Graefe's Archive for Clinical Ophthalmology, 248(6), 885-892.

PONSONBY, A.L., SMITH, K., WILLIAMSON, E., BRIDGE, D., CARMICHEL, A., DWYER, T., JACOBS, A., & KEEFFE, J. (2013). Poor Stereoacuity among Children with Poor Literacy: Prevalence and Associated Factors. Optometry and Vision Science, 90(1), 75-83.

SCHOTTER, E.R., BLYTHE, H.I., KIRKBY, J.A., RAYNER, K., HOLLIMAN, N.S., & LIVERSEDGE, S.P. (2012). Binocular Coordination: Reading Stereoscopic Sentences in Depth. PLoS ONE, 7(4), e35608.

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