

## A CLINICAL ASSESSMENT OF NEW METHODS OF TREATMENT FOR AMBLYOPIA

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### Abstract

Following the psychophysical experiments which have established that the human visual system is highly tuned for spatial frequency and orientation, the Cam Vision-Stimulator was devised to rectify the reduced sensitivity found in amblyopia by stimulating the visual neurones in all orientations, during the period of occlusion. The results of this study are presented and discussed.

### Key words

Amblyopia, contrast sensitivity, spatial frequency, spatial distortion, minimal occlusion.

For some patients total full-time conventional occlusion may cause little distress or upset, but for many patients this method of treatment can be disruptive – socially, domestically, educationally and emotionally.<sup>1</sup> In our experience, those patients who are upset by full-time occlusion fail to co-operate well, and thus the final visual outcome is lower than was originally expected. In order to reduce the distress, we have reduced the length of

daily occlusion to twenty minutes, during which time the child is supervised by a parent, and encouraged to give maximum concentration to increasingly difficult visual tasks. Although it took slightly longer to achieve maximum visual acuity, the patients and the parents were happier and more co-operative and fewer failed to comply with their treatment.

TABLE 1

METHOD OF TREATMENT and Visual acuities when treatment started.	STRABISMIC				AMBLYOPIA								ANISOMETROPIC AMBLYOPIA			
	MACULAR FIXATION				PARAMACULAR FIXATION				ECCENTRIC FIXATION							
	No. of Patients	No. of weeks or treatments (average)	No. → 6/12	No. → 6/9	No. of Patients	No. of weeks or treatments (average)	No. → 6/12	No. → 6/9	No. of Patients	No. of weeks or treatments (average)	No. → 6/12	No. → 6/9	No. of Patients	No. of weeks or treatments (average)	No. → 6/12	No. → 6/9
MINIMAL OCCLUSION <6/60 – 6/24	3	23	1	–	2	34	1	1	11	20	3	5	1	16	–	–
6/18 – 6/9	4	13.5	–	4	3	16	–	3	1	40	1	–	5	16	–	5
CAM VISION-STIMULATOR <6/60 – 6/24	8	6.5	3	–	11	10	1	2	18	7.9	4	3	7	4.6	3	2
6/18 – 6/9	14	4.8	2	9	7	3.5	1	4	1	2	–	1	14	3	5	5

Table One  
Comparison of results achieved with minimal occlusion, and with the Cam Vision-Stimulator.

We were therefore pleasantly surprised by the results achieved with this form of minimal occlusion, and were therefore encouraged to explore a fresh approach to the treatment of amblyopia.

The findings of recent psychophysical experiments have revealed that the human visual system, like the monkey's, is highly tuned and receptive to spatial frequency and orientation, and that cells in the visual areas of the brain respond selectively to gratings of a certain size and spatial orientation.<sup>2/3</sup> It has been shown that in amblyopia, this sensitivity is usually reduced, either in specific frequencies (low, medium or high) or in all.<sup>4</sup> In order to rectify this deficiency and to activate all the cortical visual neurones, the Cam Vision-Stimulator was devised on which a range of spatial frequency square-wave gratings could be slowly rotated at 1 rev/minute, covering all orientation.<sup>5</sup>

#### Pre-treatment Assessment

<sup>6</sup> Before treatment was commenced, all patients had a full ophthalmological investigation, cycloplegic refraction, and orthoptic investigation including visual acuities at near and far, using linear Snellen's test-types and single optotypes. The contrast sensitivity of either eye was assessed using a selection of round discs on which were printed low and medium sinusoidal gratings, of differing contrasts.<sup>7</sup>

#### Method of Treatment

To enhance the child's concentration and participation when possible two patients, matched for age, intelligence and level of visual acuity, were treated together.<sup>8</sup> The patients had their fixing-eye occluded during the treatment session, and each session lasted for approximately seven to ten minutes. Treatment commenced with the widest striped square-wave disc, which was rotated for approximately one minute. All the grating discs were rotated for one minute commencing with the

widest striped square-wave disc (0.5 cycles/degree) and ending with the narrowest (32 cycles/degree). A perspex plate was placed over the rotating grating on which the children drew or played games such as O's and X's, dot-to-dot etc.

Most patients had no occlusion between treatment sessions, which were usually carried out at weekly intervals.<sup>8</sup> If this method of treatment is to be effective, some improvement in the visual acuity and/or contrast sensitivity should occur within the first three treatment sessions. For this reason, each patient was given three consecutive weekly treatments and if no improvement occurred, the situation was reviewed and an alternative method considered.

#### Results

Eighty patients have completed treatment in this particular study and those who do less well are (i) eccentric fixators and (ii) those who have unsteady nystagmoid jerks in the amblyopic eye, possibly due to reduced effectivity of the 'W' cells. The follow-up period has been short, but three main points have emerged thus far:—

1. Most patients retain their maximum vision.
2. Some regression occurs in a few patients, most of whom have unsteady nystagmoid fixation jerks, with crowding or 'distortion' problems and better single-letter acuity than linear.
3. Some patients show spontaneous improvement after treatment has stopped.

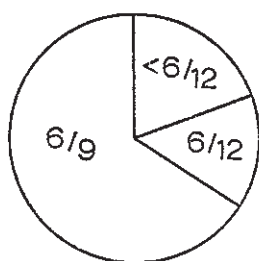
The latter finding re-emphasises the need for extreme caution to be exercised if treatment is carried out in older strabismic amblyopes. The same criteria apply for this method of treatment as for conventional occlusion, and it is of utmost importance that, if the possibility of inducing intractible diplopia is to be avoided, this treatment should only be carried out with adequate medical and clinical supervision.

TABLE 2

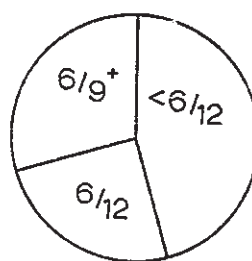
IMPROVEMENT GAINED (Expressed by 6 metre Snellen acuity)	STRABISMIC		AMBLYOPIA				ANISOMETROPIC	
	Macular Fixation		DEGREE OF VISUAL Paramacular Fixation		Eccentric Fixation		Amblyopia	
	No. < 7 years old	> 7 years old	No. < 7 years old	> 7 years old	No. < 7 years old	> 7 years old	No. < 7 years old	> 7 years old
< 1 line improved	2	6	—	6	1	6	2	4
1 line improved	5	4	—	3	1	3	2	3
2+ lines improved	2	3	4	5	4	4	3	7

Table Two

Results of patients treated with Cam Vision-Stimulator, showing the improvement expressed in lines on a Snellen's test-type at six metres.



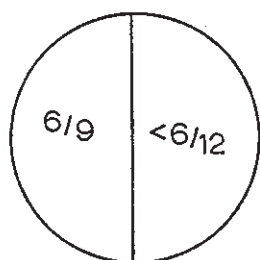
PATIENTS WITH NO PREVIOUS OCCLUSION THERAPY



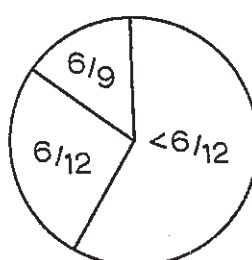
PATIENTS WITH PREVIOUS OCCLUSION THERAPY

Figure 1

Comparison of the final six metre linear acuity achieved in the amblyopic eye of patients with macular fixation.



PATIENTS WITH NO PREVIOUS OCCLUSION THERAPY



PATIENTS WITH PREVIOUS OCCLUSION THERAPY

Figure 2

Comparison of the final six metre linear acuity achieved in the amblyopic eye of patients with eccentric fixation.

The following cases demonstrate spontaneous improvement:

Case 1 - J.B. - seven years, early onset left esotropia, left eccentric fixation, unsteady nystagmoid jerks. Wearing +4.50/+1.00<sub>90</sub> R.E.; +5.00/+1.50<sub>90</sub> L.E. occluded unsuccessfully for four years. December 1977 - 6/6 R.E.; 2/60 L.E. Seven treatments given with Cam Vision-Stimulator. May 1978 - 6/6 R.E.; 6/36 + 1 L.E. near and far. Treatment stopped. July 1978 - 6/5 R.E.; 6/36 linear, 6/24 singles 6 metres; 6/24 near L.E. March 1979 - 6/5 R.E.; 6/18 linear, 6/12 singles 6 metres; 6/18 near L.E. Left fixation paramacular and unsteady.

Case 2 - J.H. - seven years; small exophoria, good binocular functions, normal contrast sensitivities. Refraction revealed: + 1.00 D.S. R.E.; +2.00/-5.50<sub>175°</sub> L.E. Vision - 6/6 R.E.; 6/12+ linear, 6/9 singles 6m; 6/9 near L.E. Three treatments given - 6/5 R.E.; 6/9+ linear 6m; 6/9 near L.E. Three treatments given - 6/5 R.E.; 6/9+ linear 6m; 6/6 near L.E. Seven months later - 6/5 R.E.; 6/5 partly L.E. 6m.

A few adult amblyopes who have lost the vision in their originally sound eye have been treated

with some success. Their motivation is obviously great, and most show some spontaneous improvement without treatment - other than the constant occlusion that they are effectively having. If no improvement occurs, there may be a pathological element present, hindering progress.

Case 3 - A.M. - 23 years; congenital right esotropia, amblyopia, eccentric fixation. Occluded unsuccessfully in childhood. Motor accident at twenty two - left vision lost, 6/36 R.E. Six weeks later - 6/12 R.E. No further improvement; five daily treatments given - 6/9+ 6m, N.5 R.E., unsteady macular fixation R.E. with mal-projection. Further five daily treatments given three months later - 6/6 6m, N4.5 easily R.E., correct projection.

#### Discussion

This method is a significant advance in the treatment of amblyopia - both physiologically and ophthalmologically. At present, it seems to be impossible to forecast the effect of treatment on each individual patient as they all seem to react differently. Although not all patients respond well, some do show large improvements in vision and

contrast sensitivity after a very short exposure to the rotating gratings, and frequently it is those who would not be expected to improve much, due to well-established criteria for regaining vision in an amblyopic eye, who respond dramatically!

Disadvantages of this method of treatment can be cited — e.g. travelling difficulties and expense for parents to bring children to be treated on a weekly basis, weekly disruption to child's education, and use of orthoptist's time. However, these disadvantages should be weighed against the advantages e.g. fast rate of improvement of vision, no supplementary occlusion is usually required between treatment sessions, the children enjoy the treatment and will therefore co-operate well, resulting in a good record of attendance and co-operation. This latter factor may well be the most important aspect as the prognosis for achieving satisfactory visual results can usually be measured by the co-operation and enthusiasm of both the patient and the parent.

Many reasons have been put forward for the effectiveness of this treatment, but have yet to be proved. Much research has still to be done, but the fact that we do not know exactly what effect this treatment has, does not detract from the observation that visual acuity and contrast thresholds can be rapidly improved without distress or anxiety to the patient. We hope at the very least that this method of treatment will provide an effective alternative to conventional occlusion.

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