Fundamentals of Rifle Shooting

The job of the shooter is to fire one perfectly executed shot!

RIFLE

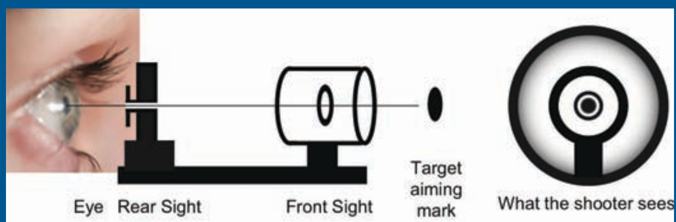
When one analyzes the general process of shooting in competition and what the athlete must do to be successful, it boils down to what we call the "job of the shooter" which is to fire one perfectly executed shot. Then analyze, reset and repeat. The job, as in every other, consists of tasks or skills accomplished in a specific way and general order. When we analyze these tasks, we can break them down to five essential components or fundamentals. Skip one or do it incorrectly and the result is very likely to be less than the acceptable standard.

A fundamental is an essential component of a system that, without it, the system fails or the structure falls. The five fundamentals of rifle shooting are: aiming, breath-control, hold-control, trigger-control and follow-through. For new shooters, learning the fundamental skills correctly provides a strong foundation to build upon, without which, the athlete will not progress as quickly or be able to reach his or her potential in the sport.

Aiming

We begin with the fundamental process of aiming. The most common type of sighting system used in rifle shooting is an aperture or peep rear sight affixed to the receiver, in conjunction with a front sight tunnel attached to the muzzle end of the barrel with changeable or adjustable front sight inserts. The most commonly used front-sight insert is an appropriately sized round aperture although a post insert may be used. Using this type of sighting system makes aiming much easier and more precise than using open sights like those found on pistols with a notch and post.

In order to hit the target consistently, the barrel must be pointed in the correct place. To do this the shooter must align their eye with the rear sight and front sight. The small opening of the rear sight should appear round with the front sight centered in the field of view. The target is not included in the definition of sight alignment.

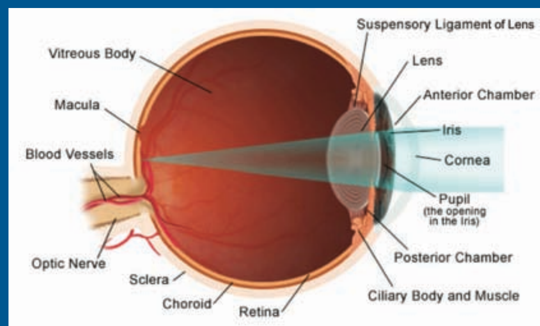


Sight Alignment

Sight picture, on the other hand, is the combination of aligned sights and the aiming point or target. The sight picture shown is an ideal image because the gun is continuously moving and so the aiming point does not stay perfectly still inside the round aperture insert ring. Aiming, then, is the dynamic process of aligning the eye, the rear sight, the front sight and the target. In theory, the aiming method described above seems quite simple and easy to understand. However, when the shooter tries to aim it can prove to be much more challenging as difficulties often arise from the peculiarities of the eye and its use during aiming.

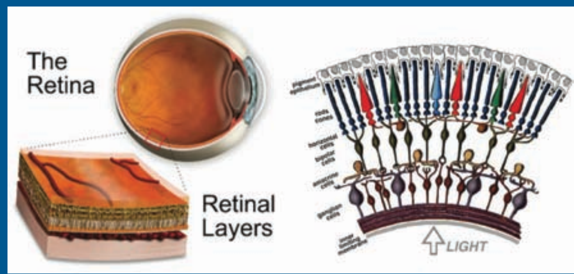
The Eye

Aiming places great demands on the shooter's visual capacity. Accuracy and consistency directly depend on visual acuity and the conditions that determine visual acuity. As the sensory organ, the human eye, coupled with the processing of the brain is capable of distinguishing millions of different colors, shapes, size, brightness and location of objects in the environment. We depend on this sense more than any other of the five senses, especially in the shooting sports, so it is important to know what we are dealing with as we aim.



Eye with Internal Structures

The eyeball is an optical device for focusing light. The front portion of the eye consists of several refractory tissues and surfaces, the cornea, aqueous humor, the iris, which has an opening called the pupil, the crystalline lens and the vitreous humor, through which light passes to stimulate a light sensitive membrane, the retina. The image formed on the retina, albeit smaller and upside down, is converted to nerve impulses by a photochemical reaction and transmitted to the visual cortex portion of the brain via the optic nerve that processes what we see.



Retina Detail with Rods & Cones

In order to see the world around us clearly, the image formed on the retina must be sharp. The normal eye at rest (or relaxed) is focused at infinity, so distant objects appear in focus, but nearby objects appear out of focus. To see closer objects clearly, the ciliary muscle contracts reflexively to change the shape of the crystalline lens to a more convex form increasing the refractive power and bring the near object into focus on the retina. This ability is called accommodation. Distant objects will now be out of focus. The eye cannot clearly focus on objects located at different distances at the same instant. While the reflex action of accommodation can take place quickly (especially in younger people when the crystalline lens is quite flexible) this puts a strain on the visual apparatus and must be avoided.

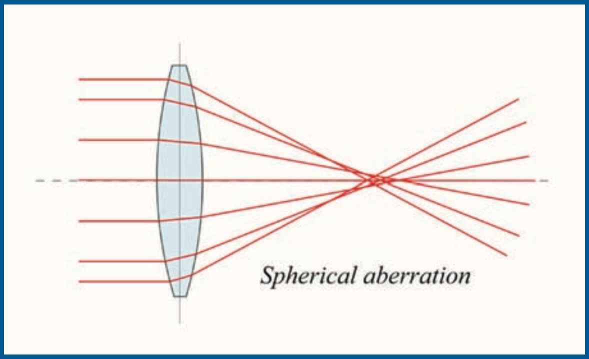
The eye also responds automatically to varying amounts of ambient light, by opening or closing the pupil via another reflexive action of the group of smooth muscles that controls the iris. This dilation or contraction of the pupil, called adaptation, regulates the amount of light entering the eye. The normal pupil opening ranges from a maximum of approximately eight millimeters to a minimum of two or three millimeters. As we age, the maximum opening decreases to six millimeters making it more difficult for older people to see at night. The pupil opening adapts much more quickly to increased illumination (a few seconds) than it does to a decrease in illumination (a few minutes). Therefore, it is critical to avoid looking at brightly illuminated objects before or during shooting, and a major reason flash photography is not permitted during shooting competitions.

The action of the pupil is similar to the f-stop in a camera. The depth of field or the range of distances that the camera (eye) sees as being in focus increases as the f-stop aperture (pupil) size becomes smaller. The artificial pupil of the fixed rear aperture, or an adjustable rear iris, takes advantage of this thereby allowing the shooter to increase the depth of field so all the elements of the sight picture are clearly seen in focus.

Imperfections of the Eye

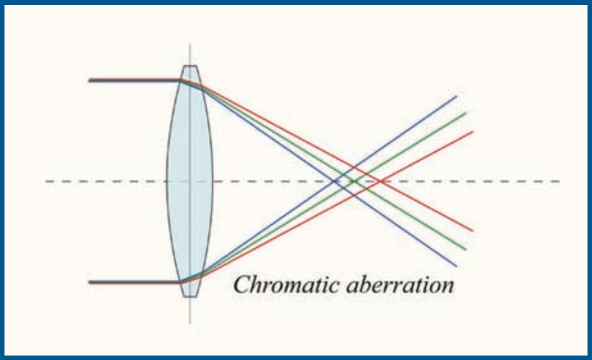
As a result of optical imperfections of the various components of the eye, the edges of the image produced on the retina are not always perfectly clear. This is the ultimate limit of the resolution of the eye or visual acuity. However, under differing conditions of ambient light and/or fatigue, visual acuity is not constant and can change.

There are several inherent phenomena that occur as a result of the eye being an optical instrument. The first is spherical aberration, which occurs when parallel rays of light passing through the crystalline lens are refracted differently and thus not focused at a single place on the retina. Light passing near the edge of the pupil, farther from the center of the opening, are refracted more than those passing through the center. This appears as a circle of diffused light rather than a sharp image. Spherical aberration is at a maximum when the pupil is open the most. Image clarity can be improved if one can eliminate the outer rays by either contracting the pupil or using an artificial pupil like that on the rear sight.



Spherical Aberration

A related problem is chromatic aberration. Visible light is made of all the colors of the spectrum. When visible light passes through a lens, light in the blue and violet region refracts more than that in the orange and red region of the spectrum focusing each color at a slightly different point, causing a fringe or margin of colors to appear around the edges of the image, especially around bright objects. This occurs because lenses have different refractive indexes for different wavelengths of light. Eliminating or reducing the amount of shorter wavelength (blue) light by a filter can improve image clarity.

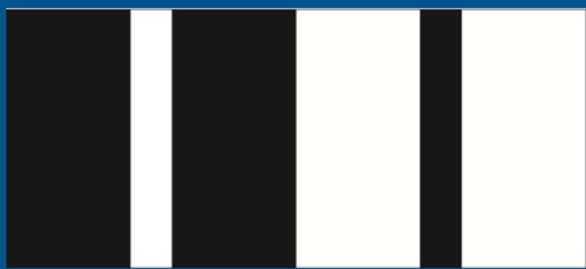


Chromatic Aberration

Another phenomenon occurs when light passes through small openings, like the pupil or rear aperture, the rays bend and produce an image on the retina that is not a single point, but a circle surrounded by a number of concentric light and dark rings of decreasing brightness. This is called light diffraction and is due to the wave nature of light. Diffraction rings are only noticeable when the pupil is very small and is the opposite of the cause of spherical aberration (large pupil). Diffraction effects are more noticeable when bright light is shining into the eyes causing the pupil to contract. Another demonstration of diffraction is found when looking through a small aperture. Looking carefully at the center of the opening, there seems to be a faint grey ring floating there, it is not dirt or fuzz, it is the diffraction pattern of the light.

Light can also be diffused as it passes through the various eye media, which are not absolutely transparent. Light diffusion manifests itself as a radiance or weakly luminous haze covering the field of vision, and is especially noticeable as a halo of light around brightly illuminated objects against a dark background or when bright light enters the eye directly.

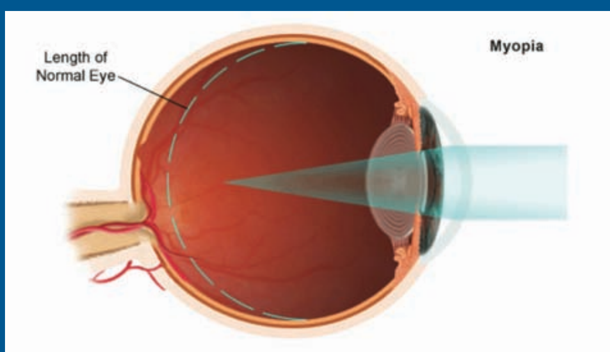
Light irradiation is probably more applicable to pistol shooting with open sights, but it is included here for those who may use a post insert to show the effect of optical over-estimation of sizes of objects set against a dark background. The widths of the black and white stripes are identical but the white stripes appear larger than the black ones do. The effect is related to the amount of light illuminating the surface. A change in the brightness of the target's white background will cause the eye to perceive the space between the front sight and the lower edge of the target as being different even though it is the same, resulting in high or low shots.



Light Irradiation

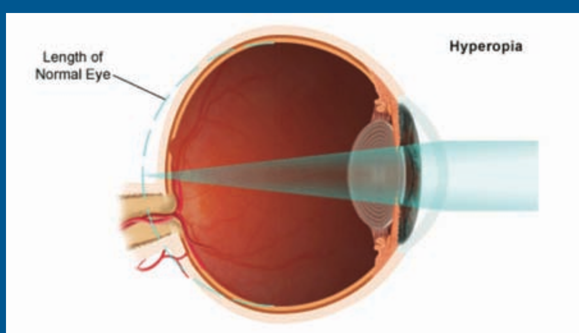
The eye is considered normal if the rays of light from a distant object entering the eye focus exactly on the retina without any effort at accommodation. However, other optical imperfections of the eye affect visual acuity including nearsightedness (myopia), farsightedness (hyperopia) and astigmatism.

Nearsightedness occurs when the parallel rays entering



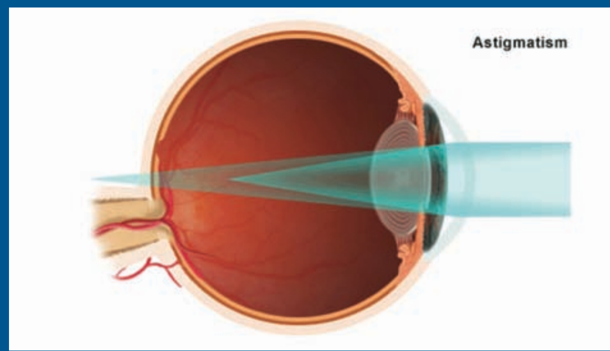
Myopia

the eye are focused in front of the retina. This is typically the result of an eyeball that is too long or a lens that has too much refracting power. Myopia is easily corrected with proper corrective lenses. Many top-level shooters are nearsighted and



Hyperopia

wearing glasses does not interfere with their performance. Farsightedness is the opposite condition from myopia. An eyeball that is too short and/or a lens that has too little refracting power causes light entering the eye to focus behind the retina. Shooters over the age of about 40, suffer from presbyopia, which is due to the gradual hardening with age of the crystalline lens so that it is no longer flexible enough for the ciliary muscles to change the shape sufficiently to focus on close objects. These conditions are a bit more challenging to correct but can be resolved by selecting appropriate corrective lenses. An eye where the cornea and the crystalline lens do not have a perfectly spherical shape is astigmatic. The light rays entering



Astigmatism

the eye do not form a single focused image on the retina, but rather several foci at various distances from the retina. This causes the image to be indistinct and erratic. Corrective lenses can also be used to fix astigmatism but it is important that the orientation of the lens in shooting glasses be maintained correctly. If the lens is rotated off the correct axis in relation to the eye, the shooter's vision will be affected. Even if the eye and its structures are perfectly normal, the tear layer on the outside of the cornea can cause slight astigmatism that can be transient. Dry weather can reduce the amount of tear layer present at various places on the cornea and this can influence clear vision until the tear layer refreshes by blinking the eyelids.

Every shooter should have their vision checked regularly with a thorough eye examination, and even small defects should be corrected. Over long courses of fire, the extra effort to accommodation will fatigue the eye with a deterioration of vision. It is also important that a corrective lens is placed so that the line of sight is perpendicular to the surface of the lens and through the center of the lens. This is because the center of the lens is ground more precisely to the prescription. Special shooting glass frames that can be adjusted to hold the lens in the correct orientation when the head is in the aiming position are essential once the shooter advances.

There is still more we need to know about the eyes and how they work including binocular vision and how to adjust and optimize the aiming aids available to the shooter. More on that in the next installment, until then, keep your eyes on the target.

▪ *Marcus Raab*