Changing pattern of stereopsis with ageing in Sri Lanka

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Summary

There are few population based prevalence estimates of stereopsis and most of the studies are in children. A prevalent study in the middle and elderly population was undertaken to highlight the impact of ageing on stereopsis.

Six hundred and four persons between 40 and 85 years with 6/6 N6 vision and no other pathology, were subjected to Frisby stereotest. Twenty nine percent had full stereopsis (3 plates seen), while 3% had no stereopsis (no plates seen).

The prevalence of defective stereopsis increased with age. The incidence of full stereopsis remains the same until the sixties, followed by an abrupt decrease by half in the seventies ($p = 0.0038$). In the elderly population defective stereopsis is a common finding in the absence of any other ocular morbidity. The finding was not associated with any symptoms.

Impaired stereopsis may be due to age related decrease in cerebral function.

Key words - stereopsis, ageing, elderly population

Stereopsis is the binocular perception of depth (1). It provides fast and easy access to information in depth in our surroundings. Little is known about normal binocular function in middle and old age. while the data on the prevalence of stereopsis in childhood is widely available (2). There are few population based prevalence estimates of orthoptic abnormalities in the elderly, although stereoacuity is considered to be an ability limited by age (3). Without a knowledge of underlying population prevalence of reduced binocular function, it would not be possible to adequately interpret the significance of such a clinical finding in an elderly person (3). A study of the impact of ageing on stereopsis in a population where its prevalence is not known would be of considerable interest.

Material and Methods

Six hundred and four persons between 40 and 85 years were selected to estimate the prevalence of stereopsis (subjects were from the city of Colombo and its suburbs). The study was conducted during two year period from June 1995 to May 1997, at the Opthalmological Clinic in St Annes Hospital, Colombo, Sri Lanka.

To be included in the study, all persons underwent a full ophthalmic examination to establish the presence of binocularity, which included corrected Snellen's visual acuity for distance. A cover test was carried out for near and distance to assess latent or manifest deviation, and ocular movements assessed for limitation of movements. All persons underwent fundus examination.

Only persons with visual acuity of 6/6 for distance in both eyes, N5/N6 for near, without a manifest deviation, and with normal ocular movements were included in this study. Persons who have had cataract surgery, glaucoma or fundus pathology were excluded. The Frisby stero-test (4) was used to ascertain stereopsis in the sample study. This is a test of global stereopsis and requires a more complex level of neural processing than local stereopsis. It eliminates the use of preferential looking techniques, dynamic random dot displays and the use of visually evoked potentials. The Frisby test rules out the use of red green goggles or polarising spectacles and the test is repeatable without the risk of the person learning to make the correct response from memory.

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The Frisby test consists of three perspex plates of 6 mm, 3 mm, and 1 mm thickness. Each plate has four squares, each 6 cm in size, with blue triangles texture printed on them. One of these four squares contains a hidden circle of 3 cm of random texture, printed on the reverse side, to give the impression of this circle sticking out of alignment either forwards or backwards. No polarising goggles are needed to create the stereoscopic effect (Fig 1).

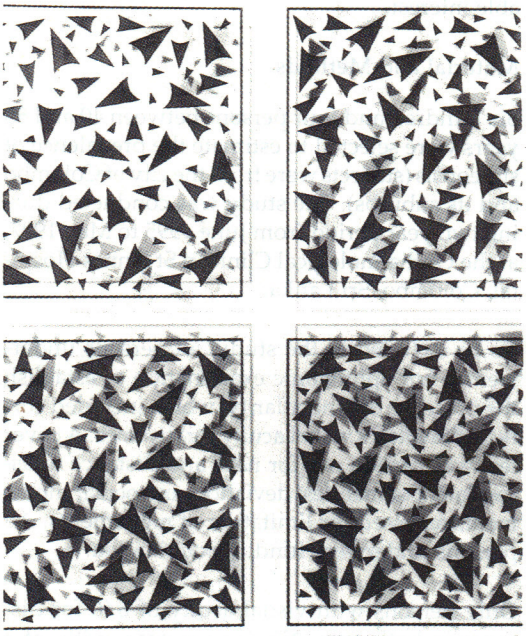

Figure 1: Photograph of a Frisby test plate

During checking and educating the person, prior to testing for stereopsis, one corner of the plate is placed on the table and the plate is twisted to and fro by 10^0 to introduce a monocular cue of motion parallax, which makes the patient see the centre circle out of alignment even if the person is monocular. The plates are turned around unobtrusively to a new random position and presented afresh, so that the circle seems to stand out as "circle in depth" in different boxes.

Procedure of the Frisby test

The 6 mm plate (thickest plate) was held vertically against a white background at approximately 40 cm from the person, avoiding reflected lights on the plates (4). The circle was demonstrated to the person initially. Then the plate was held still perpendicular to the individual's gaze, and while holding the head still, the participant identifies the circle, at least in three different positions of the plate and if correct, was recorded as "stereopsis present for the 6 mm plate." If not identified, as "stereopsis absent for same." Next the 3 mm plate and lastly the 1 mm plate were presented at approximately 40 cm from the person and the stereopsis present or absent was noted. At 40 cm the 6 cm denotes 340 seconds of arc, 3 mm 170 seconds of arc and 1 mm , 50 seconds of arc of stereopsis. But the stereopsis was not measured in terms of seconds of arc, but only in terms of the number of plates seen.

All tests were done under standard background illumination and participants with less than 6/6 N6 were excluded from the study.

Recording of results

Results were recorded according to the maximum number of plates seen.

Grade

0	No plate was seen (the test was adequately understood)
I	only one plate was seen (6 mm)
II	two plates seen (6 mm and 3 mm)
III	All three plates seen (6 mm, 3 mm, and 1mm)

Statistical analysis

The Chi-square test with Yates correctiom was used to evaluate the trend of aging on stereopsis. Comparison of the grading of stereopsis in different age subsets were made by Student's t test,

p = 0.05 considered significant. All analyses were performed using EP 16 computer programme.

Results

Initially, 830 persons were screened to determine the degree of stereopsis, 226 were excluded from the study due to the presence of ocular pathology or lack of comprehension. The final study sample was 604 persons with 6/6 N6 in both eyes.

Age distribution of the 604 persons in the study is shown in Table 1. The age ranged from 40 to 85 years. Half the persons (51%) were in the 40 to 49 age group, while only 7 (1.2%) were between 80 and 85 years.

Table 1
Age distribution in the study population

Age	No (%)
40 - 49	310 (51.3)
50 - 59	159 (26.3)
60 - 69	94 (15.6)
70 - 79	34 (5.6)
80 - 85	7 (1.2)
Total	604 (100)

Age specific prevalence of the different grades of stereopsis, as defined by the maximum number of plates seen together with the frequencies is shown in Table2. The overall prevalence of stereopsis by grade in the 604 study population, as shown in the Table were; 28.8% had full stereopsis (saw all three plates) while only 2% had no stereopsis (no plates seen). The low incidence of absent stereopsis in the overall series may be attributed to the inclusion of 40 - 60 age group in the study. The remaining 69.2% had intermediate grades.

Age specific prevalence of the different grades of stereopsis (Table 2), shows 27% in the 60 to 69 age group had full stereopsis (saw all three plates), while, the corresponding incidence in the 70 to 79 group was 15%. Only 1% in 60 to 69 age group had absent stereopsis (no plates seen), suggesting an age related trend.

Stereopsis by age group

In order to determine the changes in stereopsis in relation to age, the format of Wright and Wormald (5) was adopted. Full stereopsis was considered present if grades II or III were seen and absent if grade 0 or I were seen (Table 3). Using the above criteria, the incidence of full stereopsis is highest in the 40 to 49 age group, but remains relatively the same until the late sixties, when there is an abrupt change to 38.2% in the 70 to 79 age subset (p=0.0038) suggesting the age dependent effect (Figure 2).

The Mantei-Haenszel chi-squared test for age related trend shown in Table 4, confirms the strong age related relationship. The odds ratio for loss

Table 2
Frequency of stereopsis by age group

Age	40-49	50-59	60-69	70-79	80-85	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	
Grade*						
0	1 (0.3)	3 (2)	1 (1)	7 (21)	0 (0)	12
I	107 (35)	56 (35)	35 (37)	14 (41)	5 (71)	217
II	105 (34)	53 (33)	33 (35)	8 (24)	2 (29)	201
III	97 (30.7)	47 (30)	25 (27)	5 (15)	0 (0)	174

* maximum number of plates seen

Table 3
Changes in stereopsis by age group

Grade* Age (n)	II & III n (%)	0 & I n (%)	Odds ratio	P value
40-49 (310)	202 (65.2)	108 (34.8)		
50-59 (159)	100 (62.9)	59 (37.1)	1.10	0.7011
60-69 (94)	58 (61.7)	36 (38.3)	1.16	0.6238
70-79 (34)	13 (38.2)	21 (61.8)	3.02	0.0038
80-85 (7)	2 (28.5)	5 (71.5)		
Total	375	229		

* Grades II&III=full stereopsis, 0&I=absent
n = number of subjects

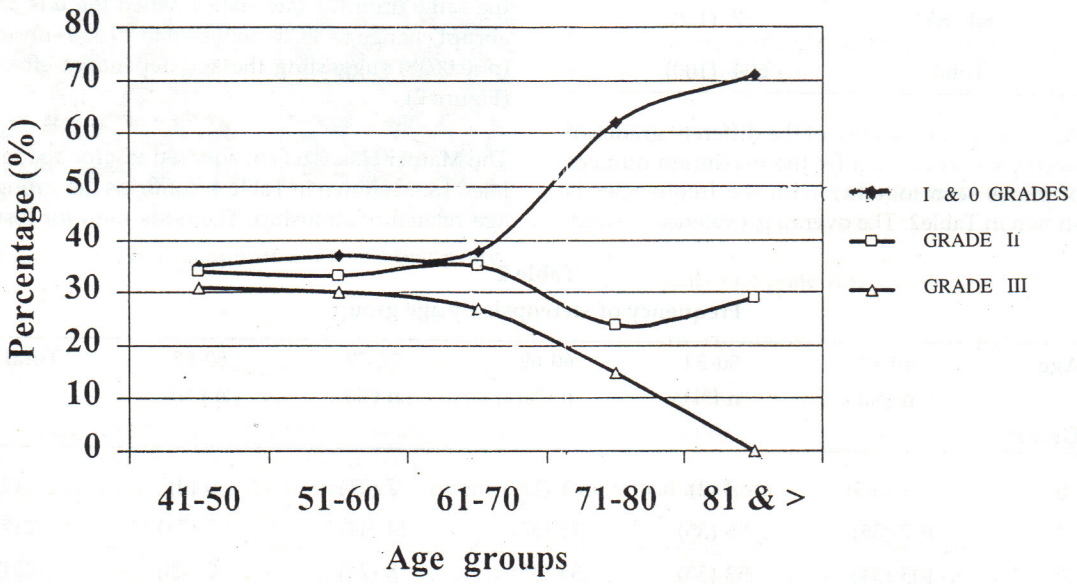

Figure 2 : Percentage change in stereopsis with advancing age

Table 4
Comparison of stereopsis in 40 to 59 and 60 to 85 age groups

Grade*	II & III	0 & I	Total
Age	n (%)	n (%)	n (%)
40-59	302 (80)	167 (73)	469 (77)
60-85	73 (20)	62 (27)	135 (23)
Total	375 (100)	229 (100)	604 (100)

Yates corrected Chi-squared value = 4.31

Mantel-Haenszel Chi-squared value 4.73

Odds ratio 1.54, $p < 0.05$

* Grades II&III=full stereopsis, 0&I absent

of stereopsis for the 60 to 85 year old is 1.54 ($p < 0.05$). The sample in the 80 to 85 age group is seven, a small one indeed (Table 3). The base line risk appears to be between 65 and 69 year old group (see Figure 2).

Discussion

Stereopsis is the binocular perception of depth (1), and develops in early infancy, between three and five months (6). Adult levels are achieved around five to seven years (7).

There are conflicting reports on changes of stereopsis with age. Reports suggesting that stereopsis does not change appreciably with increasing age are based on small samples of older age groups (8,9). Jani (10) noted an increase in stereoacuity from ages 9 to 20 years and a considerable reduction of stereoacuity over the age of 40, in a volunteer study of stereopsis using Diastereo test (4). Heron et al (2), reported a comparison of the absolute threshold of stereopsis in the adults and children, using four different methods, one which was the Frisby test. They concluded that Frisby test revealed the highest levels of stereoacuity, with the least variability for all age groups, but that there was variability between children (aged 3 to 7 years) and young adults (18 to 21 years), when tested with Frisby test. In the present study of middle and elderly age subsets the Frisby test was used due to its reliability (4).

In a recent population based study of 417 adults over 65 years of age by Wright and Wormald (5), using the Frisby test found that stereoacuity decreased with increasing age. They found in the over 65 year population full stereopsis (3 plates seen) in 37.6% while 8.6% has no measurable stereoacuity (no plates seen). Comparing these results with present sample of 135 persons over the age of 60 years, 22.2% had full stereopsis and 5.9% had no stereopsis. The relatively low incidence of absent stereopsis in our overall study sample may be attributed to the inclusion of patients in the 40 to 60 age group, who had high incidence of full stereopsis (Table 3).

Richards tested 150 students with random-dot stereograms, found about 4% were unable to see the cue offered by the disparity, while a further 10% had difficulty (11). He therefore estimates that 14% of the population lack the full ability to use binocular disparities to judge depth. In out total sample of 604 patients in the 40 to 85 age group, with 6/6 N6 in both eyes, 430 (72.7%) lacked fine stereopsis (Table 4).

Results of reports of describing detailed stereoacuity are not directly comparable to our study, as we did not measure stereopsis in terms of seconds of arc, but only in terms of number of plates seen at the normal reading distance.

Defective stereopsis did not give rise to any subjective symptoms being reported in the survey. However, no specific questions were asked with regard to the possible effect of reduced stereopsis. This aspect needs further clarification.

Analysis of the prevalence of stereopsis in the study sample demonstrates that stereopsis decreases with increasing age, and the Mantel-Haenzel chi-squared test for trend, confirms that there is a strong age dependent effect. The odds ratio for loss of stereopsis for the 70 to 79 year olds is 3.02 ($p = 0.0038$) taking the 70 to 75 year old group as base line risk. The trend is similar to a recent study by Wright and Wormald (5).

The reduced stereopsis in the elderly, may be related to an age related decrease in cerebral function. Cohn and Lasley (3) suggest neural effects of aging may be the reason for reduced stereopsis with age. There may be an association between loss of stereopsis and onset of dementia, as it has been shown that defective stereopsis occurs in Alzheimer's disease (12).

Conclusions

Population based prevalence study of stereopsis shows a decrease in stereopsis with age. The incidence of full stereopsis is highest in middle age. The base line risk appears to be between 65 and 69 year old group. Defective stereopsis was not associated with any symptoms.

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