## VS 117 LABORATORY III: FIXATION DISPARITY

## INTRODUCTION

Under binocular viewing, subjects generally do not gaze directly at the visual target. Fixation disparity is defined as the difference between the target vergence angle (binocular parallax) and the ocular converence angle during binocular fixation, as shown in Fig. 1. Fixation disparity occurs in the presence of binocular feedback, so it is a closed-loop error. It is measured under the assumption that the fixation target remains fused.

Phoria is defined as the difference between binocular parallax and the ocular convergence angle during monocular fixation (i.e., when one eye is occluded), as shown in Fig. 1. Occluding one eye dissociates binocular vergence by eliminating feedback from binocular retinal image disparity, so it is an open-loop vergence error. The phoria indicates the position of rest of the eyes. The magnitude of the phoria is proportional to the magnitude of the fixation disparity.


Fig. 1: a) Fixation disparity and b) Phoria
fixation disparity $=\Theta-\delta$
phoria $=\Theta-\alpha$
The fixation disparity indicates the balance of two forces. One force is the disparity stimulus to disparity vergence and the other is the phoria. Several factors can influence the magnitude of the resulting fixation disparity, including the strength of the disparity stimulus (i.e. image size, retinal locus and image density), the ability to adapt vergence and reduce the phoria during binocular fixation, and the effects of lenses and prisms on the magnitude of the phoria. Large complex binocular foveal images are strong fusion stimuli. If a subject wears prisms for several minutes while fusing these images, the phoria produced by the prisms tends to be reduced in time due to prism adaptation. In essence, the open-loop vergence error is
adapted away. Clinicians can be surprised by their patients' ability to adapt away the need to wear prisms when the anticipated changes in phoria produced by a new spectacle correction disappear in several hours or days.

Generally, clinicians are concerned with how well the disparity vergence system can overcome the force or stress of the phoria. Fixation disparity can be used to measure this using a provocative stress test called the forced-duction or prism-induced fixation disparity function. In this test, a patient's phoria is altered with prisms added before the eyes. The resulting changes in fixation disparity are then measured. If the changing prism has little influence on fixation disparity, either the fusional or disparity vergence system is very robust or the vergence phoria is very adaptable. These patients often respond well to vision training exercises (ocular calisthenics), whereas patient who have large changes in fixation disparity with added prism usually require optical aids of lenses and prisms to relieve visual stress related to their phorias. The purpose of this laboratory exercise is for you to learn how fixation disparity is measured clinically, and how lenses and prisms can alter the fixation disparity and reduce stress on fusional vergence.

APPARATUS<br>Vision Analysis disparometer, polaroid glasses, prisms, lenses, pen-light

## PROCEDURE

For this lab, use the same subject used in Lab V (AC/A). Attach the disparometer to the metal stand 40 cm from the subject. The subject may wear his/her corrective glasses. The subject should put on the polaroid glasses and look at the vertical lines in the lower circle of the disparometer. With the glasses on, the subject will see the upper line with the right eye and the lower line with the left eye. These lines are called Nonius lines, named after the Portuguese mathematician Nunez who invented the first Vernier caliper. The subject should fuse the parafoveal Snellen charts while attending to the Nonius lines. The lines should be illuminated with a pen-light shining through the disparometer plexiglass window on the subject's right. The experimenter will rotate the knob on the back of the disparometer until the Nonius lines appear aligned to the subject. The experimenter then notes the corresponding fixation disparity.

Perform the experiment for each of the following three conditions, with each condition repeated five times. The prism should be placed in front of the right eye, and the lenses should be placed in front of both eyes.

1. Baseline: no prism or lenses
2. Prisms: $7 \Delta$ base-in, $4 \Delta$ base-in, $4 \Delta$ base-out, $7 \Delta$ base-out
3. Lenses: +2D, +1D, -1D, -2D

## REPORT

For this lab, turn in a single group report containing:

1. Data sheet (one data sheet per group)
2. Graphs (one set of graphs per group)
3. Questions (answered individually for each group member)

GRAPHS:
Graph 1. Plot the forced-duction curve (fixation disparity as a function of prism power) for conditions 1 and 2.

Graph 2. Plot the forced-duction curve (fixation disparity as a function of dioptric power) for conditions 1 and 3 .

Graph 3. Plot the derived AC/A (prism power as a function of dioptric power). The data points for this plot can be obtained by determining the pairs of prism and dioptric power that correspond to the same fixation disparity values from Graphs 1 and 2. You can draw horizontal lines across Graphs 1 and 2 at different fixation disparity values, and then locate the corresponding prism value on Graph 1 and lens value on Graph 2.

Below Graph 3, compare the derived AC/A from this lab with the gradient AC/A from Lab II.



QUESTIONS:

1. Which of the four classes of fixation disparity curves categorized by Ogle best describes your data?
2. How would the prism-induced fixation disparity curve change if the subject viewed the Nonius lines through negative lenses in addition to the prisms?
3. A negative lens induces convergence. Why does a negative lens also induce an eso-fixation disparity?
4. A base-out prism induces convergence. Why does a base-out prism also induce an exofixation disparity?
5. Define associated phoria and dissociated phoria.
