Tests for binocular fusion

Base-out prism

This is a simple method for detecting fusion in children. The test is performed by placing a 20 Δ base-out prism in front of one eye . This displaces the retinal image temporally with resultant diplopia.

- There will be a shift of the right eye to the left to resume fixation (right adduction) with a corresponding shift of the left eye to the left (left abduction) in accordance with the Hering law
- The left eye will then make a corrective re-fixational saccade to the right (left re-adduction)
- On removal of the prism both eyes move to the right
- The left eye then makes an outward fusional movement
- Most children with good BSV should be able to overcome a 20 Δ prism from the age of 6 months. If not, weaker prisms (16 Δ or 12 Δ) may be tried, but the response is then more difficult to identify.

Binocular convergence

Simple convergence to an interesting target can be demonstratednfrom 3 to 4 months. Both eyes should follow the approachingmtarget symmetrically ‘to the nose’. Over-convergence in the infant may indicate an incipient esotropia. Divergence may be due either to a tendency to a divergent deviation or simply lack of interest.

Tests for sensory anomalies

Worth four-dot test

This is a dissociation test that can be used with both distance and near fixation and differentiates between BSV, ARC and suppression. Results can only be interpreted if the presence or absence of a manifest squint is known at time of testing.

- **Procedure**
  - The patient wears a green lens in front of the right eye, which filters out all colours except green and a red lens in front of the left eye which will filter out all colours except red
  - The patient then views a box with four lights: one red, two green and one white.
- **Results**
  - If BSV is present all four lights are seen.
  - If all four lights are seen in the presence of a manifest deviation, harmonious ARC is present.
  - If two red lights are seen, right suppression is present.
  - If three green lights are seen, left suppression is present.

○ If two red and three green lights are seen, diplopia is present.
○ If the green and red lights alternate, alternating suppression is present.

Bagolini striated glasses

This is a test for detecting BSV, ARC or suppression. Each lens has fine striations that convert a point source of light into a line, as with the Maddox rod.

• **Procedure.** The two lenses are placed at 45° and 135° in front of each eye and the patient fixates on a focal light source . Each eye perceives an oblique line of light, perpendicular to that perceived by the fellow eye. Dissimilar images are thus presented to each eye under binocular viewing conditions.

• **Results** cannot be interpreted unless it is known whether strabismus is present.

○ If the two streaks intersect at their centres in the form of an oblique cross (an 'X'), the patient has BSV if the eyes are straight, or harmonious ARC in the presence of manifest strabismus.
○ If the two lines are seen but they do not form a cross, diplopia is present.
○ If only one streak is seen, there is no simultaneous perception and suppression is present.
○ In theory, if a small gap is seen in one of the streaks, a central suppression scotoma (as found in microtropia) is present. In practice this is often difficult to demonstrate and the patient describes a cross. The scotoma can be confirmed with the 4 Δ prism test (see below).

4 Δ prism test

This test distinguishes bifoveal fixation (normal BSV) from foveal suppression (also known as a central suppression scotoma – CSS) in microtropia and employs the principle described in the 20 Δ test (the Hering law and convergence) to overcome diplopia.

• **With bifoveal fixation**
○ The prism is placed base-out (microtropia is commonly esotropic not exotropic) in front of the right eye with deviation of the image away from the fovea temporally, followed by corrective movement of both eyes to the left
○ The left eye then converges to fuse the images .

• **In left microtropia**
○ The patient fixates a distance target with both eyes open and a 4 Δ prism is placed base-out in front of the eye with suspected CSS .
○ The image is moved temporally in the left eye but falls within the CSS and no movement of either eye is observed

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○ The prism is then moved to the right eye which adducts to maintain fixation. The left eye similarly moves to the left consistent with the Hering law of equal innervation, but the second image falls within the CSS of the left eye and so no subsequent re-fixation movement is seen

TIP The 4-dioptre prism base-out test is useful to distinguish bifoveal fixation from foveal suppression (central suppression scotoma), which occurs during binocular viewing in patients with monofixation syndrome.

Synoptophore

The synoptophore compensates for the angle of squint and allows stimuli to be presented to both eyes simultaneously .It can thus be used to investigate the potential for binocular function in the presence of a manifest squint and is of particular value in assessing young children (from age 3 years), who generally find the test process enjoyable. It can also detect suppression and ARC.

• The instrument consists of two cylindrical tubes with a mirrored right-angled bend and a +6.50 D lens in each eyepiece.This optically sets the testing distance as equivalent to about 6 metres.

• Pictures are inserted in a slide carrier situated at the outer end of each tube. The two tubes are supported on columns that enable the pictures to be moved in relation to each other and any adjustments are indicated on a scale.

• The synoptophore can measure horizontal, vertical and torsional misalignments simultaneously and is valuable in determining surgical approach by assessing the different contributions in the cardinal positions of gaze.

Grades of binocular vision

Binocular vision can be graded on the synoptophore as below

• **First grade** (simultaneous perception – SP) is tested by introducing two dissimilar but not mutually antagonistic pictures, such as a bird and a cage.

○ The subject is then asked to put the bird into the cage by moving the arm of the synoptophore.

○ If the two pictures cannot be seen simultaneously, then suppression is present.

○ Some retinal ‘rivalry’ will occur although one picture is smaller than the other, so that while the small one is seen foveally, the larger one is seen parafoveally (and is thus placed in front of the deviating eye).

○ Larger macular and paramacular slides are used if foveal slides cannot be superimposed.

• **Second grade** (fusion). If simultaneous perception slides can be superimposed then the test proceeds to the second grade, which is the ability of the two eyes to produce a composite picture (sensory fusion) from two similar pictures, each of which is incomplete in one small different detail.
○ The classic example is two rabbits, one lacking a tail and the other lacking a bunch of flowers. If fusion is present, one rabbit complete with tail and flowers will be seen.
○ The range of fusion (motor fusion) is then tested by moving the arms of the synoptophore so that the eyes have to converge and diverge in order to maintain fusion.
○ The presence of simple fusion without any range is of little value in everyday life.
• **Third grade** (stereopsis) is the ability to obtain an impression of depth by the superimposition of two pictures of the same object which have been taken from slightly different angles. The classic example is a bucket, which should be appreciated in three dimensions.

Detection of abnormal retinal correspondence

ARC is detected on the synoptophore as follows:
• The subjective angle of deviation is that at which the SP slides are superimposed. The examiner determines the objective angle of the deviation by presenting each fovea alternately with a target by extinguishing one or other light and moving the slide in front of the deviating eye until no movement of the eyes is seen.
• If the subjective and objective angles coincide then retinal correspondence is normal.
• If the objective and subjective angles are different, ARC is present. The difference in degrees between the subjective and objective angles is the angle of anomaly. ARC is said to be harmonious when the objective angle equals the angle of anomaly and inharmonious when it exceeds the angle of anomaly. It is only in harmonious ARC that binocular responses can be demonstrated. The inharmonious form may represent a lesser adaptation or an artefact of testing.