Computerized tests for vergence performance screening at schools

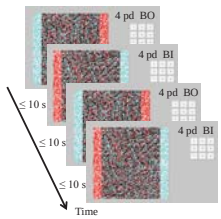
Aiga Švede, Iveta Liepa, Madara Bumbiška, Kristīne Buile, Sergejs Fomins, Gunta Krūmiņa

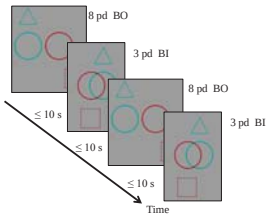
Department of Optometry and Vision Science, University of Latvia, Kengaraga Str. 8, Riga, LV-1063, Latvia

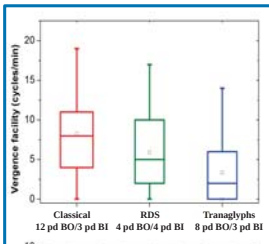
Nowadays, a proportion of a near work is increasing at schools. Therefore, it is important to understand whether complains appearing during near work could be related to visual (accommodation or binocular vision) problems. If complains are related to binocular vision problems, it would be important to assess the vergence system functions. One part of vergence assessment includes fusion reserves and vergence facility. Fusion reserves are describing vergence amplitude, but vergence facility reflects the vergence dynamics.[1] Therefore, we tested computerized tests for vergence performance evaluation, which could be useful for screening at schools, and compared them with classical methods (prism bar for fusion reserves and 12 pd BO/3 pd BI prism flipper for vergence facility) [2-6].

Vergence facility

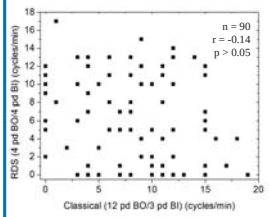
Method: Stimulus (observed through red-blue glasses) and the sequence of the stimulus presentation used in computerized tests based on random dot principle (RDS, 4 pd BO/4 pd BI, number perceived) and tranaglyphs (8 pd BO/3 pd BI, one fused circle perceived). Subjects (90 pupils, age 7-19 y.) had to give the response during 10 s or the stimulus is switched to opposite.

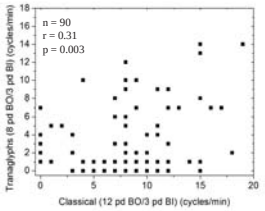


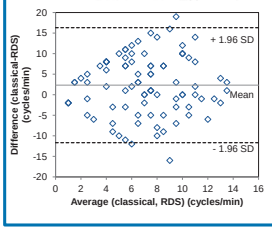


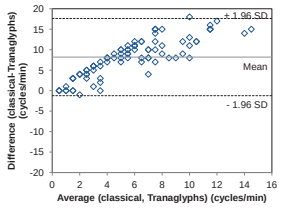


Results: the group's mean values of the classical method and both computerized tests were statistically different (t-test: $p < 0.01$). There were weak correlation between individual measurements. It was easier for subjects to perform classical method or RDS neither to fuse tranaglyphs.

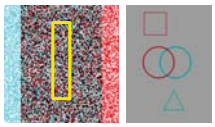




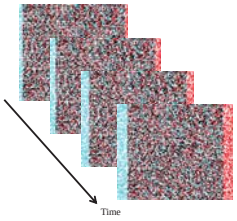


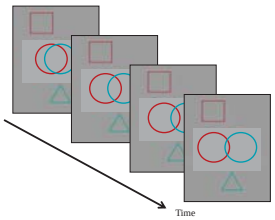


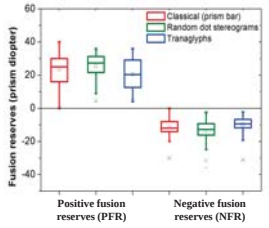
Fusion reserves



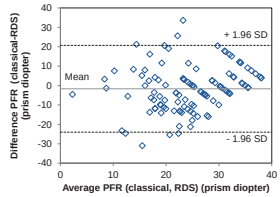
Method: Stimulus (observed through red-blue glasses) and the sequence of the stimulus presentation used in computerized tests based on random dot principle (RDS, bar perceived) and tranaglyphs (fused circle perceived). Subjects (114 pupils, age 7-19 y.) had to give the response as soon as fusion breaks. Stimulus velocity – 200 mm/min. The maximum value – 34Δ.

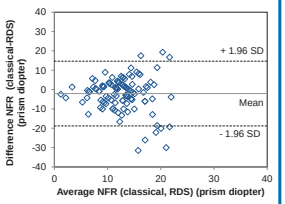


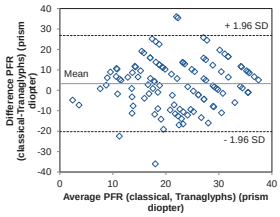


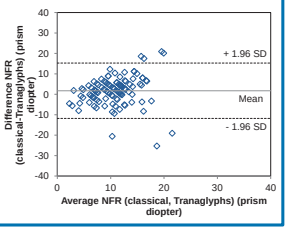


Results: the group's mean values of the classical method and both computerized tests (except PFR measured with RDS) were statistically different (t-test: $p < 0.01$). There were weak correlation between individual measurements (RDS: $r_{PFR} = 0.24$; $r_{NFR} = -0.05$; Tranaglyphs: $r_{PFR} = 0.27$; $r_{NFR} = 0.09$). It was easier for subjects to perform classical method or RDS neither to fuse tranaglyphs.









Test \ Criterion		Validity	Reliability	Yield	Cost
Vergence facility	RDS	±	+	±	+
	Tranaglyphs	-	-	±	+
Fusion reserves	RDS	±	±	±	+
	Tranaglyphs	±	-	±	+

Evaluation of screening tests and programs[7]:

- **Validity** – ability to identify those who have the condition
- **Reliability** – consistency of results of screening process
- **Yield** – number of persons identified to be "at-risk"
- **Cost** – personnel and equipment

Test \ Criterion			Only VF or FR (norm = mean)		Sheard criterion: FR + phoria	
			Sensitivity	Specificity	Sensitivity	Specificity
Vergence facility	RDS		43%	40%		
	Tranaglyphs		69%	49%		
Fusion reserves	RDS	PFR	56%	65%	0%	99%
		NFR	61%	41%	67%	99%
	Trana-glyphs	PFR	60%	58%	0%	94%
		NFR	67%	52%	67%	96%

Conclusions

Tests for vergence facility and fusion reserve evaluation based on Random-dot stereogram method most of all corresponded to the criterion for screening. Technical changes (changes in disparities for vergence facility and control symbols – dynamic markers[8] for fusion reserves) should be made to improve criterion "reliability of the method" and to make it possible to use these two methods in vision screening.

Additional experiments are necessary to determine what vergence performance testing is more appropriate for visual problem diagnostic (asymptomatic and symptomatic participants) and define appropriate norms for computerized tests useful for screening at schools.

Reference

1. Scheiman M., Wick B. (2008) Clinical management of binocular vision. 3rd edition. Philadelphia: Lippincott Williams & Wilkins, pp. 4-9
2. Gall R., Wick B., Bedell H. (1998) Vergence facility: establishing clinical utility. *Optometry and vision science*, Vol. 75, No. 10, pp. 731-742
3. Goss D.A., Becker E. (2011) Comparison of near fusional vergence ranges with rotatory prisms and with prism bars. *Optometry*, Vol. 82, pp. 104-107
4. Melville A.C., Firth A.Y. (2002) Is there a relationship between prism fusion range and vergence facility? *British Orthoptic Journal*, Vol. 59, pp. 38-44
5. Rowe F.J. Fusional vergence measures and their significance in clinical assessment. *Strabismus*, Vol. 18, No. 2, pp. 48-57
6. Jimenez R., Perez M.A., Garcia J.A., Gonzalez M.D. (2004) Statistical normal values of visual parameters that characterize binocular function in children, *Ophthalmic and Physiological Optics*, Vol. 24, No. 6, pp. 528-542
7. Guiedlines for vision screening in Missouri schools. http://dss.mo.gov/fsd/rsb/childrensvision/vision_screening_guidelines.pdf
8. Rozhkova G.I., Vasiljeva N.N. (2010) A computer-aided method for the evaluation of fusional reserves with objective control of fusion break. *Human Physiology*, Vol. 36, No. 3, pp. 364-366

The study is supported by ERAF project No. 2011/0004/2DP/2.1.1.1.0/10/APIA/VIAA/027