Vision Science III - Binocular Vision Module

Lecture 26 - Anomalous Correspondence

(Steinman Chapter 2, p.. 17-19, P. 39-41; Chapter 3, P. 67-70; Griffith)

ANOMALOUS CORRESPONDENCE

In strabismus the person should see either diplopia or suppress. In some cases he is able to fuse, in spite of the strabismus. This indicates that he has **anomalous correspondence**. This is a subtle binocular anomaly seen in as many as half of strabismus cases. It may be present with or without eccentric fixation.

Normally the two foveas are corresponding retinal points, and they both have the same oculocentric visual directions—straight ahead. In anomalous correspondence, the fovea of the better eye is matched with some other point on the retina of the deviating eye. This occurs **only during binocular fusion**, and it reflects an attempt by the visual system to reconcile two disparate or non-corresponding retina images.

In the case of strabismus, the images fall on non-corresponding points on the two retinas, and the visual system must deal with confusion and diplopia. This may lead to suppression of the image from the deviating eye. Another way to deal with the conflict is to re-designate the visual directions in the deviating eye such that a non-foveal point becomes the corresponding point for the fovea in the other eye. Binocular fusion will then become possible as illustrated in Fig. 1.

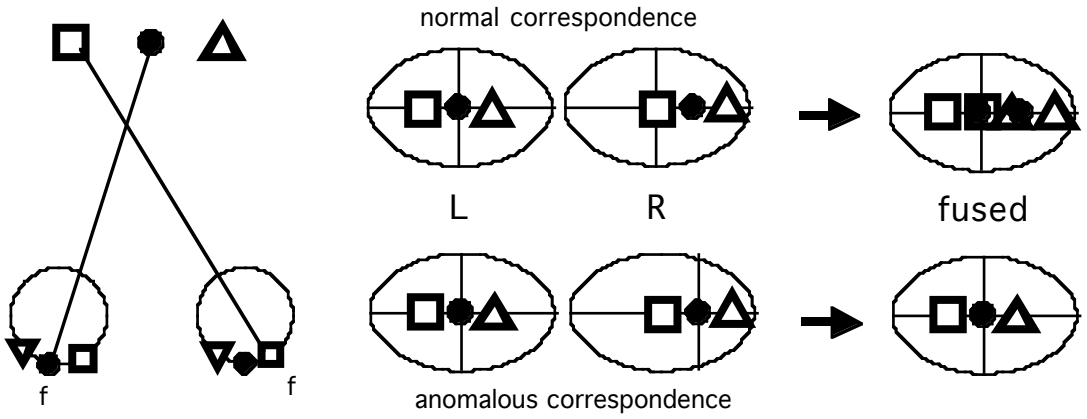

Figure 1. Example of normal and anomalous correspondence in a right esotropia. In normal correspondence, different images fall on corresponding retinal points, leading to diplopia and confusion. In anomalous correspondence, the visual system shifts its oculocentric coordinate system so that the visual directions of the left fovea and right non-foveal point (dot image on both) correspond. This eliminates diplopia and confusion.

In explaining anomalous correspondence, references often designate three angles:

- Angle H is the objective angle of strabismus and may be measured using the cover test with loose prisms. This is the angle of deviation for the eyeball itself.
- Angle S is the subjective angle of strabismus. It may be measured using the same principles as the von Graffe test or by measuring the perceived angle of diplopia.
- Angle A is the angle of anomaly. In normal correspondence, angle H (objective angle) and angle S (subjective angle) are equal. **In anomalous correspondence these angles are not equal,** and the difference between them is the angle of anomaly. Therefore

$$\text{angle A} = (\text{angle H} - \text{angle S}). \qquad (1)$$

When normal correspondence is present, the two diplopic images are separated by the same angle as the angle of esotropia. Angle H and angle S are equal, so the angle of anomaly is zero; there is no anomalous correspondence.

In anomalous correspondence there is no diplopia; the subjective angle of strabismus is zero. Yet the right eye is still esotropic. Therefore angle H is large, angle S is zero, and in this case,

angle A = (angle H - angle S) = (angle H - 0) = angle H (2)

One way to measure the subjective angle of strabismus is to present a different image to each eye in a stereoscope while both eyes are viewing and fusing. One object is foveally fixated by the good eye, and a different object, seen by the strabismic eye, is moved in that eye's visual field until it appears to align with the good eye's fixation object. This locates the subjective fixation axis for the deviating eye. In normal correspondence, the subjective fixation axis originates at the fovea. But in anomalous correspondence the fixation axis in the deviating eye originates from some other point on the retina. This is designated Point "a" in Fig. 2. The three angles (H, S, A) are also illustrated in Fig. 2. In the figure, the subjective angle (S) is smaller than the objective angle (H); therefore the angle of anomaly is:

angle A = (angle H - angle S) < angle H but > 0 (3)

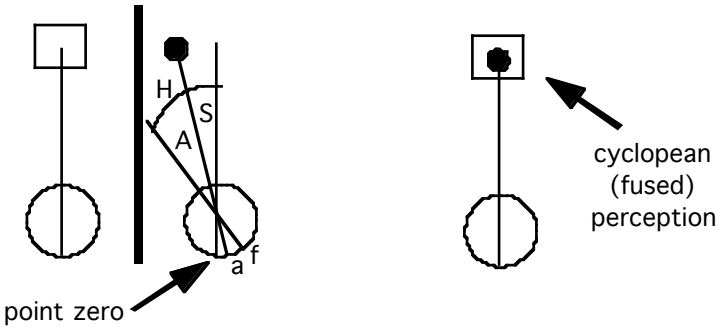

Figure 2. In a stereoscope each eye can be presented with a different target. The dot (for OD) is moved until it appears in the same visual direction as the square (seen by OS). This locates the anomalous fixation axis and anomalous point "a". Point zero is the retinal projection of straight ahead. This is a case of a right esotropia. Anomalous correspondence is sometimes called "anomalous retinal correspondence" and is abbreviated ARC. Technically this designation is incorrect because the change in correspondence does not occur in the retina, but in the visual cortex.

ANOMALOUS CORRESPONDENCE CATEGORIES

There are several sub-categories of anomalous correspondence, based upon the relationship between angles H, S and A. They are summarized in Table 1.

Harmonious anomalous correspondence

Figure 3 illustrates a case of **harmonious** anomalous correspondence. The sensory adaptation completely compensates for the angle of strabismus, and there is no subjective angle of strabismus. It is called "harmonious" because the angle of anomaly is equal to (in harmony or agreement with) the objective angle of strabismus.

Table 1. Types of anomalous correspondence.

Category	Characteristics
I. Normal correspondence	Angle H = angle S; angle A = 0.
II. Anomalous correspondence	Angle H does NOT equal angle S.
A. Harmonious anomalous correspondence	Angle S = 0. Angle A = angle H.
B. Unharmonious	Angle S is NOT equal to 0.
1. Unharmonious a.c.	Angle S < angle H
2. Paradoxical a.c., Type I	Angle A > angle H; angle S < 0.
3. Paradoxical a.c., Type II	Angle S > angle H; angle A < 0.

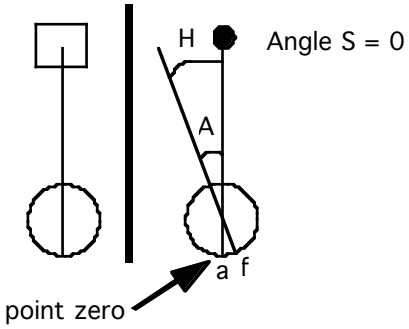

Figure 3. Harmonious anomalous correspondence.

Point zero refers to the retinal point where the true straight ahead image falls. Point a is the anomalous point, which acquires the anomalous oculocentric visual direction of straight ahead. In this case of harmonious anomalous correspondence, Point a and Point zero are the same. Harmonious a.c. is the most common type.

Unharmonious anomalous correspondence

Harmonious anomalous correspondence is relatively easy to understand. Unharmonious anomalous correspondence, is a bit more complex. The most common form of unharmonious anomalous correspondence will be explained first. Then we will consider two unusual subtypes of unharmonious anomalous correspondence, which are referred to as Paradoxical Type I and Paradoxical Type II anomalous correspondence.

In the most common type of **unharmonious** anomalous correspondence (formerly called typical unharmonious anomalous correspondence), there is a subjective angle of strabismus (angle S), but it is smaller than the objective angle of strabismus (angle H). This is illustrated by Fig. 4, which schematically shows an esotrope looking into a haploscope. Note that this example was also illustrated in Fig. 2, above.

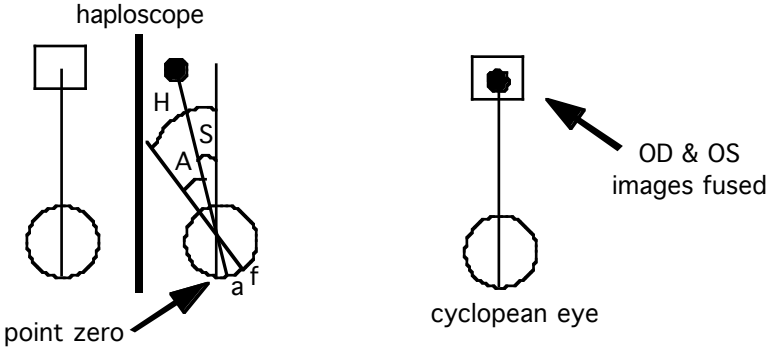

Figure 4. Example of an esotrope with typical unharmonious anomalous correspondence.

In harmonious anomalous correspondence (Fig. 3) Point a was located at Point zero. In unharmonious anomalous correspondence, Point a is located somewhere between the fovea and point zero. In object space, the dot is moved slightly nasally, through angle S, toward the true visual axis until the patient perceives that it is centrally aligned with the square. It is as if the visual system only *partially compensates* for the strabismus.

Paradoxical anomalous correspondence
These subtypes of unharmonious correspondence represent unexpected or paradoxical adaptations to strabismus and are sometimes seen following strabismus surgery.

Paradoxical Type I anomalous correspondence is illustrated in and Fig. 5 below. In this example of right esotropia, the objective angle H is directed nasally, but the dot must be moved to the temporal visual field in order to appear aligned with the foveal image of the other eye. Angles H and S are in opposite directions and the angle of anomaly (A) is the sum of the angles H and S. Even though the person is esotropic, he visualizes objects as if he were exotropic.

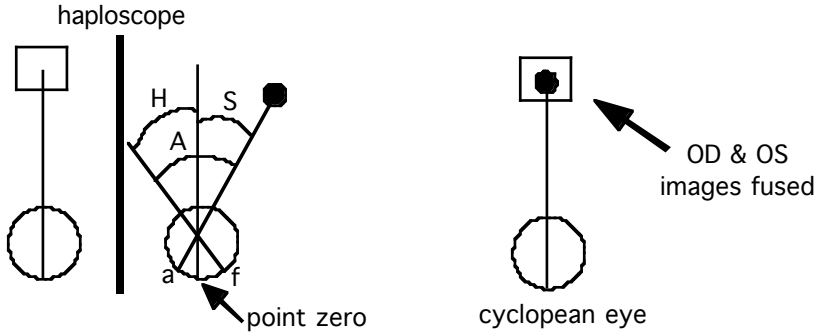

Figure 5. Example of an esotrope with paradoxical type I anomalous correspondence.

Figure 6 explains how this adaptation might occur. Consider a person who had a constant right esotropia. Rather than suppressing the right image, the person develops harmonious anomalous correspondence so that the zero point becomes the anomalous point (a).

Surgery attempts to realign the eyes, but it fails to realign them perfectly--they are still slightly esotropic following surgery. If the visual system retains the same anomalous point (a), it will now be rotated to a point nasal to the zero point, creating a Paradoxical Type I unharmonious anomalous correspondence.

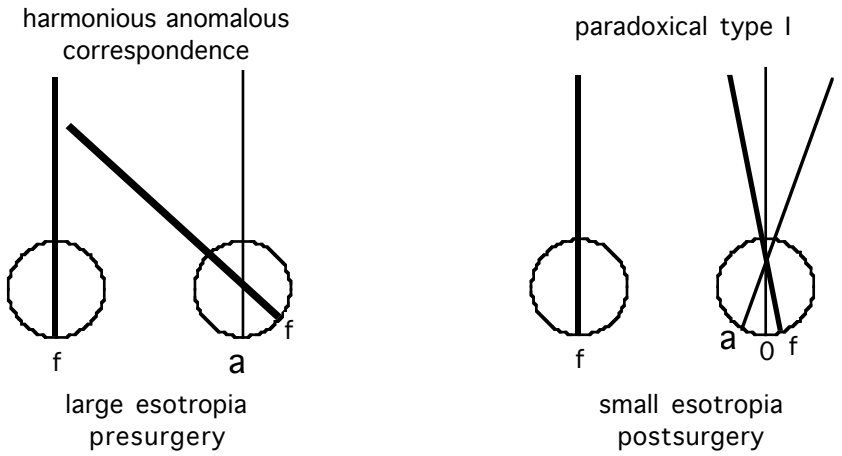

Figure 6. This illustrates how a harmonious anomalous correspondence prior to esotropia surgery can become a paradoxical type I anomalous correspondence after surgery.

Paradoxical Type II anomalous correspondence is illustrated Fig. 7. Although the eye is slightly esotropic (angle H), the dot must be moved through a greater angle S than the objective angle of strabismus (angle H). The angle of anomaly (A), which is between the true visual axis and anomalous subjective fixation axis, is smaller than angle S. Point a is on the opposite side of the fovea than point zero.

This can occur following surgical overcorrection of an exotropia, as illustrated in Fig. 8. The person with an exotropia develops a harmonious anomalous correspondence prior to surgery. Surgery overcorrects the exotropia and the person is left with a slight esotropia. If the eye retains the same anomalous point, a, the subjective angle (S) will now be larger than the objective angle (H) as shown in Fig. 8.

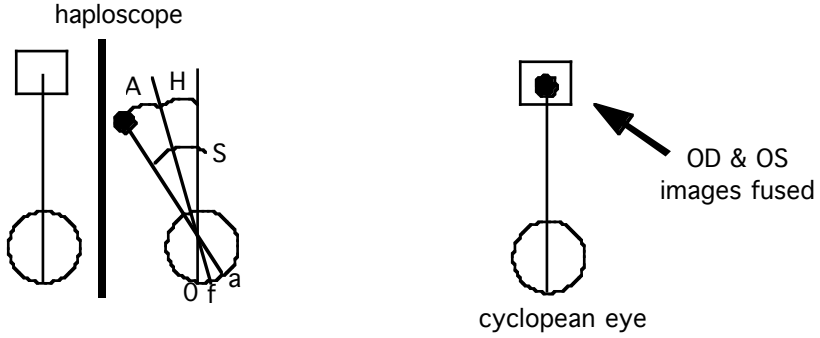

Figure 7. In paradoxical type II, the subjective angle (S) is greater than the objective angle (H).

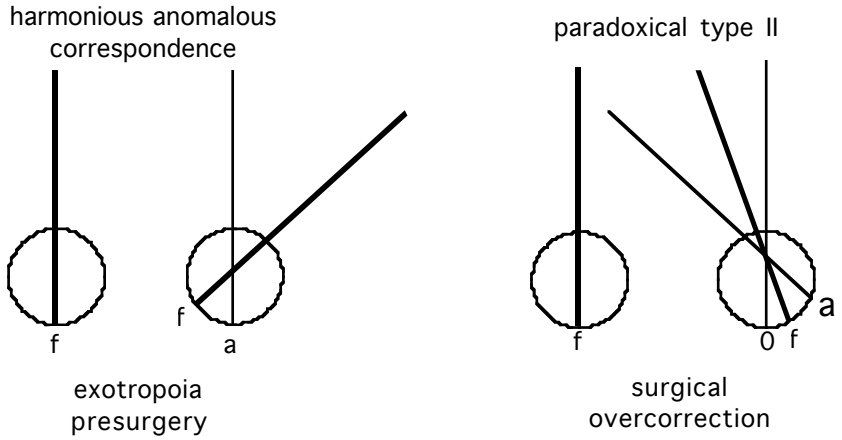

Figure 8. An exotropic person with harmonious anomalous correspondence prior to surgery can have a Paradoxical Type II unharmonious correspondence following a surgical overcorrection.