Subjective vergence performance evaluation using computerized programs

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Introduction

Nowadays a near work takes a large part of our daily activities. Therefore, it is important to understand whether complains appearing during near work could be related to visual problems. If these conditions are associated with vision, there may be specific changes of accommodation functions or binocular vision. If complains are related to binocular vision problems, it would be important to assess the vergence system functions. Vergence assessment includes fusion reserves, vergence facility, and convergence evaluation. Fusion reserves are describing vergence amplitude, but vergence facility reflect the vergence dynamics.[1]

Purpose

To make a computerized test to evaluate vergence performance, which could be useful not only in clinics, but also for screening at schools.

Results

Average value of positive fusion reserves (PFR) and negative fusion reserves (NFR), measured with classical method, was 21 ± 8 Δ and 13 ± 6 Δ, respectively. Using RDS method, PFR was 24 ± 8 Δ, NFR was 14 ± 8 Δ. Using tranaglyphs, PFR was 12 ± 8 Δ, NFR was 16 ± 9 Δ (Fig. 3). Comparing classical method and both computerized methods, NFR measurements were similar with classical method (t-test, $p = 0.4$ for RDS, $p = 0.6$ for tranaglyphs), but PFR measurements showed significantly smaller average value, measured with tranaglyphs, than classical method and RDS ($p < 0.001$). But still both computerized methods could be used to differentiate subjects with decreased fusion reserves (as showed by ROC analyses). Approximate norms of fusion reserves for each age group were defined (Table 1).

Average values of vergence facility measurements with RDS was 3 ± 4 cycles per minute but individual results ranged from 0 till 13 cycles per minute. Using tranaglyphs and 14 prisms base out/3 prisms base in, average values of vergence facility was 1 ± 2 cycles per minute. Using tranaglyphs and 8 prisms base out/3 prisms base in, average values of vergence facility was 2 ± 3 cycles per minute (Fig. 4). Comparing classical and computerized methods, they showed significantly different results (t-test, $p < 0.001$).

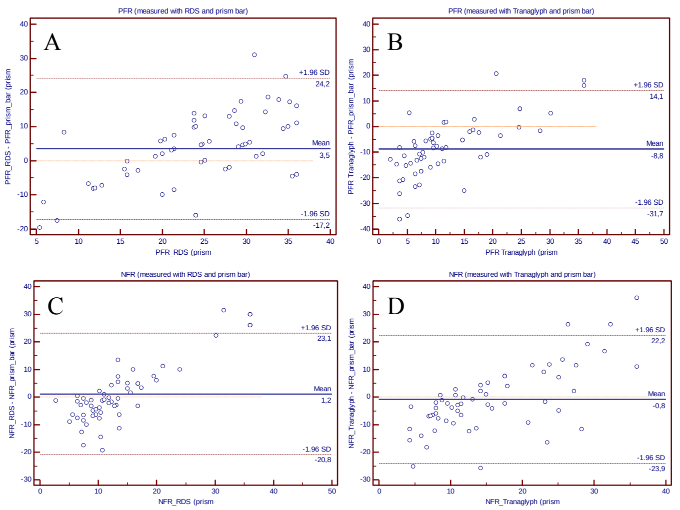

Figure 3. Bland-Altman analysis for positive and negative fusion reserves measurements with classical and computerized methods.

Conclusions

Vergence facility measurement with computerized tests was too complicated for children. It was harder to keep proper vergence performance stimulated with base out prism, independent of the prism size used.

Fusion reserves were properly measured using computerized tests (compared with classical method). For children, it was easier to perform and to understand test were RDS stimulus presentation was used.

Additional experiments are necessary to determine what vergence performance testing is more appropriate for visual problem diagnostic and define appropriate norms for computerized tests.

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Method and subjects

65 subjects (age 7-17 y.) participated in the experiment (all of them had vergence facility measurement, but only 59 performed fusion reserves measurements). We used computerized tests for vergence facility (Fig. 1) and fusion reserves (Fig. 2) measurements. Dichoptic images were shown using red-blue glasses. Additionally, we measured heterophoria (Thorington test), near point of convergence, stereovision (TNO), vergence facility (12Δ base out/3Δ base in), and fusion reserves (prism bar). Two latest methods are classified as classical measurements of vergence performance.

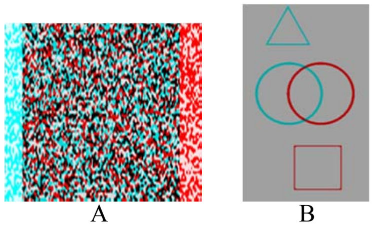

Figure 1: Images used in computerized tests for vergence facility measurement based on random dot principle (A, RDS, 4 prisms base out/4 prisms base in, number perceived) and tranaglyphs (B, 14 prisms base out/3 prisms base in, or 8 prisms base out/3 prisms base in, one fused circle perceived).

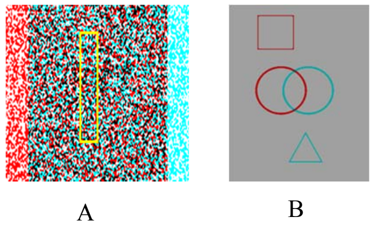

Figure 2: Images used in computerized test for fusion reserves measurement based on random dot principle (A, bar perceived) and tranaglyphs (B, one fused circle perceived). Stimulus for each eye were moved laterally with a speed of 200 mm/min. The maximum value was 34Δ.

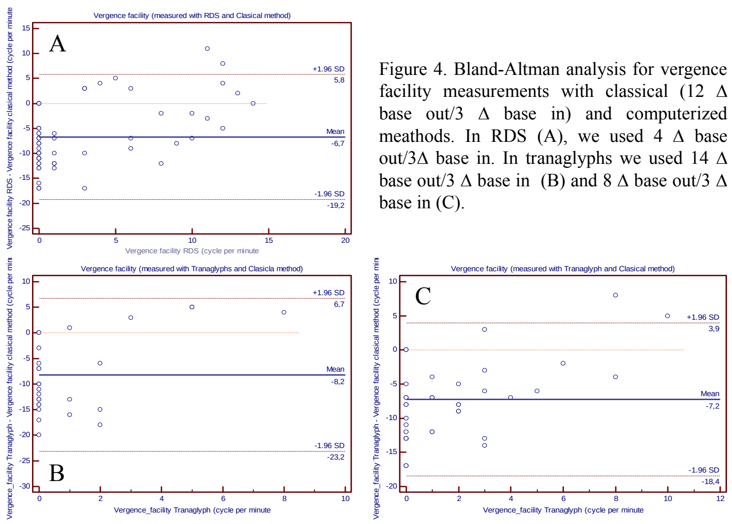

Figure 4. Bland-Altman analysis for vergence facility measurements with classical (12 Δ base out/3 Δ base in) and computerized meathods. In RDS (A), we used 4 Δ base out/3Δ base in. In tranaglyphs we used 14 Δ base out/3 Δ base in (B) and 8 Δ base out/3 Δ base in (C).

Table 1. Norms of fusion reserves defined in literature for classical method (measured with prism bar) and expected norms for computerized tests using RDS and tanaglyphs.

Age / Method	7 – 9 years		10 – 12 years		13 years and older	
	PFR	NFR	PFR	NFR	PFR	NFR
Classical method	19[2]	12[2]	18[2]	10[2]	19[1]	13[1]
RDS	16	10	17	10	20	14
Tranaglyphs	16	9	16	9	19	18

Reference

1. Mitchell Scheiman, Bruce Wick., Clinical management of binocular vision. 3rd edition. Philadelphia: Lippincott Williams & Wilkins, 2008. pp. 4-9
2. R.Jimenez, M.A.Perez etc., Statistical normal values of visual parameters that characterize binocular function in children, Opthalmic.Physiol.Opt.,2004.,vol.28, pp 528-542

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