

VISUAL DEVELOPMENT OF 148 PRE-SCHOOL CHILDREN OVER A PERIOD OF 3 YEARS

P. Dunlop, D.B.O.

Summary: A longitudinal study on 148 pre-school children in the Newcastle area was undertaken beginning in 1973. Results showing the progressive development of visual acuity, lateralisation in the central binocular visual field and stereopsis are discussed.

In 1973, the subjects for this study were selected from children attending the five Kindergarten Union pre-schools in the Newcastle region by four investigators, Prof. B. Fenelon, Dr. D. Dunlop, Mr. S. Allen and the author. As well as providing sufficient numbers, the pre-schools ensured a relatively uniform standard of pre-school experience for each child.

Criteria for a child's participation in the study were attendance at a Kindergarten Union pre-school during 1973, parental permission, eligibility to enrol in an Infants school in 1974 and the absence of major physical or intellectual handicap.

Of 175 children studied in 1973, 148 children (79 males and 69 females) remained at the end of 1975. Complete psychological, ophthalmological and orthoptic data are available for these children. For the purposes of this paper, only the orthoptic data is being discussed. As a basis for this each child had a full ophthalmological examination including retinoscopy and fundal examination under full cycloplegia early in the study. This procedure was repeated with some children where visual acuity or other findings suggested that some change had occurred. The orthoptic examination was carried out in the pre-school in 1973 and subsequently in a central orthoptic clinic. This included visual acuity, cover test, ocular movements, binocular function - including sighting eye and reference eye, and convergence. Colour vision was estimated using the Matsubara test. No child underwent any ocular treatment regime during the course of the study.

At the onset of the study it was expected that reference eye would be elicited provided the children were co-operative and the result should be clearly 'right' or 'left'. But this was not so. Statements indicating alternation or movement of both indicators, sometimes with a tendency to normal or to crossed correspondence with the preferred hand, were elicited. This condition may be more properly termed immature or undeveloped reference in the central binocular field.

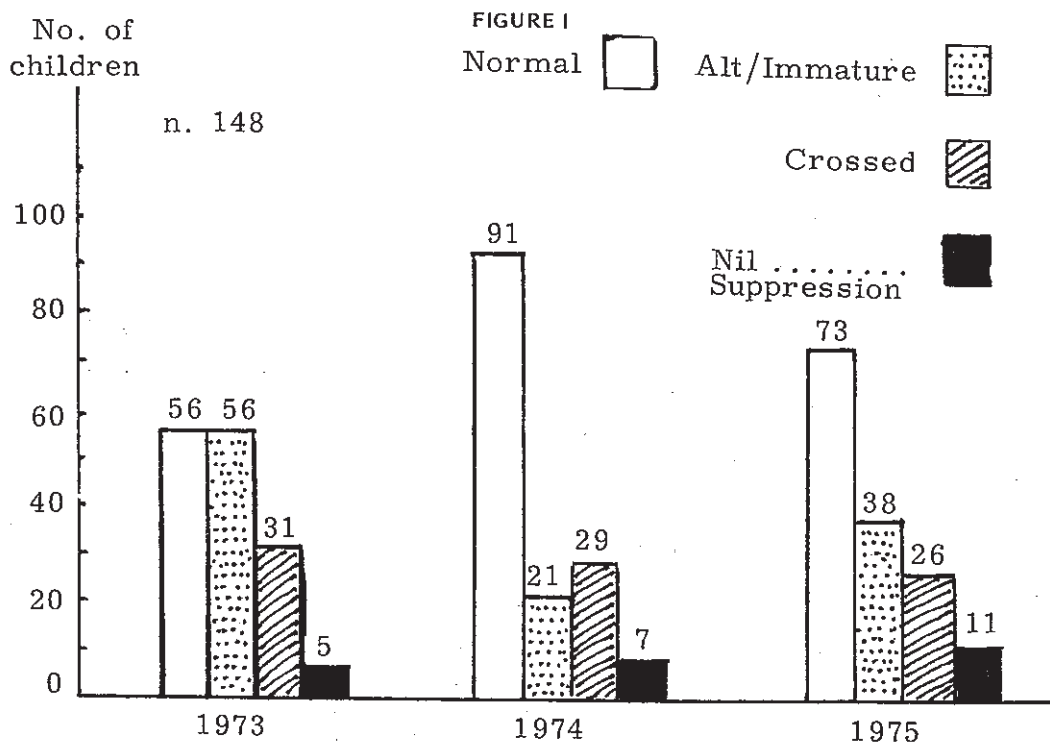


Figure I - Response to reference eye test in 148 children over a 3 year period.

Figure I illustrates the number of children and their responses to reference eye testing in each of the three years of the study. It is evident that in some children a normal correspondence pattern was replaced by an immature pattern, and vice versa during this period. However the children who presented with crossed correspondence at 4½ years appeared to remain in that state over the next two years.

The variation of the normal and alternating/immature responses follows a pattern of "inconsistencies" explained by Touwen (1976) and should be regarded as part of normal neurological development. On the other hand the consistency of crossed responses suggests that these children may not be following a normal pattern of neurological development. Further study along these lines is being pursued by the four original investigators and will be published later.

The eleven cases in 1975 where suppression occurred and no reference eye was possible in the central binocular field were made up of 4 esotropias; 4 esophorias; 1 exotropia and 2 exophorias, i.e. 7.4% ocular muscle imbalance in the group. Five cases of amblyopia were found, one of whom had already been successfully treated prior to the study (3%). Ten children (9 males and 1 female) had defective colour vision, i.e. 7% which indicates that this group is fairly representative of the general population.

Convergence was measured using the range of fusion elicited on the synoptophore and the act of convergence to a near object. Voluntary convergence was also looked for. In 1973, 46 (31%) of the children had achieved it. In 1974, 66 (44%) and in 1975, 86 (58%) had achieved it. This shows a gradual attainment of frontal control of the vergence system of eye movements.

FIGURE II

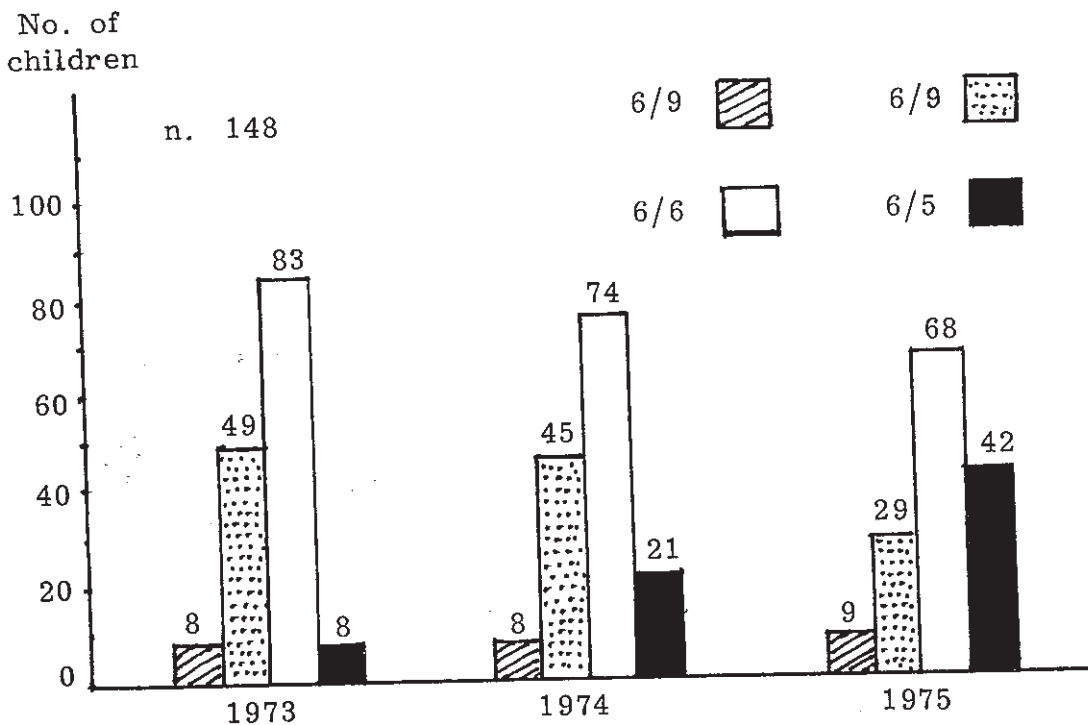


Figure II - Changes in visual activity between 4½ and 6½ years of age.

Figure II and Table I show the number of children and their level of visual acuity (in both eyes) over the three year period. Where vision was not equal in both eyes the child was categorised at the level of the weaker eye.

As time passed, the number of children attaining 6/5 visual acuity in both eyes increased with a corresponding decline in the numbers in the next two categories. The number of children who failed on 6/9 in one eye at least did not alter throughout the three year period.

TABLE I

TABLE SHOWING VISUAL ACUITY (OF WEAKER IN BOTH EYES) OF CHILDREN
OVER A 3 YEAR PERIOD (BETWEEN 4½ and 6½ YEARS OF AGE).

| | <6/9 | 6/9 | 6/6 | 6/5 | Total | |
|------|-------|-----|-----|-----|-------|-----|
| 1973 | Boys | 4 | 24 | 46 | 5 | 79 |
| | Girls | 4 | 25 | 37 | 3 | 69 |
| | Total | 8 | 49 | 83 | 8 | 148 |
| 1974 | Boys | 6 | 23 | 38 | 12 | 79 |
| | Girls | 2 | 22 | 36 | 9 | 69 |
| | Total | 8 | 45 | 74 | 21 | 148 |
| 1975 | Boys | 6 | 16 | 34 | 23 | 79 |
| | Girls | 3 | 13 | 34 | 19 | 69 |
| | Total | 9 | 29 | 68 | 42 | 148 |

Stereopsis was tested with standard synoptophore slides depicting multiple objects at various distances, e.g. Birds in the cage (D.49 and D.50) and Christmas Tree (D.53 and D.54). Responses were graded on 0-4 scale* as done in previous studies (Dunlop 1972 and Dunlop et al 1973). There was very little change in responses over the three year period, i.e. between 4½ and 6½ years of age. Those children who showed good stereopsis with this test at 4½ remained good, and those with a poor response remained defective.

- * Stereopsis Grades
- 0 — Full
 - 1 — Good with one mistake
 - 2 — Good but slow and needing stimulation
 - 3 — Weak, several mistakes
 - 4 — Nil.

TABLE II

A. STEREOPSIS RESPONSES ON SYNOPTOPHORE TEST

| Year | 4 (nil) | 3 | 2 | 1 | 0 (full) | Total |
|------|------------|---|---|----|-------------|-------|
| 1973 | 1 | 1 | 9 | 66 | 71 | 148 |
| 1974 | 1 | 1 | 6 | 63 | 77 | 148 |
| 1975 | 2 | 0 | 7 | 64 | 75 | 148 |

STEREO-ACUITY RESPONSES ON WIRT-TITMUS TEST

B.

| Year | Nil | 800" | 400" | 200" | 140" seconds of arc | 100" | 80" | 60" | 50" | 40" | Total |
|------|-----|------|------|------|------------------------|------|-----|-----|-----|-----|-------|
| 1973 | 1 | 0 | 2 | 2 | 1 | 9 | 62 | 12 | 15 | 44 | 148 |
| 1974 | 2 | 0 | 1 | 3 | 2 | 5 | 35 | 17 | 27 | 56 | 148 |
| 1975 | 2 | 0 | 1 | 1 | 2 | 3 | 18 | 12 | 27 | 82 | 148 |

FIGURE III

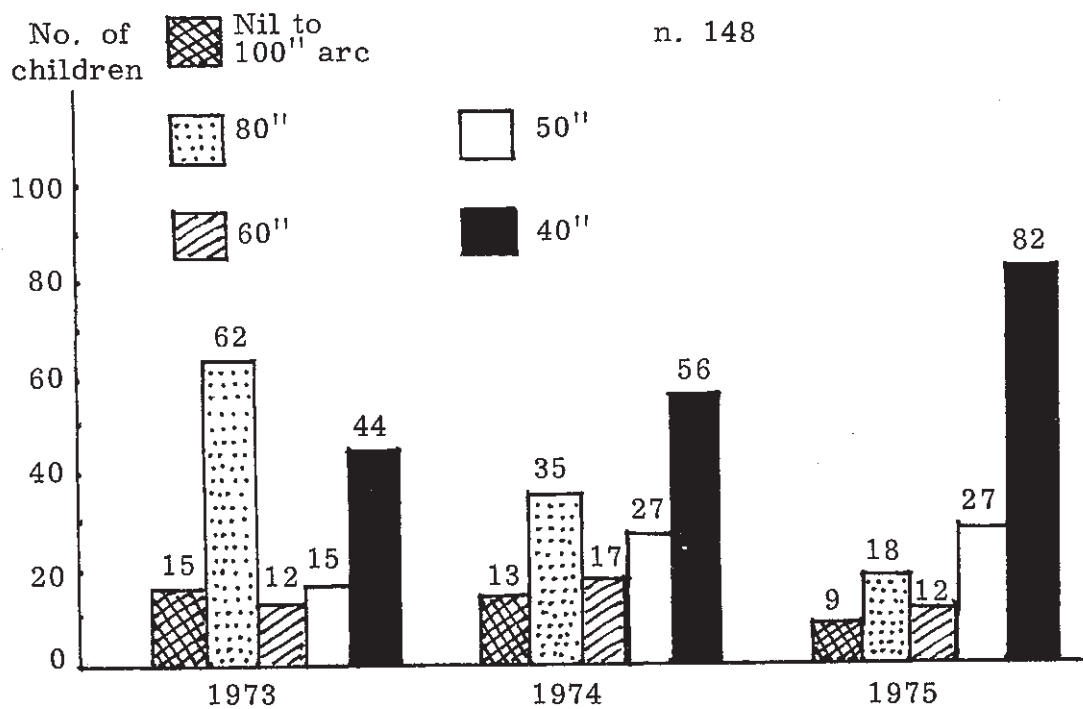


Figure III - Changes in Wirt-Titmus response between 4½ and 6½ years of age

The unchanging pattern of results on the synoptophore tests for stereo-perception, usually called stereopsis, contrasts with the stereo-acuity results on the Wirt-Titmus test. Whereas 80 seconds of arc was appreciated by most children at 4½ years of age, the higher level of stereo-acuity, 40 seconds, was not achieved by most children until 6½ years of age. The number who failed at the 80 second level remained much the same over the three year period. The gradual increase of stereo-acuity with increasing age was also observed by Romano et al (1976).

Conclusions

"Reference eye" test results indicated that some children varied between normal and immature correspondence but those with crossed correspondence remained crossed.

The number of children capable of voluntary convergence increased steadily over the three years. So did the numbers of children with good visual acuity (6/6 or 6/5 in both eyes) and those with good stereo-acuity (40 seconds of arc). There was however little change in the numbers having visual acuity below 6/9 in one or both eyes, or stereo-acuity below 100 seconds. The distribution pattern on synoptophore stereopsis tests remained the same throughout.

Acknowledgements

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