STIMULATION OF NORMAL BINOCULAR VISION WHILE TREATING STRABISMUS BY THE LOCALIZATION METHOD*

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THE localization method of treating strabismus (Starkiewicz, 1956a, b; 1958) is based on provoking simultaneous ocular localization reflexes, aimed in exactly the same direction, by the stimulation of symmetrical pairs of points in each retina. This can be achieved by getting the patient to take part in various exercises and games during which the retinæ are stimulated symmetrically by the light-rays coming from the surrounding objects.

The first aim of the localization method is to evoke the impression of the same direction in space by a simultaneous stimulation of the two maculae and other symmetrical pairs of points in the two retinæ.

The second aim is to overcome suppression and to restore simultaneous perception.

The third aim is to overcome amblyopia by associating ocular stimuli with tactile and kinaesthetic stimuli. Treating amblyopia by making a child read or look at pictures or films is only partly effective.

When the fixation point on the retina of the squinting eye is normal (*i.e.* central fixation), the treatment is carried out in the following stages:

(1) Setting the eyes parallel by operation or by prismatic correction. This is followed by occluding each eye in turn for 1 to 3 weeks for several months. In this way the normal localization reflexes in each eye are trained, and at the same time the eyes are set parallel and suppression is counteracted.

(2) The application of an alerno-obscurator, which covers each eye in turn every other second for 5 to 8 hours daily for 1 to 6 months, a visual acuity reducer (partial occluder) being placed in front of the fixing eye.

Fig. 1 (opposite) shows a swinging alerno-obscurator (*a*), with a transistor apparatus for operating it (*b*), and a device for charging the battery (*c*).

Fig. 2 (opposite) shows various models of the apparatus: swinging (*a*), rotary (*b*), and "shutter" (*c*). An apparatus similar to the alerno-obscurator was constructed independently by Beiras (1958).

While the alerno-obscurator is in use, the patient is asked to perform various physical exercises, in which all his muscles may be engaged, such as table-tennis, lawn tennis, bowls, and other ball games.

(3) The uncovering of both eyes is followed, as a rule, by the restoration of normal sight, though in some cases a second operation or a longer period of prismatic correction may be needed.

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FIG. 1.—Apparatus.
 (a) Swinging alerno-obscurator.
 (b) Transistor-apparatus for operating the alerno-obscurator.
 (c) Device for charging storage-battery.

FIG. 2.—Various types of alerno-obscurators:
 (a) Swinging. (b) Rotary. (c) "Shutter".

When the fixation point on the retina of the squinting eye is eccentric, this eye is given an exact prismatic correction and a visual acuity reducer is placed in front of the fixing eye. Beiras (1962) reports that he applies automatic prismatic correction, employing the television ophthalmoscope (Ridley, 1958). The patient also carries out exercises, while the alerno-obscurator is applied. The restoration of normal vision to the amblyopic eye is followed by an operation to straighten the eyes.

In these cases of eccentric fixation, amblyopia, if present may be treated by the after-image method of Bangerter (1955) and Cüppers (1958) the squinting

eye being subjected to uniocular localization training, provided that the following conditions are present:

- (i) Fixation is becoming central;
- (ii) Normal binocular vision has begun to develop;
- (iii) Prismatic correction is given to counteract any residual angle of deviation.

In these conditions the Bangerter-Cüppers method may be used to try to overcome the amblyopia of the squinting eye. This treatment *in these circumstances* will not interfere with the training of normal binocular vision, but will on the contrary assist it. In general, however, the second and third conditions are not observed (Bangerter, 1955; Wilczek, Krzystkova, and Pająkova, 1961); although it is possible to produce central fixation and good central vision in the squinting eye by this means, the procedure is such that an alternating squint with false macular correspondence of the retinae is likely to develop and become established. This is undesirable because it will obstruct the restoration of normal binocular vision.

NEW TESTS OF RETINAL CORRESPONDENCE

(1) *Bimacular-umbralic Test* (Starkiewicz, 1958).—The patient's straight eye fixes the white light, the image of which is made to fall precisely upon the macula of the squinting eye by means of an exact prismatic correction. A red glass is placed before the squinting eye, and the patient is asked to indicate the direction of the light he sees. Then either dark filters or "visual-acuity-reducers" are put in front of the fixing eye, and the patient is again asked to indicate the position of the red light.

Although the correspondence is not infrequently anomalous, it is possible to make the correspondence become normal or near-normal by employing dark filters before the fixing eye.

This observation has been confirmed by Bagolini (1961), who replaced the red filter by a striated lens.

(2) *Bimacular-alternate Test* (devised by Strzyzewski).—This is similar to the previous test, but there is a supplementary stage in which the eyes are covered alternately every half second or every second. My experience has shown this to be more sensitive than the bimacular-umbralic test. It is possible to detect the earliest moment at which normal retinal correspondence is established in the course of treatment.

Case Reports

Fig. 3 shows the markings of respective parts of the diagram of the eye and cerebral cortex which is referred to below.

Case 1, a 27-year-old woman

Right Eye: Hypermetropia +1.5 D sph. Visual acuity 1.0.

Left Eye: Secondary divergent strabismus 20°. Hypermetropia +2 D sph. Eccentric fixation. Visual acuity 0.06.

FIG. 3.—Construction of scheme used in Figs 4 and 5. There is a red filter in front of the squinting eye. The track of the macular localization reflex in the squinting eye is marked by a broken line and a white circle striped vertically. The track of the macular reflex in the fixing eye is marked by a continuous line and a white circle striped horizontally. The direction of the subjective localization of these sensations is placed against a black background in the upper part of the figure.

In the first year of life a convergent squint had appeared in the left eye (Fig. 4a, overleaf).

The image of an object located straight ahead (horizontally-striped circle) fell onto the macula of the right (fixing) eye; it provoked the straight ocular localization reflex of the extremities (horizontally-striped circle on black field). The image of an object located at the right side (white circle) fell on the macula of the left (squinting) eye and provoked the ocular localization reflex of the extremities to the right, as well as the subjective sensation of the object to the right (white circle on black field). The establishment of the relationship of the eyes, the muscles of the upper and lower extremities, and the cerebral cortex had been going on since birth (*i.e.* for 16 years).

After an operation, which had been performed when the patient was 16, a 20° secondary divergent squint developed (Fig. 4b, overleaf). The image of an object located straight ahead (horizontally-striped circle) provoked, through the mediation of the right eye, a straight macular localization reflex as well as a correct straight sensation of the object (horizontally striped circle on black field). The image of an object located on the left side (white circle) stimulated the macula of the left eye, which gradually created a new macular localization reflex of the extremities to the left, and also the subjective sensation of the object to the left (white circle on black field). It should be added that the macular localization reflex of the left eye directed to the right could not be completely extinguished, but was rather suppressed. This new relationship of the eyes, the muscles of the extremities, and the cerebral cortex had been taking shape in the patient for the next 11 years, *i.e.* up to age 27.

An operation was then performed to straighten the eyes.

FIG. 4.

Fig. 4(c) shows the results of the retinal correspondence examination carried out before starting treatment on September 4, 1961. A red filter is placed in front of the left eye. The object, consisting of a white light (horizontally and vertically-striped circle), is placed straight in front stimulating both the maculae. The right eye originates the sensation of the white light straight in front (horizontally-striped circle) while the left eye does so in respect of the red light to the right (vertically-striped circle).

On November 22, 1961, after a period of 2½ months training, the bimacular-alternate test (Fig. 4d) revealed that normal retinal correspondence was present. However, the normal binocular vision was extremely poor, and after keeping both eyes uncovered for a longer time, the patients saw the red light 10° to the right.

Thus, in binocular vision, the left eye constantly locates its macula exactly on the object fixed by the right eye. In uniocular tests, the left eye continued to display eccentric (paramacular) fixation. At present the patient is aware of diplopia, but this is expected to subside gradually and normal fusion to become stronger. Her appearance is shown in Fig. 4(e).

Case 2, a boy aged 9 years, had had a left alternating divergent squint of about 15° outwards and 5° upwards since the age of 2½ years (Fig. 5a, overleaf). Both eyes were hypermetropic (+1 D sph.) and the visual acuity was 1·0. The convergence reflex was preserved.

On April 28, 1961, after prismatic correction of the squint, anomalous retinal correspondence was discovered with a red glass in front of the left eye, but neither dark filters in front of the fixing right eye, nor rapid alternating occlusion of the eyes (Fig. 5b, overleaf) were able to change the localization of the red macular stimulus in the left eye, which was constantly perceived by the patient 15° to the left.

The eyes were set parallel by surgery of the external, superior, and inferior rectus muscles of the left eye.

After almost 2 months of intensive localization training with the alterno-obscurator (on June 14, 1961), the macular stimulus in the left eye was localized only 2° to the left (Fig. 5c, overleaf), and by August 7, 1961, normal binocular vision had been restored without the need for filters and alternate occlusion (Fig. 5d, overleaf). The eyes were set parallel and convergence and divergence were maintained. The patient's present appearance is shown in Fig. 5(e) (overleaf).

Conclusions

(1) The localization method of treating strabismus is based upon the fundamental physiological phenomena underlying the impact of visual impressions. Both the theoretical basis and practical results indicate that complete correction of squint is possible in all children and in adults even up to 30 years of age.

FIG. 4.—Course of treatment of Case 1, with a secondary divergent squint, severe amblyopia, and eccentric fixation of the left eye.

(a) First there was a convergent squint in the left eye. The establishment of this state of the eyes, muscles of the extremities, and cerebral cortex had been going on for 16 years.

(b) After an operation performed at the age of 16 years, a secondary divergent squint developed, and this state of the eyes, hands, and brain continued for a further 11 years.

(c) The eyes were set parallel by surgery. On September 4, 1961, a red filter was placed in front of the left eye; the macular stimulus of this eye was perceived by the patient not straight ahead but 5° to the right. Intensive treatment with the alterno-obscurator and localization exercises were begun.

(d) On November 22, 1961 (*i.e.* after 3 months) the rapid alternate covering of the eyes led to a superposition of the macular stimuli in both eyes, indicating that a weak, but normal correspondence of the retinae was being formed and that normal binocular vision was being initiated.

(e) Patient's appearance, November 30, 1961. The eyes are now parallel, and binocular vision is normal, but in uniocular vision the fixation of the left eye remains eccentric.

FIG. 5

(2) Abnormal retinal correspondence is the most important defect to be watched for in treating strabismus. Our studies show that in most cases the subjective localization of the macular stimuli in the squinting eye gradually become normal during treatment by the localization method.

(3) The most sensitive test which will reveal the presence of a very vague, newly-formed, true retinal correspondence is the bimaxillary-alternate test. The bimaxillary-umbral test is somewhat less sensitive, though it is important in tracing the development of normal binocular vision.

(4) In cases of eccentric fixation, a complete cure of the squint is possible, although in unocular vision the fixation of the previously squinting eye remains eccentric. We consider, however, that such cases of squint may be regarded as cured; the patient seems to be satisfied, his appearance is normal, and there is a normal binocular vision. Each day the patient becomes more comfortable, normal binocular vision is strengthened, and the fixation of the previously squinting eye improves.

(5) While the squint is being treated by the localization method, the after-image treatment of amblyopia by the Bangerter-Cüppers method is merely auxiliary. The after-image treatment may first be given alone, without the localization "hand and eye" exercises. If the squinting eye is given training on the corrector, localizer, etc., this must be done when the following conditions have been fulfilled:

- (i) When normal (central) fixation has been established;
- (ii) When normal binocular vision has, at least, been initiated;
- (iii) When an exact prismatic correction has been placed in front of the squinting eye.

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FIG. 5.—Course of treatment of Case 2, with a divergent alternating squint of -15° horizontal and 5° vertical in the left eye.

- (a) This state of the eyes and cerebral cortex had been present since the 3rd year of life.
- (b) April 28, 1961, the angle of deviation was corrected prismatically and a red filter was used in front of the left eye. The macular reflex of the left eye was localized 15° to the left.
- (c) On June 14, 1961, during the bimaxillary-umbral test, the macular reflex of the left eye was localized only 2° to the left.
- (d) On August 7, 1961, the simultaneous macular stimuli arising from the same object were seen by each eye at the same place. Normal binocular vision with straight eyes was therefore present.
- (e) Patient's appearance on December 14, 1961, i.e. 4 months after the end of the treatment. The patient has normal binocular vision with a somewhat reduced range of convergence.