OPTICAL DEMONSTRATIONS

ENTOPTIC PHENOMENA, VISION AND EYE ANATOMY

The pupil as a first line of defence against excessive light.

<u>DEMONSTRATION 1.</u> PUPIL SHAPE; SIZE CHANGE

Make a triangular shape with the tips of your fingers; bring the triangle closer to your eye: What happens to the shape of the triangle?

Now open and close the other eye. Observe your own (consensual) Pupillary Reflex.

The pupillary reflex has been well studied quantitatively. If we arbitrarily increase gain of the pupillary reflex.

<u>DEMONSTRATION 2.</u> OSCILLATING PUPIL

Shine penlight just on the edge of the pupil. Pupil will oscillate in size.

In general, with poor focus as in uncorrected myopia size of blur circles is related to the size of pupil. Therefore decreasing pupil size causes improved resolution with sufficient ambient light

<u>DEMONSTRATION 3.</u> REFRACTIVE DISORDER/ PINHOLE

Chose a myopic subject: Find the far point of distinct vision by seeing how far they can see the tip of a pin clearly. Place text just beyond far point so as to be unreadable. Now view through narrow pinhole.

<u>ABBERATIONS AND DIFFRACTION</u>

The pupil plays a complex role in relation to image quality and hence to acuity. Three major physical factors are related to pupil size - can a point of light be imaged as a point on the retina?

<u>Spherical Aberration</u>

In any simple spherical lens, the edges of the lens refract more than the centre. Therefore, a distant point cannot be imaged as a point.

(Human cornea is actually somewhat flatter at edge; consider effects of hard contact lenses with large pupils).

<u>Diffraction</u>

Points of light are actually imaged as concentric bright/dark rings. Diffraction effect is greater with smaller pupils.

<u>Chromatic Aberration</u>

Short wave length light is refracted more than long wavelengths.

Therefore, given a white light, different wavelengths will be imaged at different depths.

DEMONSTRATION 4. BLUE-FREE ZONE IN CENTRAL FOVEA

DIRECTIONALITY OF VISION

Visual world is imaged on the retina as in a camera (left-right; up-down inversion). Yet we locate directions accurately relative to our position in space.

DEMONSTRATION 5. PRESSURE PHOSPHENES

Press gently with a cotton swab on the cornea of your eye. Can you see a pale flash of light? Where does it seem to come from?

Schlodtmann's Experiment and the innate nature of visual direction.

(Keep in mind the orderly relationship between retinal position and visual direction: How is it that we can adapt to optical disruption of direction such as in inverting or lateral-displacing prisms?)

RETINAL VESSELS AND THE STABILIZED IMAGE

Retinal receptors are supplied by way of the choroidal circulation and the pigment epithelium.

Inner nuclear and ganglion cells by way of central retinal artery.

Why don't you see these vessels since they lie in the path of the light? Probably because their shadows are stabilized on the retina.

Therefore, if we illuminate eccentrically, we might see them.

DEMONSTRATION 6. PURKINJE VESSEL FIGURE

Illuminate eye through the sclera with a penlight. It is now possible to see an important point about the position of retinal vessels relative to the fovea

DEMONSTRATION 7. AFTER IMAGE IN FOVEA WITH VESSELS

Rods have lower thresholds and different spectral sensitivity than cones. Purkinje allegedly observed the relative brightness of the rose and its leaves in his garden. His actual experiment involved differences in visibility of coloured cards as the morning light began to appear.

DEMONSTRATION 8. RED AND BLUE: BRIGHTNESS IN DIFFERENT LEVELS OF ILLUMINATION

SPEED OF RESPONSE

Cones work more rapidly than rods: Activate ganglion cells sooner and the message reaches the brain sooner. Even within the photopic range, lower illumination levels lead to slower response of receptors and ganglion cells.

DEMONSTRATION 9. REACTION-TIME UNDER CONDITIONS OF DIM AND BRIGHT ILLUMINATION

Two illusions induced by differences in latency of response.

DEMONSTRATION 10. FLUTTERING HEARTS

A more subtle effect can be seen binocularly.

DEMONSTRATION 11. PULFRICH EFFECT

Object moves back and forth

Seen as a disparity by the two eyes. Therefore interpreted as depth hence elliptical orbit.

PERSISTENCE OF ROD AFTER IMAGES

DEMONSTRATION 12. FLASH AFTER 5 MINUTES DARK ADAPTATION

We will make this the last demonstration, since to work we should dark-adapt for some time.

CENTRAL COURSE OF OPTIC NERVE FIBRES

Retinal ganglion cells fire, and axon conducts centrally; first along retinal surface. The fibers gather at the optic nerve head, and thence through to the brain. The transmission on the retinal surface is via unmyelinated optic nerve fibers.

DEMONSTRATION 13. BLUE ARCS

(l) Why are they shaped as they are?

(2) Why are they coloured blue?

There are no receptors at the point where the optic nerve leaves the eye.

DEMONSTRATION 14. BLIND SPOT

Close one eye. Push card towards and away from the open eye.

STABILITY OF THE VISUAL WORLD: EFFERENCE COPY AND THE ILLUSION OF MOVEMENT

When we sweep our eyes over the scene in front of us, it appears to remain stable. Why? Not necessarily because it is stable.

<u>DEMONSTRATION 15.</u> JIGGLING YOUR EYE WORLD MOVES

Helmholtz Interpretation: Signal from brain nulls apparent movements of the world when we voluntarily move our eyes.

(Note! Not brought into play during vestibular induced movements).

THERE EXIST A PARALLEL SET OF EXPERIMENTS WHICH REINFORCE THE VIEW

Suppose you have a stable image on your retina and will the eyes to move. What happens? Conversely, if you jiggle your eye, the after-image remains stable.

<u>DEMONSTRATION 16.</u> ACTIVE AND PASSIVE MOVEMENT OF THE EYE WITH AN AFTER IMAGE ON FOVEA

EYE MOVEMENTS

Some systematics about movements of the eye. There are five distinctly different mechanism of eye movement. Saccade, pursuit, OKN, VOR and vergence.

<u>DEMONSTRATION 17.</u> SMOOTH PURSUIT VS. SACCADIC MOVEMENT

Observe your partner

(1) following a smoothly moving target

(2) trying to replicate that movement

Only saccade is under voluntary control.

<u>DEMONSTRATION 18.</u> ACCOMMODATION AND VERGENCE MOVEMENT

Ask subject to view a distant target: observe the eyes and pupil as you bring it closer to their face. (pupil size decreases as eyes converge)

VESTIBULO-OCULAR REFLEX

DEMONSTRATION 19. SHAKE HAND WITH HEAD STILL; SHAKE HEAD WITH HAND STILL

also READ TEXT WHILE SHAKING HEAD OR BODY

ADAPTATION TO DISPLACED VSISION

DEMONSTRATION 20.

Point at target. Adapt. Mis-point when prism removed.

Argument that effect is not visual

(1) Doesn't transfer between arms

(2) Transfer to pointing to a sound source

VISION IN CONFLICT WITH PROPRIOCEPTION

DEMONSTRATION 21. Visual Capture

VISUAL CONTROL OF GRASPING

DEMONSTRATION 22. Catch ball of different sizes.