Vision Science III - Binocular Vision Module

Lecture 25 - Eccentric Fixation

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

ANOMALIES ASSOCIATED WITH STRABISMUS AND AMBLYOPIA

The major developmental binocular anomalies are amblyopia and strabismus. As we discussed in Lecture 24, patients with amblyopia have other visual anomalies besides poor stereopsis or reduced visual acuity. They also have:

- poorer contrast sensitivity (sometimes just high spatial frequencies, central vision)
- reduced vernier acuity
- the crowding effect
- reduced binocular luminance summation
- slower neural transmission from the amblyopic eye
- abnormal space, direction and motion perception

Two other anomalies sometimes seen in strabismic and amblyopic patients are:

- eccentric fixation
- anomalous correspondence

References: Griffin JR. Binocular Anomalies - Procedures for Vision 2nd ed. Professional Press, Inc., Chicago, IL. p. 88-123 and Griffin JR, Binocular Anomalies - Diagnosis and Vision Therapy, 3rd ed. Butterworth-Heineman, 1995.

ECCENTRIC FIXATION

Amblyopic and strabismic eyes sometimes do not fixate normally. Fixation may be unstable or the eye may have nystagmus. It may also be anomalous in the sense that some point other than the fovea is used for fixation. This is known as **eccentric fixation**.

Eccentric fixation can be present during both monocular and binocular viewing conditions, but **it manifests itself under monocular conditions**. This is important to keep in mind to avoid confusion with anomalous correspondence, which we will consider in the next lecture. *In contrast to eccentric fixation, anomalous correspondence is present only during binocular fusion and must be measured in those conditions*.

Eccentric fixation is seen in the **amblyopic or strabismic,** that is, the **non-dominant eye**. Generally in esotropia, a point on the nasal retina is used for fixation, while a point on the temporal retina is used for an exotropic patient with eccentric fixation. In addition, the eccentric fixation point is often displaced vertically.

Figure 1 illustrates an example of nasal eccentric fixation in a right esotropia. When neither eye is occluded, OD turns inward, and OS (the dominant eye) fixates straight ahead. By occluding OS, you force OD to fixate. In this case, OD attempts to fixate with Point e, the eccentric point located nasal to the fovea (f).

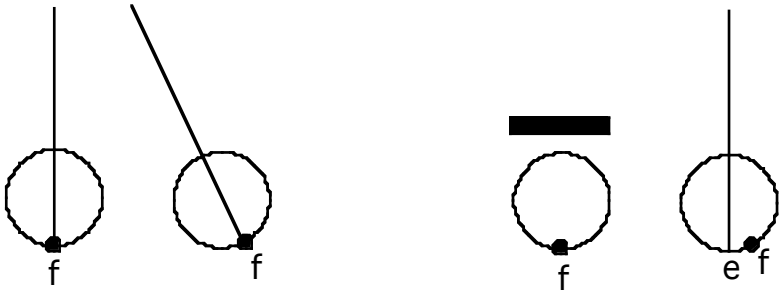

Figure 1. Eccentric fixation.

Visuoscopy / direct ophthalmoscopy
The easiest way to diagnose eccentric fixation is to use a direct ophthalmoscope. Select the foveal fixation target, and ask the patient to look directly at the target as you observe the fovea. The eye not being examined should be occluded.

Normally you will see the foveal light reflex in the exact center of the projected target. In eccentric fixation the foveal light reflex will not be centered, indicating that the patient is using some other point on the retina to fixate. The eccentric fixation point is the retinal point located at the center of the fixation target. You should note the:

- direction of the fixation point relative to the fovea
- magnitude of the deviation relative to the fovea in degrees, and
- whether the fixation point is steady or unsteady

Examples

- 1 degree nasal [to the fovea], steady or
- 2 degrees superior-nasal, unsteady.

Some ophthalmoscopes have reticles that can be used to measure angular distances on the retina. To verify the angular size of the reticle grid lines, project your ophthalmoscope onto a wall and measure 1) the distance to the reference mark from the target center, and 2) the distance to the wall. From this, compute the tangent of this angle, the arc tangent and the angle.

You can also estimate angular distances on the fundus by remembering that the distance from the optic nerve head to the fovea is about 15 degrees, and the optic nerve head diameter is about 5 degrees. The ophthalmoscopic technique for diagnosing eccentric fixation is sometimes called **visuoscopy**.

Haidinger's Brushes
Haidinger Brushes are an entoptic phenomenon observed when a person looks at a diffusely illuminated blank surface through a rotating polarizer. As the polarizer rotates you may notice a small figure eight or bow-tie pattern which rotates about the fixation point. One web site describes how you can see Haidinger's brushes when staring at the screen of a laptop computer (http://world.std.com/~mmcirvin/haidinger.html).

This phenomenon is probably caused by light polarization of xanthophyl pigment in Henle's nerve fiber layer in the macula. This provides a way to subjectively *locate where the fovea projects* in object space.

An instrument known as the Macular Integrity Tester-Trainer (MITT) may be used to generate Haidinger's brushes. Normally, when the patient fixates the reference dot on the faceplate, he will see the rotating brush pattern centered on the dot. This shows that the fovea coincides with the fixation point. In eccentric fixation, Haidinger's brushes are not centered on the fixation dot. The patient can use a pencil to indicate the center of the Haidinger's brushes while fixating the dot. Figure 2, below, shows a nasal eccentric fixation in OD. In this case the dot is temporal to the Haidinger's brushes, so the person has nasal eccentric fixation. Haidinger's Brushes can also used in vision therapy to correct eccentric fixation.

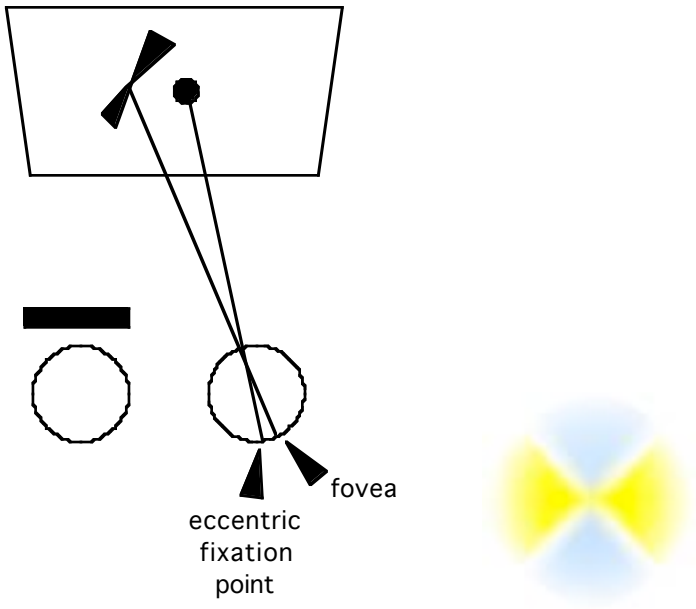

Figure 2. Haidinger's brushes tag the location of the foveal projection point in object space. This illustrates a nasal eccentric fixation in the right eye.

Foveal afterimage transfer

Figure 3, illustrates the Brock-Givner method to diagnose eccentric fixation using afterimage transfer. The example shows a nasal eccentric fixation in the left eye.

To do this test, the amblyopic eye (OS) is occluded while an afterimage is created on the fovea of the dominant eye (OD). The afterimage may be created using a strobe or by having the patient stare at a very bright vertical line. The dominant eye is then occluded and the patient is instructed to fixate the center of a horizontal scale with the left eye. Because of afterimage transfer, the patient perceives the afterimage (from OD) located in the direction corresponding to the OS fovea (assuming normal correspondence). It is as if the afterimage is transferred to the left eye fovea and is then projected into object space. In normal fixation, the afterimage will appear centered on the fixation point at the center of the horizontal scale. In eccentric fixation, the OS eccentric fixation point will be directed toward the center dot, but the fovea will be pointed at some other point. The location of the afterimage along the horizontal scale gives the magnitude and direction of the eccentric fixation.

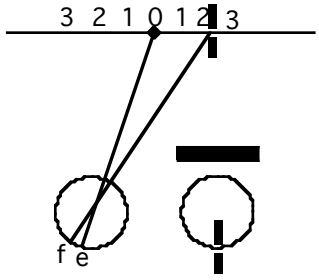

Figure 3. Using an afterimage on the OD fovea to measure a nasal eccentric fixation in a left esotropia.

Visual acuity and eccentric fixation

Since visual acuity decreases in the peripheral retina, the magnitude of the eccentric fixation will determine the best possible visual acuity that the patient may obtain in a case of eccentric fixation. This is summarized in Table 1 (taken from Griffin, 2nd Edition, Table 2J). Depending on the severity of the amblyopia, the visual acuity may be worse than that listed in the table.

Table 1. Visual acuity associated with eccentric retinal points.

Retinal eccentricity (degrees)	Maximum visual acuity
0	20/20
1	20/30
2	20/40 - 20/50
3	20/50 - 20/60
4	20/60 - 20/70
5	20/70 - 20/100
10	20/100 - 20/160