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DARK ADAPTATION

When persons move from a relatively bright or well-lighted area to a relatively dark area, it takes a brief amount of time before the human eye can *see* the detail or even the existence of certain objects that may be present in the relatively dark area. This phenomenon is called *dark adaptation*.

The occurrence of "dark adaptation" should be of concern to individuals controlling the presence and amount of lighting in areas where hazards may exist for pedestrians, and of special concern in the safe design of such facilities as theaters, auditoriums, night-use parking lots and similar locations where persons are likely to pass from relatively light environments to relatively dark environments.

Dark adaptation can also affect the perception of the operators of motor vehicles under a variety of conditions. Dusk driving conditions have traditionally been associated with poor perception and an increased incidence of automobile accidents. This may be related to the reduced visual capability of the eye as light conditions change from light to dark. That is, while the cones experience a diminished ability to function, not enough time or "darkness" is available to cause the rods to function.

The adaptation of the human eye to different absolute (and relative) levels of brightness and darkness, and the ability to see under such conditions, is brought about by the reactions of specific structures of the eye that react differently under relatively light and dark conditions.

First, when a person goes from a relatively light area to a relatively dark area, the pupil of the eye increases in size to admit more light. Conversely, the pupil tends to contract in bright light to limit the light that enters the eye. This process takes a few seconds, and as one proceeds from one condition of illumination to another, one may be partially "blinded" until this process is complete.

A second reaction of the eye involves the chemical *bleaching* and *reconstitution* of rhodopsin or "visual purple" in the rods of the eye. Under relatively dark conditions, the cones of the eye (which are color sensitive) lose much or all sensitivity. Vision in dim light is the function of the rods, which have a low threshold of excitation; that is, they respond to light of low intensity. The rods are not concerned with color vision as their visual impulse are recorded in black and white or a combination of the two (shades of gray).

The rods of the eye require rhodopsin in order to function. In bright light conditions, rhodopsin is bleached out of the rods rather quickly and they cease to function, with vision being achieved solely by the cones. When an individual passes from bright to dim light conditions, rhodopsin must be resynthesized or reconstituted. Until this takes place, vision is seriously impaired. Data regarding the rate of rhodopsin resynthesis indicates that 50 percent of the resynthesis process may take place in 10 to 12 minutes of total dark conditions. The same data indicates that the time required for complete dark adaptation can take up to 30 to 40 minutes or more.

Also, while rhodopsin may be "completely reconstituted" after a period of time in total darkness and "completely bleached" in bright sunlight, in mid-range lighting conditions, rhodopsin may be reconstituted and present in the eye in some proportion to the degree of diminished general lighting or selectively bleached by spot lighting. Further, while "dim light" (relative to "bright light") will allow some degree of rhodopsin to be reconstituted, thus enabling some corresponding degree of "night vision" to be achieved, should one move from dim lighting conditions to "relatively darker" lighting conditions, one will experience a coinciding diminution of night seeing ability.

Night vision is also affected by visual angle. When you want to see something in ordinary daylight, you turn your eyes toward it -- you point your fovea toward it -- because this is the most sensitive part of the eyes in daylight. Because the cones (in the fovea or center of the retina) are insensitive to twilight or night conditions, foveal vision (looking straight at an object) is not effective in seeking out dim targets after dark. The general population is typically unaware that as the angle of view from the fovea is increased, the concentration of the (night vision) rods becomes denser, and night vision is enhanced. At night, when illumination is below that of about full moonlight, the fovea of the eye is almost blind, and one cannot see faint targets at night by looking directly at them – one must look slightly away from them. Use of this technique, being radically different from normal experience, typically requires training and a conscious effort to succeed. It is not generally known that if an observer merely wants to *detect* something at night, he or she should look about 20 degrees to one side of where it is *expected* to be, and, if an observer wants to *identify* something at night, he or she should look 4-8 degrees to one side of it.

Another critical factor related to the ability to visually detect objects under reduced light conditions is *expectancy*. It is very important to understand that *target detection under night light conditions is extremely difficult even when an observer* ***expects*** *the target to be present. Such detection in regard to* ***unexpected*** *targets is exceptionally difficult.*

Select References

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