BALLISTIC FIREARMS TRAINING CENTER, LLC

Optics – Night Vision and Target Acquisition

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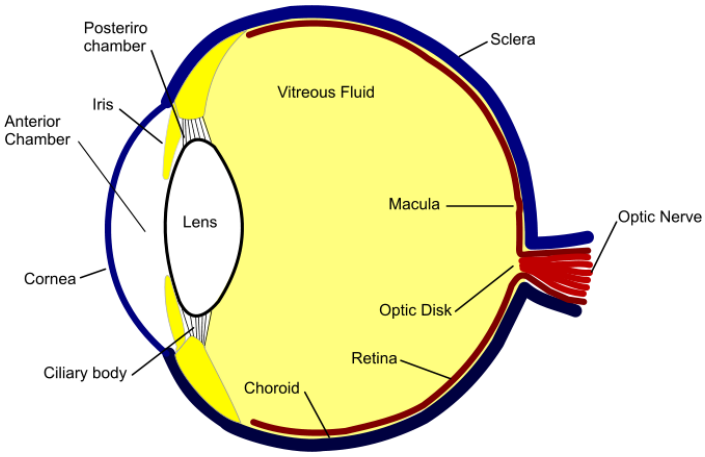
The primary sense used in defensive handgun use is vision. Understanding vision optics in well lighted scenarios versus twilight or in darkness is explored.

Vision is not always accurate during stressful events. Interpretation of a scene is often reported differently by people. The differences can be subtle or vastly different. Sometimes witnesses don't even see what other witness claimed to have happened. To understand this and the tactical implications one should understand eye function along with accompanying psychological and physiological effects on the body.



The eye is a sensory object and doesn't see anything; it does send sensory information from its receptors to the brain where the eye sensory information is interpreted. The quality of the information sent to the brain and how this information is interpreted is dependent on multiple factors.

The cornea protects the eye lens allowing light to pass through the lens. The iris controls the amount of light entering the eye. This prevents overstimulation of the retina receptors.

The image a person sees is projected against the retina. The macula is the center of retina and is composed of about 7 million cones that interpret color. Surrounding the cones at the center of the retina are rods. It is estimated that there are around 120 million rods in the surrounding retina. Rods don't perceive color but are more sensitive to low light and perceive motion in low light. Rods are not sensitive to red light; this is why red lights are used at night so as to not ruin night vision.

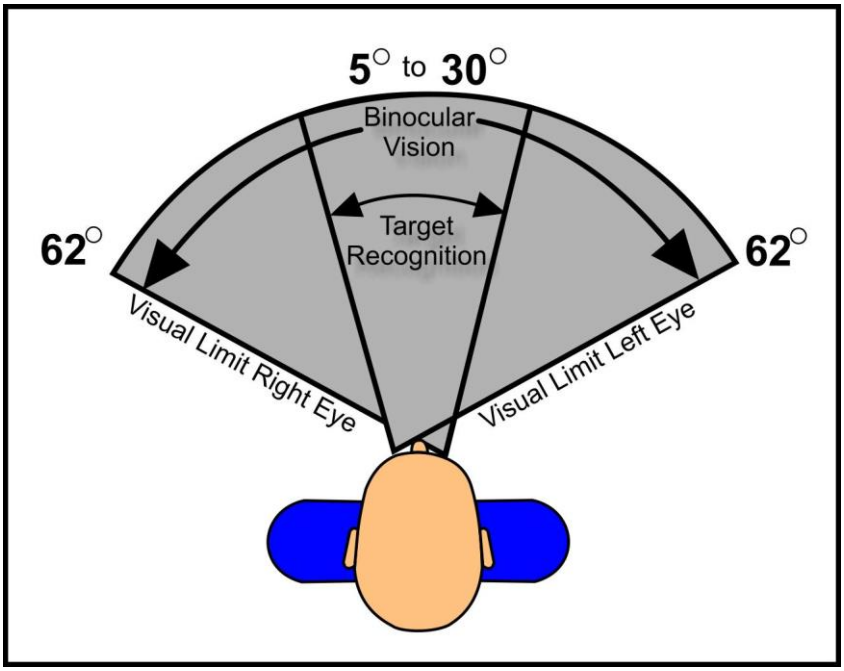
The choroid is the layer between the sclera and retina that provides blood flow to the eye. The reflection from the retina, red eye, is caused by the blood rich choroid.

The ciliary body is composed of ligaments and muscle surrounding the lens. The ciliary body is responsible for focusing the image on the retina.

Vision can be broken down into three phases; daylight, twilight, and night. The cones at the center of the retina provide the best clarity about the subject such as shape, texture, contrast, and colors. Daytime vision is cone dominated and provides depth perception. It is during the daytime, that the eye is most fixated on a subject and has the best control. Eye movement from target to target is smooth and controlled in the daylight environment.

Accurate focusing relies on a well lighted environment to maintain optimal focus and targeting to keep the object centered on the cone rich area of the eye for all the aforementioned reasons.

Binocular vision also relies on accurate focusing. Judging distance is accomplished by the overlap of visual fields; right and left eye overlap. A person has approximately a 30 degree field of view for target recognition where distance can be judged and the maximum amount of light is on the cone of each eye. This is where the term "tunnel vision" comes from. Visual acuity is obtained when the head is turned toward the target of interest. Vision outside the binocular field is out of focus. Degradation of focus is gradual, worsening toward the outward periphery of the visual field.



Tunnel vision is both good and bad. If there are multiple threats and they are not all in the binocular vision field they may not be seen because of the primary threat in the visual target field. This is why tactical trainers emphasize to look left and right after engaging a target or when first coming upon a volatile scene to assess the total threat environment.

Twilight (low light) diminishes the ability to focus on an object as clearly as it would during daylight. Less light is cast onto the cones. Cones require a minimal level of light to fixate onto a target and maintain controlled focus. The interval between daylight and night vision, twilight, shifts vision stimulation from cones to the rods. Eventually, the rods dominate the visual field. Color stimulation from the cones diminishes, the ability to focus clearly diminishes until night vision is acquired and rods dominate the visual field.

The resulting loss of color, contrast discrimination, and diminishing focus ability is lost. However, during this time peripheral, and movement perception in the spatial field of the rods is acquired due to the large number of rods 120 million versus 7 million cones. Depth perception and details on targets is diminished. The amount of degradation is dependent on how much night time light is available (e.g. full moon versus no moonlight).

Nighttime vision results in loss of color and target detail. The pupil will dilate resulting in additional focus degradation. Movement and peripheral awareness increase but shapes, target detail, texture, and contrast is vastly diminished. Cone transition takes about 5 to 7 minutes to be lost in darkness, whereas, it takes rods 30 minutes to adapt to darkness. It is important to note that night vision will be lost if light is presented in the field (e.g. flashlight, muzzle flash, car headlights, etc.) Once this occurs it will take another 30 minutes for the rods to fully adapt to darkness.

Psychological and Physiological Effects of Stress on Vision

As stated earlier, the quality of information sent to the brain for visual interpretation varies due to variables such as light quality (daytime, twilight, or nighttime), ability to focus, personal vision deficits, prior personal experience, and interpretation of visual information.

In a non-stressful environment, these variables cause people to often interpret scenes differently. How often have we observed a landscape or view only to find others around us seeing things we have not noticed? Now, put the same people into the stress of a life or death scenario and the variances in visual processing is exasperated.

In a tactical environment, vision is the primary sensory input. When the body perceives stress and is preparing itself for an offensive attack (time deficit), adrenaline and cortisol's are dumped into the blood stream. The adrenaline causes the ciliary muscles to relax during high level stress events resulting in poor focus (even in daylight conditions). This is the reason tactical trainers teach focusing on the front weapon sight only. The ability of the eye to rapidly change focus is lost; hence, focus on the front sight of the weapon is critical.

The use of both eyes is necessary in a tactical environment to enable depth perception and gain a greater field of vision. If one eye, is closed the closed eye and open eye try to accommodate one another. The open eye will dilate more because the closed eye is has light shut out. The closed eye also cannot focus so the open eye will not focus as well. The closing of one eye to aim will also limit the amount of sensory image data to the brain.

Depth perception is diminished due to loss of focus (ciliary muscles relax). A person must shift from a front sight of a weapon to a perpetrator and back again. This all takes time and in a defensive position the time deficit to recognize a threat and react puts a person at high risk of injury or death.

Target recognition further delays reaction time based on experience of an individual and the persons psychological makeup. Always remember the defensive operator has to overcome a time deficit to an attack. The past experience a person has is vital to threat recognition. It is the brain that interprets the visual signals and compares this visual information against prior experiences in training and actual field encounters.

It is not uncommon for an operator involved in a shooting to not remember all the details of the shooting. This is due to several factors. Adrenaline is known to hijack the ability to think; cognitive ability is diminished. Tactically, personnel are trained to react to a multitude of high stress life threatening situations. This is done to discern threat levels, thus, decreasing reaction time. Visual processing time is reduced. A person will react to a threat in an appropriate manner based on training and experience. The reaction to the threat often times bypasses cognitive processing (reflex psychomotor memory) thus, reducing reaction time.

The ability to remember all the events is a short term encounter is not uncommon. Can you remember every stop or small town you drive through every day to work? Do you have to think and process batting softballs out to the boys you are training. Batting balls at first is hard; you throw up a ball and miss hitting it. You do this over and over again; until one day, you can hit a ball out to the

left field, right field, center field, hit ground balls, etc. all without cognitive processing. This is called reflex psychomotor memory.

Reflex psychomotor memory is developed through repetition and variability in training scenarios. Police and military recognize the importance of this and now use training simulators and live fire exercises with Simunitions ammunition (soap filled bullets), and live fire drills to help reduce reaction time by reducing reaction time to visual threats. This training is useful but only with qualified personnel that can handle stress better than the average person.

Not all people handle life threatening stress well. Generally, people who enter special operation units; SWAT or Military Special Operation Groups handle life threatening stress much better than the average person. Army Special Forces typically graduate 1 person out of every 100 people who start training.

Specialized training over a lengthy training period identifies personnel best qualified. Attrition during training is a natural way to select those best suited for high stress environments. People often think that going into an elite unit trains them in right stuff to be a special operator. In reality, the military use this training to sort out the elite people. Those that pass already possess the skills to handle high stress operations. Weapons training, tactics, etc. are technical skills that are learned and become the tools of an elite warrior.

Conclusion

Tactical defensive shooting relies primarily on a persons' ability to process threat recognition in a minimal amount of time. This is diminished when adrenaline and cortisol's are dumped into the blood stream. Additionally, and more importantly our sense of sight is adversely affected during twilight and full nighttime darkness. The ability of an individual in these conditions to interpret a deadly threat and overcome the time deficit from and offensive act takes a special person and a large amount of training. Training has to be variable so and effective operator can observe, adapt, and execute the proper threat response. The proper threat response may require an operator to do nothing when everything around him is in total chaos.