# Journal Club

1 March 2011

Graefes Arch Clin Exp Ophthalmol (2010) 248:885–892
DOI 10.1007/s00417-009-1251-y

PEDIATRICS

# Binocular function in school children with reading difficulties

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- Most previous analyses have looked at dyslexic children, or unselected groups of school-age readers
- No prior reports on primary school age poor-readers without dyslexia

# Prior Studies

- Children with reading and learning difficulties may have:
  - Higher incidence of hypermetropia,  anisometropia, anisokonia, fixation disparity
  - Exophoria at near, convergence insufficiency, lowered fusional vergence reserves
  - Vertical phorias
  - Poor accommodation

  - or NONE of the above

# Prior Studies 2

- Children with dyslexia, compared with normal readers may have:
  - Lower fusional vergence reserves (+ and -)
  - Vergence instability on dissociation
  - Poor vergence co-ordination after saccades

  - Other studies have shown no vergence problems in dyslexics

# Study Design

- Cross sectional study in Madrid, Spain
- 87 non-dyslexic poor-readers identified by schools (8-13yo, 30F 57M)
  - normal IQ
  - Lowest 30%ile reading battery test
  - BSCVA 20/20, no strab,  <2.00DS <1.00DC
- 32 ‘age-matched’ controls (14F 18M)

# Measurements

- Single optometrist measured:
  - Non-cycloplegic retinoscopy and subjective refraction
  - Horizontal scanning (DEM test)
  - N / D heterophoria (von Graefe)
  - N / D horizontal fusional ranges (rotating prisms)
  - AC/A ratio (gradient)
  - Near point of convergence (penlight)
  - Stereoacuity (Randot)

- Refraction +0.20

- No relationship between near and distance binocular variables and school grade, or age.

- Not commented whether there was a difference statistically, but higher proportion of hyperopia (<2.00) in the study (29%) vs. the control group (15%)
  - Study eyes +0.20 +/- 0.6D
  - Control eyes -0.20 +/- 0.8D

**Table 1** Means and standard deviations of distance horizontal heterophoria and distance horizontal fusional vergence ranges recorded in the study (poor readers) and control (normal readers) groups. Units for all measures are prism diopters. Positive numbers represent esophoria while negative numbers indicate exophoria. BI Blur control group $n$=8 and study group $n$=27; BO Blur control group $n$=12 and study group n=22

| Parameters | Control group ($n$=32) | Study group (poor readers) ($n$=87) |
|---|---|---|
| Phoria | −0.0±1.6 | −0.4 ±1.6 |
| BI Break [a] | 11.1±3.4 | 9.1±3.0 |
| BI Recovery [a] | 5.0±2.4 | 3.6±1.9 |
| BO Blur | 11.4±6.0 | 14.2±6.7 |
| BO Break | 17.8±6.1 | 19.0±8.3 |
| BO Recovery | 7.9±3.5 | 6.0±4.1 |

[a] Denotes statistical significance at the level 0.01.

BI = Base In; BO = Base Out.

**Table 2** Means and standard deviations of near horizontal heterophoria, near horizontal fusional vergence ranges, AC/A ratio, near point of convergence (NPC), and stereoacuity in the study (poor readers) and control groups.Units: NPC, centimeters: stereoacuity, seconds of arc; all others, prism diopters. Positive numbers represent esophoria, negative numbers represent exophoria. BO Blur control group $n$=12 and study group $n$=22

| Parameters | Control group ($n$=32) | Study group (poor readers) ($n$=87) |
|---|---|---|
| Phoria | −1.7±3.4 | −1.6±3.7 |
| BI Blur | 11.5±6.6 | 13.0±3.8 |
| BI Break | 17.6±5.7 | 18.8±4.7 |
| BI Recovery | 9.0±4.45 | 8.9±3.3 |
| BO Blur | 18.7±7.8 | 18.8±4.6 |
| BO Break | 25.1±7.2 | 26.3±7.7 |
| BO Recovery | 12.4±4.8 | 12.2±7.1 |
| AC/A | 2.8±1.7 | 2.1±1.7 |
| NPC Break | 4.3±2.3 | 3.7±3.2 |
| NPC Recovery | 7.9±3.2 | 9.1±5.2 |
| Stereoacuity | 23.8±8.6 | 25.2±11.3 |

BI = Base In; BO = Base Out.

**Table 3** Means and standard deviations of near point of convergence (NPC) values recorded in our study (for 87 poor readers and 32 normal readers) compared to other studies performed on unselected readers. Units: NPC, centimeters

| Author | *N* | Age | Method | Break point/recovery point |
|---|---|---|---|---|
| Hayes et al. (1998) | 297 | Kindergarten | Push-up with accommodative task (three measurements) | 3.3±2.6 / 7.3±4.8 |
| | | Third grade | | 4.1±2.4 / 8.7±4.2 |
| | | Sixth grade | | 4.3±3.4 / 7.2±3.9 |
| Rouse et al. (1998) | 206 | 8–13 | Push-up with accommodative task (three measurements) | 2.7±3.7 / 6.9±7 |
| Borsting et al. (1999) | 14 | 8–13 | Push-up with accommodative task (three measurements) | 3±2 (break point) |
| Borsting et al. (2003) | 392 | 8–15 | Penlight push-up technique | 3.9±3.9 / 6.7±5.1 |
| Jimenez et al. (2004) | 1,015 | 6–12 | Penlight push-up technique | 5.2±4.4 / 11.4±7.2 |
| Adler et al. (2007) | 20 | 6–9 | Penlight push-up technique (three measurements by the same examiner) | 6.5±5.4 / 10.9±5.6 |
| | 17 | 11–13 | | 6.3±3.5 / 11.3±4.7 |
| Maples et al. (2007) | 132 | 6 | Push-up with accommodative task (three measurements) | 2.6±2.7 / 7.0±5.9 |
| | 162 | 7 | | 3.1±6.1 / 7.9±8.4 |
| | 164 | 8 | | 2.7±3.3 / 6.9±7.2 |
| | 63 | 9 | | 3.3±6.7 / 7.1±6.7 |
| Present study | 87 | Poor readers 8–13 | Penlight push-up technique (three measurements by the same examiner) | 3.7±3.2 / 9.1±5.2 |
| | 32 | Controls 8–13 | | 4.3±2.3 / 7.9±3.2 |

**Table 4** Mean stereoacuity values obtained in our study compared to other studies. Units: stereoacuity, seconds of arc.

| Author | *N* | Age | Stereoacuity |
|---|---|---|---|
| Buzzelli (1991) | 13 | Normal readers 13 | 24±8.77 |
| | 13 | Children with dyslexia 13 | 23.46±15.46 |
| Evans et al. (1994) | 43 | Normal readers 7–12 | 20 (median) |
| | 38 | Children with dyslexia 7–12 | 25 (median) |
| Oduntan et al. (1998) | 791 | 6-12 | 25.32±9.93 |
| Kulp & Schmidt (2002) | 36 | 8-9 | 25 (median) |
| Jimenez et al. (2004) | 1,016 | 6-12 | 25±10 |
| Present study | 87 | Poor readers 8–13 | 25.2±11.3 |
| | 32 | Normal readers 8–13 | 23.8±8.6 |

# Discussion

- Lower base-in break or distance also seen in 51-60 year olds (same authors)
- Unsure what mechanisms underly this finding
- “it is important to identify any divergence limitation early on so that, through training, convergence and divergence subsystems can be balanced to reduce the symptoms of visual fatigue and loss of attention and interest that often occur in children with reading difficulties … although there are no data to support this proposal”