

Eagle-Eyed Sharp Shooters: The Importance of Visual Skills and Acuity in Precision and Military Marksmanship

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Marksmanship is the ability to consistently and accurately shoot one's desired target. It is an important skill for members of the military or competitive shooters to refine. As a soldier in the military, it is crucial to be able to accurately shoot because it could protect many lives by eliminating dangerous threats. Competitive shooting athletes must also be stellar marksmen in order to elevate their careers and compete in world-class matches, such as the Olympic Games. There are many components that go into becoming an elite marksman, such as significant amounts of practice, but vision is one of the most important. Vision includes visual acuity, saccadic latency, fixation stability, and binocular versus monocular amplitude. Some of these aspects of vision are more exclusive to competitive precision shooting, such as monocular amplitude. Other aspects are more relevant to military shooting, such as saccadic latency or binocular amplitude. However, visual acuity is crucial for all aspects of marksmanship.

In fact, visual acuity, or the clarity of a person's vision, is so important to military marksmanship that there are visual acuity standards that must be met by prospective soldiers in order to enlist. These standards state that a person's corrected or uncorrected vision must be 20/40 or better, to be in the United States Navy, Army, or Marine Corps (Hatch, Hilber, Elledge, Stout, & Lee, 2009). The inclusion of visual acuity in physical aptitude assessments began in World War II (Wells, Wager, Reich, &

Hardigan, 2009). The requirements have been refined as the standards have evolved over time, leading to the annual vision screening for all service members beginning in 1995. Presently, visual acuity standards are set to monitor both military occupational special eligibility and the ability to enlist in special operations and jobs, combat readiness, and marksmanship (Wells et. al. 2009).

There have been several studies done to test the accuracy of the visual acuity standards set by the United States military. Hatch et. al. analyzed the effect of visual acuity on marksmanship and target discrimination. Participants simulated five different visual acuity ranges by wearing refractive lenses that corrected, over-corrected, and under-corrected vision to various degrees. Participants then shot at randomly presented targets from varying distances with the glasses to test the effects of visual acuity on shooting performance. To test target discrimination, "enemy" and "friend" targets were presented randomly in each of the visual acuity levels, and participants were instructed to shoot at only at "enemy" targets (Hatch et. al., 2009). The performance-based results of the study lead to the conclusion that the United States military's visual acuity standards are accurate and valid, as they support optimal marksmanship performance and target discrimination.

In a similar study by Wells et. al., the relationship between marksmanship performance and visual acuity was investigated. Wells et. al. eval-

uated twenty-eight participants under simulated night conditions and day conditions using either a prescription that created blurry vision or the participant's normal prescription. The participants then used the Army's Engagement Skills Trainer 2000, which is a video simulation system, to test their marksmanship skills. They concluded that a significant relationship between marksmanship performance and visual acuity exists, showing that marksmanship performance decreases as visual acuity decreases (Wells et. al., 2009). This study also supports the visual acuity requirements of the military, as individuals who have better visual acuity are more likely to demonstrate accurate shooting. Studies have also been conducted to find ways of improving marksmanship in relation to eyesight, such as the Moore et. al. quiet eye training study. Teaching task-specific gaze control, also known as quiet eye training, has been known to enhance motor skill attainment (Moore, Vine, Smith, Smith, & Wilson, 2014). Moore et. al. randomly assigned twenty participants to either technical training or quiet eye training in simulated maritime marksmanship tasks to see how quiet eye training affected the accuracy of firing at rapidly approaching target with machine guns. A moving-target task was completed as a baseline test prior to the trainings and two retention trials. The quiet eye training group demonstrated more accurate performance and stronger gaze control than the technical training group (Moore et. al., 2014). This study indicates that the use of quiet eye training in the military could enhance marksmanship skills as soldiers would be able to focus for longer periods of time and have greater visual target locking which leads to increased accuracy. This could be particu-

larly useful for maritime marksmen, such as members of the United States Navy, as targets are typically in motion while in the water. By having an increased ability to visually lock into a target in motion, the soldier would be more likely to shoot accurately as the target is in greater focus.

While studying the effect of visual acuity on marksmanship in the United States military is still relevant, as evidenced by research exploring the necessity of visual acuity requirements, there are also other focuses currently being explored regarding visual acuity and marksmanship. Research has found a relationship between vision and competitive shooting accuracy. Competitive shooting has taken the spotlight largely due to the Olympic Games bringing competitive shooting to an international stage and introducing the sport to spectators and researchers all over the world.

One study conducted related to vision and competitive shooting accuracy analyzed the benefit of moveable pistol sights. Carkeet, Brown, and Chan examined how spatial interference affects vertical pistol sight alignments (see Figure 1) and its effects on shooting accuracy. Participants simulated aligning virtual pistol sights to a virtual target displayed on a computer screen. The simulated target displayed varying distances and the participants aimed the simulated pistol at it accordingly by adjusting the virtual sights. The accuracy of the adjustment of the placement of the virtual sights in relation to the virtual target demonstrated that systematic error of vertical sight alignment is affected by the proximity of the target in the visual field. This would affect the performance of pistol shooters as the visual sight picture would have to change based on target distance in order to consistently hit the center of the target (Carkeet, Brown, & Chan, 1996). However, because sights on modern pistols are adjustable, performance in pistol shooting would not be likely to change significantly if the shooter adjusts their sights to compensate for the systematic errors. This study demonstrates the importance of the moveable sights in precision pistol shooting because they enable shooters to create a more consistent visual cue even when the target is placed at different distances. Without the adjustable sights, the pistol shooter would need to visually place the sights in different places on the target as it moved distances, creating more room for error as the marksman is less consistent in their visual cues.

Another study examined the effect of a three-month visual training program on pistol shooting and visual function at the Olympic Train-

ing Center in Sant Cugat, Barcelona, Spain. Eleven members of the Catalan Government Special Intervention Squad participated in this clinical trial that worked to enhance visual skills in order to improve pistol shooting performance (Quevedo i Junyent & Solé i Fortó, 1995). A pre-test evaluated the pre-existing visual function and the average shooting scores, and a post-test analyzed these same features after the participants completed the three-month training program. The results indicate that precision shooting scores increased significantly. Three months after completing the program – six months after the commencement of the program – the researchers evaluated the scores again to determine if the increase could be attributed to the visual training or simply practice. The pistol scores decreased significantly three months after the completion of the visual training program, indicating that visual training caused the improvement in pistol shooting performance – not merely practicing pistol shooting (Quevedo i Junyent & Solé i Fortó, 1995).

Additionally, the visual training program by Quevedo i Junyent and Solé i Fortó improved visual function itself. This is seen in several of the variables evaluated in the pre- and post-tests, including saccadic fixations or the points between rapid eye movements, accommodative facility at distance and at near, binocular analytical amplitude, negative relative accommodation, among others. Typically, elite competitive pistol shooters tend to have a dominant eye that is much stronger than the non-dominant eye. After completing the visual training program, there was a reduction in the average differences between both eyes, improving binocularity rather than the monocular typical

of precision shooters (Quevedo i Junyent & Solé i Fortó, 1995). This is also beneficial for non-competitive shooters such as police forces or the military, as they often must aim with both eyes open and non-blinded. This study also suggests a causal relationship between visual skills improvement and improvement in pistol shooting scores, demonstrating the transfer of visual skills into performance skills (Quevedo i Junyent & Solé i Fortó, 1995).

Visual skills relate to shooting performance in disciplines outside of pistol shooting as well. A study by Francesco Di Russo, Sabrina Pitzalis, and Donatella Spinelli examined the visuo-motor functions used in visual scanning in high-level clay target shotgun shooters in comparison to a control group. Visual scanning was measured by fixation tasks and saccadic tasks in this study. Each of the individuals in the experiment throughout both the professional shooting group and the control group had normal visual acuity. In the fixation task, participants were subjected to a standard condition and a distracter condition while fixating on a center point over the course of one minute. The shooters were significantly better at the fixation task than the control group, both with and without the distracters (Di Russo, Pitzalis, & Spinelli, 2003). In the saccadic task, participants once again experienced a standard condition and a distracter condition while performing visually guided saccades toward a target as quickly as possible. The shotgun shooters demonstrated faster saccadic latency than that of the control group in both conditions (Di Russo et. al., 2003). This reveals that elite shooters in shotgun disciplines have stronger visual skills in relation to fixation stability and saccadic latency than people who do not

shoot. These skills are likely developed due to the nature of the sport; shotgun shooters need to track sporting clays in order to shoot them. Having faster saccadic latency and a stronger fixation stability is likely to improve target locking with the target in motion, similar to maritime marksmen needing to locate and lock onto moving targets in the sea.

A future research study could analyze the ability to strengthen the non-dominant eye to the point where it functions comparably, if not equally, as well in precision pistol shooting to the dominant eye. According to the study by Quevedo i Junyent and Solé i Fortó, the differences between the dominant and the non-dominant eye could be generally reduced following their three-month visual training program. Competitive precision pistol shooting is a monocular sport; often special glasses have a prescription lens over the dominant eye and a blinder that covers the non-dominant eye, allowing it to remain open and absorb light without providing any visual interference when aligning the sights to the target. A visual training program that spans longer than three-months with more frequent practice sessions could potentially strengthen the non-dominant eye more significantly.

If more balanced monocular vision could be obtained, either eye could be used for aiming purposes in precision pistol shooting. This could be beneficial for precision shooters who have sustained an injury or infection to their dominant eye by enabling them to continue shooting at a high level by switching eyes. Additionally, precision shooters who have a dominant hand that is different from the dominant eye – for example, shooting left-handed with a right eye dominance – could benefit from the

ability to switch eyes. Learning to switch eyes would enable these shooters to become more balanced and stable, as they would no longer need to twist around in order to see their sights clearly. Finally, balancing out the capabilities of the dominant and non-dominant eye could enable stronger binocular vision, which would be beneficial to military marksmen as they often are shooting with both eyes open when in battle.

Overall, visual skills and visual acuity are incredibly useful in marksmanship. This can be seen in competitive settings, such as precision pistol or clay-target shooting, and in military or police settings. While each of these shooting disciplines is very different, they all rely on similar visual capabilities in order to lock on to a target and properly align the sights to take accurate and consistent shots. As more visual training programs are developed, marksmen of all disciplines can improve their craft, making them more competitive or keeping communities safer.

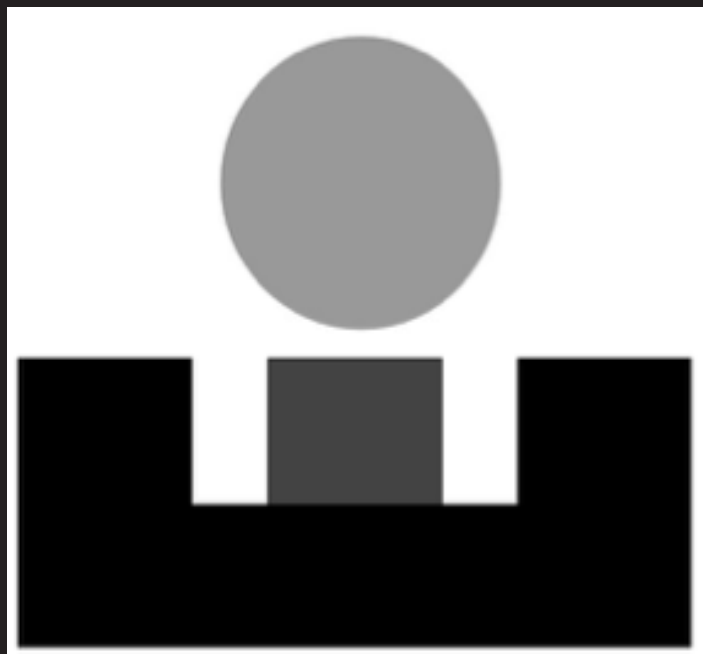


Figure 1 – The front sight (middle rectangle) is lined up with the back sights (outside rectangles), controlling the up/down placement of the shot. The front sight is directly in between the back sights, controlling the left/right placement of the shot. The gray circle simulates the target (Nothnagle, 2019).

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