ır resolution of the eye

t separation that two objects can have and still be dis-
ɛparate depends on their brightness and contrast. For
sion, the diffraction limit for a 2 millimeter pupil
ıbout 1 arc minute at the fovea. For scotopic vision acu-
ıes markedly and is hard to measure, but becomes a
ı degree or so.

ıse the eye's resolution is limited to 1 arc minute does not
er bright objects go unnoticed. It is a matter of contrast.
, of course, and even the largest of those is subarc second
ınspots less than 1 arc minute in diameter are detectable
kings on the solar disk under photopic conditions.

:onstants of the eye

se time of the eye depends on light level: 20 milli-
1/10 second for photopic conditions; 1 second and
scotopic. Pupil size adjustment takes a few seconds.
ınts of up to an hour are associated with the chemical
ıt accompany dark adaptation.

ɔwnst to us, image fluctuations are necessary to stimu-
l. Experiments show that if the eye's movement is pur-
ated, perception slowly fades until nothing but a gray
1 remains[12].

ƆF THE DISAPPEARING RAINBOW

xt you see a nice rainbow try the following experi-
ich demonstrates the need for image movement in
rst put aside your camera; it cannot record what you
: to perceive. Now fixate on some part of the bow. This
y and requires extreme concentration and discipline
:he eye naturally wanders. It may help to fixate on a
nd object near the bow, such as a tree branch or
ıle. Anyway persist. Suddenly you will become aware
:ainbow has faded away; it has simply vanished! Any
f your eyes and it will instantly reappear.

ʼou have just experienced demonstrates that the eye
detector that requires constant movement to func-
Section 7.5. In fact there is nothing peculiar to the
as a test object, except its smoothness and lack of
ıkes it an easy target.

7.6 Color vision

The eye is a trichromatic receptor. Our color sensors, the retinal cones, contain three kinds of pigments, call them red, green, and blue, that selectively absorb light (Figure 7.6). Light induced neural stimulations by these cones are sent to the brain for interpretation. Notice that the red and green cones are not well separated in wavelength and that the blue absorption extends well into the ultraviolet where there is little natural light. Taken together, this arrangement yields color vision just as the dye layers in color film produce color pictures.

Certain pairs of colors can add to produce white light as perceived by the eye. These pairs are called complementary colors: yellow and blue-violet; red and blue-green, for instance.

Complementary colors are those that when added produce a colorless sum. The complementary color of a given color can be perceived in its afterimage.

Chromatic adaptation is another effect that may explain 'green shadows' (Section 1.3) made famous by Goethe[13]. Look through a red filter for a minute or so, then remove it and notice that the scene takes on a blue-green hue. Your red response has fatigued to favor the green.

During twilight we encounter two quirks of color vision: color constancy and the Purkinje effect. Color constancy causes an object to retain its accustomed color regardless of illumination conditions. My blue sweater remains blue to me even in the red rays of a low sun, while strangers might assert that it is a dark brown.

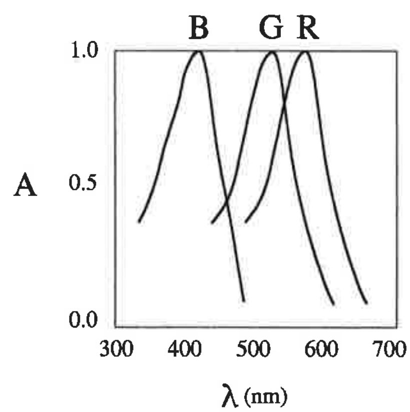

Fig. 7.6 The retinal surface has been examined to measure how the light absorption (*A*) of the cones depends on wavelength λ independent of perception by the brain.

Well after the sun has set our peak color sensitivity shifts from 560 nanometers to 500 nanometers (the Purkinje effect), so that red objects grow abnormally dark and green foliage assumes greater prominence in the landscape.

Not completely understood, color vision has many aspects that are subjective and involve the translation of visual input by the brain. These kind of experiences, which are perfectly real and repeatable, have not been adequately dealt with by any one theory[14–16].

SUBTLETIES OF VISION

7.7 Mach bands

The eye is not to be trusted in the judgement of luminance adjacent to a step change in brightness. Our eye will think it sees nonexistent light and dark bands parallel to a contrast step. These regions are called Mach bands (see Figure 2.5B).

Mach bands are present because cones do not operate independently. One cone 'knows' what its neighbor is seeing and responds both to the amount of light falling on it and the adjacent receptors. At a high contrast bright boundary, the interplay between adjacent cones causes a bright stripe where the image becomes dark, and a dark stripe where the image goes bright[17, 18].

Fig. 7.8 Setting sun over the Sea of Cortez carves a notch ou irradiation.

7.8 Irradiation

Brightly illuminated areas having sharp boundaries appear to the eye larger than they should. This is called irradiation and examples are found in the apparently exaggerated width of a crescent moon against its dark side, or the notch in the horizon produced by a setting sun (Figure 7.8).

Irradiation is a consequence of scattered light in the receptor and is common to both photographic film and the eye. All the light entering a photographic emulsion is not absorbed; some is scattered within the gelatin layer. When scattered into a region where little or no direct light falls, it exposes the film and the result is indistinguishable from the adjacent bright image. At the high contrast boundary of an overexposed image of the sun, this scattered light spreads across the boundary to produce an enlarged disk. Irradiation in the eye, called the entopic halo, is what we see around street lamps at night.

7.9 After-images

If you gaze intently at a bright scene for several s close your eyes, or glance at a uniform and d strange-colored duplicate of the original is perc after-image[2]. Color of the after-image will be co the original. Such after-images can complicate th the green flash or colored shadows, phenomena and not physiological in origin. In our eagernes flash we may stare too long at the solar disk and t may be overridden by after-images. Subtle co around us may also be lost.

Retinal fatigue, or saturation, is the expla images. Gazing at a green object leads to a depress sitivity; on turning to a less bright white scene cones dominate so that the object area is now sens magenta.