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Hunter vision screening

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Abstract
Visual deficiencies are found to be a factor in hunting accidents. Hunting, by its nature, is very dependent on vision. However, a vision test is not required to obtain a hunting license. In an age matched population, 278 licensed hunters were screened to assess visual abilities. The data collected through this screening survey of appropriate visual skills for hunters, suggests a need for the implementation of vision requirements for a hunter prior to licensing. A suggested battery of screening tests appropriate for hunting vision skills are presented.

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HUNTER VISION SCREENING

By

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A thesis submitted to the faculty of
the College of Optometry Pacific
University Forest Grove, Oregon for
the degree of Doctor of Optometry
May, 1992

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Lee Ann Remington, O.D.
HUNTER VISION SCREENING

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ABSTRACT

Visual deficiencies are found to be a factor in hunting accidents. Hunting, by its nature, is very dependent on vision. However, a vision test is not required to obtain a hunting license. In an age matched population, 278 licensed hunters were screened to assess visual abilities. The data collected through this screening survey of appropriate visual skills for hunters, suggests a need for the implementation of vision requirements for a hunter prior to licensing. A suggested battery of screening tests appropriate for hunting vision skills are presented.

Key Words: hunter, vision screening, hunting accidents, hunting vision skills
INTRODUCTION

The 1989 North American Association of Hunter Safety Coordinators Hunting Accident Report, revealed that 1693 hunting accidents occurred during the year 1989. 172 of these were fatal and 1521 were non-fatal. At least one of the parties involved was reported to have deficient visual skills in 846 (49.9%) of these accidents. If the hunter had been aware of his visual deficiency prior to entering the hunting field and had subsequently corrected or compensated for it, some of these accidents might have been prevented.

The current Fish and Wildlife Service hunting regulations in several states require strict identification of hunted game animals such as sex and species of waterfowl, upland game birds and big and small game. At this time, there are no regulations governing vision requirements prior to obtaining a hunting license in any of the fifty United States.

The importance of good vision in association with a firearm is obvious. Good vision is necessary in hunting more than in any other sport. The eyes play a major role in spotting game, aiming and firing. If a hunter is deficient in any visual skill, he/she may not only be dissatisfied by an empty game bag, but also is a threat to the lives of fellow hunters in the field.

According to the North American Association of Hunter Safety Coordinators 1985-1989 Hunting Accident Report, four of the major causes of hunting accidents are:

The victim is mistaken for game.

The victim is out of the shooter's sight.

The victim is covered by the shooter swinging on game.

The victim moves into the line of fire.

All four of these are vision related and optimal vision is required to prohibit the occurrence of an accident. Deficient visual skills are often the cause of both inability to bag game as well as the cause of many hunting accidents.

The visual skills required for a safe and successful shooter consist of: static visual acuity, dynamic visual acuity, peripheral vision, visual eye-hand coordination, eye-body coordination, visual concentration, color perception, depth perception, accommodative flexibility, oculomotor accuracy, binocularity, motor function, eye dominance, perception of speed, perception of angular motion, contrast sensitivity, figure ground interpretation and visualization.
The American Optometric Association Hunting and Vision News
Backgrounder describes several of these visual skills involved in the action of spotting game, taking aim and firing. Since these steps occur in split second sequence in most hunting instances, visual skills must be accurate, precise and second nature to the shooter.

The visual skills every hunter needs include:

**Good Distance Acuity** - The ability to see sharply and clearly at a distance. It is also an important part of the visual process used in aiming and firing. Distance vision can be blurred by nearsightedness (myopia), farsightededness (hyperopia) and higher degrees of astigmatism. These three conditions can be compensated for by corrective lenses.

**Good Nearpoint Acuity** - The ability to see clearly objects at a close distance. For hunters this is especially important in sighting the first bead on their gun sights for accurate shooting. Precise nearpoint vision is also important in cleaning and loading of guns, reading ammunition labels and checking the working mechanism of the firearm.

Sometime after age forty, most people gradually begin to lose the ability to focus at close distances. Without corrective lenses or specific modified gunsights, aiming and firing of a gun can become inaccurate and inconsistent for a hunter of this age population.

**Peripheral Awareness** - The ability to "see out of the corner of the eye", or efficiency of our "side" vision. This skill enables a hunter to maintain an awareness of what is going on around him/her while keeping the center of visual attention on the gunsight and game.

This skill allows the hunter the ability to spot fast moving targets while swinging on game, before it moves into the line of fire. It also gives the hunter cues for balance and surrounding environment orientation while swinging on moving game.

A hunter with good peripheral awareness is less likely to cause an accident when swinging on game or to become an accident victim himself/herself by stepping into the line of fire of a fellow hunter he/she did not see.

**Depth Perception** - The ability to quickly and accurately judge the distance between the hunter and the quarry, as well as to accurately judge the speed of the game on the run, or a fast rising bird, is depends on depth perception.

Depth perception requires that the two eyes work together as a team. Good depth perception can give clues in an unfamiliar area when determining how
far away objects and game are. This visual skill helps to position and center on the moving target in order to hit the mark or bring down the game with the first shot. For the purposes of this study, stereopsis and depth perception are used synonymously.

**Visual Pursuit** - The ability to use the eyes to follow a moving target smoothly and easily is an essential vision skill for hunting.\(^1\)

This skill is also based on good eye teaming and muscle balance. In order to follow a moving target or game, the hunter must have smooth and accurate visual pursuit skills.

**Color Vision** - Hunters need to rely on their ability to distinguish colors properly to help them locate game against a variety of backgrounds and, at the same time, avoid mistaking a fellow hunter or domestic animal for game.\(^1\) Genetically, 8.0% of all males and 0.4% of all females are color deficient.\(^2\) Color vision is not something that can be corrected, but the hunter should be aware of the deficiency. The hunter may learn to discriminate shades and put more attention on the detail of an unknown object before firing. If hunters are aware of their condition, they may learn to adapt to it or compensate for it.\(^7\)

**The Dominant Eye** - Every person with vision in both eyes has a sighting or dominant eye. For 85% that eye is on the same side as the dominant hand.\(^1\) When it is not, difficulties in accurately sighting a gun may arise.

Mismatch between sighting eye and handedness, especially with handguns, usually results in misses and possibly unsafe conditions for other hunters in the field. The same angle of error between an incorrect sighting eye and the gun is projected out along the line in which the bullet will travel. At the gunsight, the distance of this error angle may seem small, but once the bullet has traveled a hundred yards or further the distance of the angle of error becomes dangerously large.

**Double Vision** - The condition in which a single object is perceived as two objects rather than one is diplopia.\(^15\)

1963 was the earliest study on the visual skills of hunters by the Minnesota Optometric Association. It was reportedly the first hunter casualty study ever made in this country relative to eye defects.\(^1\) It was reported that 77% of the hunters involved in accidents had deficient vision in some area.\(^4\) It was also found that 60% of those who had been the cause of a fatal accident were color blind and that three out of four of these hunters never suspected that they had a defect.
For most states the only source of any vision screening that coincides with hunting licensure is that given by the state Department of Motor Vehicles.

The purpose of this screening is to provide data supporting the need for visual screening of hunters prior to their licensure. Hunters identified with deficient visual skills can then be corrected or taught to compensate for that deficiency. At the very least, the hunter will be aware of the inadequacy.

METHODS

Licensed hunters were screened for visual problems related to hunting. The number per age category closely adheres to the age category percentages of licensed hunters according to both the 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation and Oregon's 1985 Survey of Fishing and Hunting Wildlife Associated Recreation Publications.

Each hunter was asked for subjective responses to ten questions relating to their awareness or unawareness of any possible visual deficiencies. Each of these areas was tested using standard test conditions. Following are the questions:

1. Is your vision as good as your friends?  Y  N
2. Do you have trouble seeing in the distance?  Y  N
3. Is one eye better than the other?  Y  N
4. Are you or someone in your family color blind?  Y  N
5. Do you ever see double?  Y  N
6. Do you have trouble following things moving in front of you? (i.e. golf ball, tennis ball)  Y  N
7. Are you right or left handed?  R  L
8. When shooting, which eye do you sight with?  R  L  Both
9. Do you use corrective lenses while hunting?  Y  N
10. Are you color blind?  Y  N

Below, are the tests administered to each volunteer hunter.

1. Uncorrected distance visual acuity
2. Habitual distance visual acuity
3. Habitual near visual acuity
4. Depth perception
5. Color vision
6. Peripheral vision
7. Dominant eye
8. Eye movements
9. Diplopia
TESTING PROCEDURES AND MATERIALS

Distance Visual Acuity was measured using a ten foot back illuminated standard Snellen letter chart. Testing was done for only those habitually wearing corrective lenses for distance. Hunters who wore corrective lenses were tested without their habitual visual correction.

Habitual Distance Visual Acuity was measured using a ten foot back illuminated standard Snellen Letter Chart. Habitual distance visual acuity was with habitual correction in place.

Habitual Near Visual Acuity was measured with a reduced Snellen card under standard nearpoint lighting and with habitual near correction in place.

Depth Perception was measured using the stereo fly stereogram test by Titmus while the subject was wearing appropriate polarized glasses and under standard nearpoint lighting to assess the degree of the hunter’s stereopsis.

Color Vision was tested under standard color test illumination using the Ishihara’s tests for color blindness or color deficiency plates.

Peripheral Vision was tested monocularly using confrontation fields with presentations in all eight fields of view.

Dominant Eye was determined using a hole card and a distant target. The subject was instructed to hold the hole card with both hands at arms length. The hole card was brought from waist level to eye level until the distant object was centered within the hole of the card. The determined dominant eye was the eye which viewed the object when centered.

Eye Movement Skills were assessed utilizing pursuits, saccades, and rotational abilities.

Diplopia was determined through a subjective response upon questioning.

PASS-FAIL CRITERIA

Pass-fail criterion of each visual skill were based on the Pacific University College of Optometry’s Vision Screening Program standards or the standards determined by the test manufacturers.

The fail criteria for each skill was:

Best Distance Visual Acuity - 20/30 or poorer either eye.
Best Near Visual Acuity - 20/30 or poorer either eye.\textsuperscript{10}

Depth Perception - < 60 arc seconds stereoacuity.\textsuperscript{12}

Color Vision - 7 or less correct answers out of 14.\textsuperscript{11}

Peripheral Vision - any field loss by confrontation fields.\textsuperscript{13}

Eye Movement - non-smooth pursuit\textsuperscript{12} score of 2+ or less for saccades\textsuperscript{12}

Diplopia - any diplopia reported before or during testing procedures, excluding those tests that are meant to induce diplopia.

The average time spent screening each individual hunter was seven minutes.

RESULTS

The three pie graphs entitled "The U.S. Hunting Population", "The Oregon Hunting Population", and "Screening Population", give breakdowns of the respective populations. The information on the U.S. and Oregon hunting populations comes from the most recent census information available.\textsuperscript{9} The screening population was gathered to match as closely as possible the current hunting population. The procedure of age matching the population is outlined in the discussion section.
FIGURE 2
THE OREGON HUNTING POPULATION

65+ 9%  
16-17 6%  
18-24 10%  
45-64 20%  
25-44 56%

FIGURE 3
SCREENING POPULATION

65+ 3%  
16-17 11%  
45-64 20%  
18-24 16%  
25-44 50%
The color vision screening results were evaluated according to whether someone in the subject's family is color blind, whether or not the individual is color blind, and their actual color vision results. Figure 4 shows the percent of hunters in each age group that failed the color screening. Figure 5 goes on to show the percent of hunters in each age group that did not know they had a color deficiency. The hunters were directly asked if they had a color deficiency and this was compared to whether they failed the screening.

**FIGURE 4**
% OF EACH GROUP THAT FAILED COLOR VISION SCREENING

<table>
<thead>
<tr>
<th>Age Categories</th>
<th>% of Each Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>12*15</td>
<td>7.7%</td>
</tr>
<tr>
<td>16*17</td>
<td>6.9%</td>
</tr>
<tr>
<td>18*24</td>
<td>10.5%</td>
</tr>
<tr>
<td>25*44</td>
<td>11.8%</td>
</tr>
<tr>
<td>45*64</td>
<td>8.5%</td>
</tr>
<tr>
<td>65+</td>
<td>16.7%</td>
</tr>
<tr>
<td>Ave.</td>
<td>10.1%</td>
</tr>
</tbody>
</table>

**FIGURE 5**
OF THE INDIVIDUALS THAT HAD A COLOR DEFICIENCY, THE % OF EACH GROUP THAT DID NOT HAVE KNOWLEDGE OF THEIR DEFICIENCY

<table>
<thead>
<tr>
<th>Age Categories</th>
<th>% of Each Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>12*15</td>
<td>66.7%</td>
</tr>
<tr>
<td>16*17</td>
<td>50.0%</td>
</tr>
<tr>
<td>18*24</td>
<td>25.0%</td>
</tr>
<tr>
<td>25*44</td>
<td>78.6%</td>
</tr>
<tr>
<td>45*64</td>
<td>75.0%</td>
</tr>
<tr>
<td>65+</td>
<td>0.0%</td>
</tr>
<tr>
<td>Ave.</td>
<td>49.2%</td>
</tr>
</tbody>
</table>
Figure 6 shows the percentages of the hunters tested for color deficiency. This was found by dividing those with a deficiency by the total population. Those who had a deficiency were further separated into those who were aware and those who were not aware of their deficiency.

**FIGURE 6**

% OF TOTAL SCREENING POPULATION FAILING COLOR VISION SCREENING

- 6.5% FAILED WITHOUT KNOWING
- 3.5% FAILED AND KNEW OF DEFICIENCY
- 90.0% PASSED

Figure 7 is a table showing the percentage of the total hunting population that either failed the screening or had a family member with a color deficiency.

**FIGURE 7**

<table>
<thead>
<tr>
<th>% OF TOTAL SCREENING POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAILED NOT KNOWING OF COLOR DEFICIENCY</td>
</tr>
<tr>
<td>FAILED KNOWING OF COLOR DEFICIENCY</td>
</tr>
<tr>
<td>TOTAL % THAT FAILED SCREENING</td>
</tr>
<tr>
<td>HAS A FAMILY MEMBER WITH DEFICIENCY</td>
</tr>
</tbody>
</table>
Information was gathered to determine what percentage of the hunting population shoot with their non-dominant eye to shoot and what percentage fire with their non-dominant hand. The subjects which dominant hand matched with the side of the body they shoot with were considered normal. If the subject's dominant hand did not match with the side of the body they fired from, they were classified as "shoot cross handed" (shooting their firearm from their non-dominant side). Not matching their dominant eye to which eye they sight with resulted in a classification of "shoot with non-dominant eye". If a subject reported that they were ambidextrous, they were considered normal for the side they shoot with. If a subject reported aiming their gun with both eyes, they were listed as normal. Figure 8 shows these percentages.

![Figure 8](image-url)

Information was compiled relative to anisometropia, a difference in the visual acuities of the two eyes. The data gathered to determine how many were aware of this difference, how many used the poorer eye to shoot with, and how many used their poorer eye as the dominant eye. The visual acuities of the subjects were determined with Snellen acuity charts. Snellen acuity is expressed in the form of a fraction. It is a comparison between a normally sighted person and one with compromised vision. For example, 20/40 visual acuity means that a person with that acuity ability sees at a distance of 20 feet what a normally sighted person could see at a distance of 40 feet. A person with 20/400 visual acuity, therefore, would have to be 20 feet from an object to see it as well as a normally sighted person would see it from 400 feet.
Figure 9 shows that 10.8% of those screened had a difference between their eyes of at least two Snellen lines of distance acuity with their correction in place. Figure 10 illustrates that of these 10.8%, 26.7% did not know the difference existed. From the 10.8% that have anisometropia, it was determined and is shown in Figure 11 that 33.3% of them used their poorer eye to shoot with. Figure 12 reports that of the 10.8% of the population that were found to have anisometropia 4.3% used their poorer eye as dominant.
FIGURE 11
OF THE 10.8% OF THE SCREENING POPULATION WITH A DIFFERENCE BETWEEN THEIR EYES

USE BETTER EYE TO SHOOT 66.7%

SHOOT WITH POORER EYE 33.3%

FIGURE 12
OF THE HUNTERS THAT HAVE A DIFFERENCE BETWEEN THEIR EYES

95.7% better eye as dominant

4.3% worse eye as dominant
Figure 13 shows how many individuals within each age group had a distance visual acuity of 20/30 or worse with the eye used for sighting.
Figure 14 shows the percentage of hunters in each age group who reported double vision.
The two areas tested to obtain information on a hunter's ability to locate and track movements are called saccades and pursuits. Saccades are eye movements from any starting position to an exact desired location. An example would be the movement necessary to quickly and accurately adjust eye position to locate a target, used when locating a launched clay pigeon or finding a game bird once it has flushed. A pursuit is a smooth, continuous track of a target once it has been located. An example would be the movement needed to follow a thrown target or following a flushed bird. The screening also asked whether hunters knew that they had a problem or felt they could be improved. Figure 15 reports the percentage of each age group who failed eye movements. This includes those who failed either test or both.

Figure 15

% of each group that failed eye movements

<table>
<thead>
<tr>
<th>Age Categories</th>
<th>% of Each Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-15</td>
<td>5.1%</td>
</tr>
<tr>
<td>16-17</td>
<td>13.8%</td>
</tr>
<tr>
<td>18-24</td>
<td>7.9%</td>
</tr>
<tr>
<td>25-44</td>
<td>7.6%</td>
</tr>
<tr>
<td>45-64</td>
<td>8.5%</td>
</tr>
<tr>
<td>65+</td>
<td>16.7%</td>
</tr>
<tr>
<td>Average</td>
<td>8.3%</td>
</tr>
<tr>
<td>Total</td>
<td>8.3%</td>
</tr>
</tbody>
</table>
The breakdown of hunters who failed the eye movements screening is shown in Figure 16. The hunters that failed fell into one of three categories: failing only pursuits, failing only saccades, or failing pursuits and saccades.
Figure 17 shows data on those hunters who reported problems with tracking and/or failed the screening. Hunters who either reported problems or failed the eye movement screening were put into three possible categories: those who reported poor tracking and failed the screening, those who reported no problems and failed the screening, or those who reported poor tracking and passed.

**FIGURE 17**

% OF TOTAL SCREENING POPULATION EITHER REPORTING PROBLEMS OR FAILING EYE MOVEMENTS

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported Poor Tracking and Failed</td>
<td>1.1%</td>
</tr>
<tr>
<td>Reported No Problems and Failed</td>
<td>7.2%</td>
</tr>
<tr>
<td>Reported Poor Tracking and Passed</td>
<td>6.1%</td>
</tr>
</tbody>
</table>
The percentage of hunters in each age group who failed the near vision screening with acuities of 20/30 or worse in either eye is shown in Figure 18.
Figure 19 shows the percentage of hunters in each age group who failed the distance vision screening with acuities of 20/30 or worse in either eye. Visual acuity was measured with the hunter's habitual correction. That is, whatever the subject normally uses. If a person does not wear correction, than that is their habitual.
Information on those who hunt without glasses and have 20/30 or worse acuity is shown in Figure 20.

![Figure 20](image)

**FIGURE 20**

HUNTERS THAT FAIL THE DISTANCE VISION SCREENING WITHOUT GLASSES AND DO NOT USE THEM TO HUNT

<table>
<thead>
<tr>
<th>Age Categories</th>
<th>% of Each Group</th>
<th>With 20/30 or Worse Visual Acuity Either Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-15</td>
<td>7.7%</td>
<td></td>
</tr>
<tr>
<td>16-17</td>
<td>6.9%</td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>10.5%</td>
<td></td>
</tr>
<tr>
<td>25-44</td>
<td>5.9%</td>
<td></td>
</tr>
<tr>
<td>45-64</td>
<td>25.5%</td>
<td></td>
</tr>
<tr>
<td>65+</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Total AVE.</td>
<td>10.1%</td>
<td></td>
</tr>
</tbody>
</table>
Figure 21 shows those who failed the visual acuity screening utilizing various failure criteria. Only those hunters failing the visual acuity screening are included and are placed in one of four categories: those who failed near vision with worse than 20/40 using both eyes, those who failed near vision with 20/30 or worse in either eye, those who failed distance acuity with worse than 20/40 using both eyes, and those who failed distance acuity with 20/30 or worse either eye. All of the failure criteria were evaluated with habitual correction.
The number of hunters who failed the stereopsis screening with a score of six or less on the Titmus Wirt Dot Test are shown in Figure 22.
The criteria for failure were:

**Double vision** - hunter reporting occasional doubling of images

**Hunt without prescription** - any hunter with distance visual acuities of worse than 20/40 using both eyes

**Hunt without prescription** - anyone hunting with distance visual acuities of worse than 20/30 using both eyes.

**Distance visual acuity** - habitual distance visual acuity 20/30 or worse in either eye.

**Distance Visual Acuity sighting eye** - visual acuity of sighting eye 20/30 or worse

**Near visual acuity** - habitual near visual acuity 20/30 or worse in either eye

**Depth** - scoring six or less on the Titmus Wirt Dot

**Color** - 7 or more incorrect answers with the Isochromatic Plates

**Fields** - failing to perceive a small target presented to their peripheral view.

**Movements** - hunters showing inadequate pursuits or saccades
Figure 23 is a table that gives a summary of the reasons for failure. These are shown by age categories.

<table>
<thead>
<tr>
<th>ALIEN REASON FOR FAILING SCREENING</th>
<th>AGE GROUPS</th>
<th>POP. AVE.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12*15</td>
<td>16*17</td>
</tr>
<tr>
<td>DOUBLE VISION</td>
<td>17.9%</td>
<td>6.9%</td>
</tr>
<tr>
<td>HUNTING W/O Rx 20/30</td>
<td>7.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td>HUNTING W/O Rx 20/40</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>DIST VA</td>
<td>15.4%</td>
<td>6.9%</td>
</tr>
<tr>
<td>DIST VA SIGHTING EYE</td>
<td>7.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td>NEAR VA</td>
<td>35.9%</td>
<td>13.8%</td>
</tr>
<tr>
<td>DEPTH</td>
<td>25.6%</td>
<td>27.6%</td>
</tr>
<tr>
<td>COLOR</td>
<td>7.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td>FIELDS</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>MOVEMENTS</td>
<td>5.1%</td>
<td>13.8%</td>
</tr>
</tbody>
</table>
Figure 24 shows the percentage within each age group population failing in at least one of the screened areas. The visual acuity criteria for this Figure was less than 20/40 using both eyes.
Figure 25 shows the percentage of the total number screened who failed in at least one of the screened areas. The visual acuity criteria for this Figure was less than 20/40 using both eyes.
DISCUSSION

In order to more accurately represent the hunter population, an attempt was made to match the distribution of the age categories used by the United States Department of Fish and Game. The sample was gathered at random. As each age group reached the necessary size to best represent the actual hunter population, data was no longer taken on that particular age group. For example, approximately 50% of the current hunting population is between the ages of 25 and 44. The target population for the screening was 275 hunters. When approximately fifty percent of the target screening population was hunters between the ages of 25 and 44, data in that age category was no longer collected. The screenings continued until each age group was appropriately represented. The age categories, in decreasing order of size are: 25-44 year old, 45-64 year old, 18-24 year old, 16-17 year old, and over the age of 65. Therefore, conclusions concerning the current hunting population can accurately be drawn from the sample gathered.

Screening techniques were used to assess visual acuity, color vision, visual pursuits, depth perception, and peripheral awareness. Screening tests are designed to identify individuals with a high probability of showing a deficiency. If the passing criterion for a screening are set too high, the tests fail too many individuals. This is referred to as a false positive and indicates those subjects who fail the screening but are not deficient in that area. The most valid practical screenings tests available were used. The screening criteria used in this study were not designed to determine whether a person should hunt, but were intended to inform individuals who might benefit from correction or knowledge of their condition.

Color vision is very important to the hunter for successful hunting and to avoid tragedy. Distinguishing between colors helps a hunter to discriminate game from non-game species and, more importantly, game from people. Eight percent of the male population are genetically color deficient. Likewise, 0.4% of women are born with color vision problems. Color vision deficits can be acquired due to the progression of a variety of conditions that affect the eye, its nerves, or the visual cortex (the area in the brain where visual information is processed). 10.1% failed the screening test for color vision and 49.2% of those that failed did not know of their color deficiencies. As Figure 7 shows, six out of one hundred hunters screened have a possible color deficiency and are unaware of the problem. It was not determined whether the color deficiencies were congenital or caused by conditions affecting the eye. There is no cure for congenital color vision deficiencies. By making individuals aware of their deficiencies, however, they can learn to compensate and use extra caution.

The American Optometric Association reports that 85% of the population sight with the eye on the same side as their dominant hand. For example, hunters that are right handed and sight with their right eye or hunters that are left handed and sight with their left eye. This screening investigated the number of hunters who use their non-
dominant eye to sight and those that fire their gun with their non-dominant hand. Fourteen percent of the screening population fire with their non-dominant hand and 22.7% aim with their non-dominant eye. Some difficulty and awkwardness can occur when using firearms that are designed to be fired with the hand opposite to that which is used. As discussed in an earlier section, inaccuracy can result from sighting the firearm with a non-dominant eye.

Eye dominance and associated visual acuity were investigated. The screening population was examined for anisometropia -- a significant difference between the eyes' visual acuity ability. 10.8% had a difference of two or more Snellen lines of acuity. Of that number, 26.7% were unaware that a difference existed. One third of the hunters that showed a difference used their poorer eye to sight with. Most hunters sight with only one eye. An individual sighting with the poorer eye can actually have poorer vision while sighting a gun than normally. Figure 13 shows that 8.3% of the population fail a distance visual acuity screening with the eye used for sighting. The failure criteria used here was 20/30 or worse. It is therefore suggested that hunters who feel they have a difference in visual acuity between their eyes should have their vision tested. Since just over one-fourth of the individuals who had anisometropia were not aware of the problem, hunters should be encouraged to have regular vision exams to ensure that their sighting eye is corrected fully.

Those hunters who participated in the screening were also asked if they ever experienced double vision (diplopia). Responses tabulated in Figure 14 shows one out of ten reported that they occasionally see two images when they realize only one is present. There are some situations in which double vision is a normal finding. 16 For instance, it is normal to see distant images doubled when one concentrates on a near object. In the like manner, near objects directly in front of the eyes appear doubled when looking at a distant object. Diplopia that occurs abnormally may be caused by an imbalance in the eye muscles, resulting in the eyes pointing in different directions. 19 This could be quite troublesome when attempting to sight game. The subjects were not asked to qualify their response of occasional double vision and the source of the double vision was not investigated.

Pursuit and saccadic eye movements were evaluated. 8.3% of the population failed either the smooth following movements of pursuits, or the quick location eye movements of saccades. Accurate and efficient visual pursuit of game requires both quick eye movements and smooth following eye movements. 1 Both skills can be improved through training and practice. It is difficult for an individual to assess their own eye movement abilities. Therefore, the percentage who know that their eye movements are below normal is naturally low. There was actually a much higher percentage of the total population who felt they had poor movements and passed, 6.1%, as compared to those who correctly knew that they had poor eye movements, 1.1%.

Visual acuity screening criteria are designed to find those individuals within a population that have below normal visual acuities. The screening criteria used by Pacific University is set at 20/30 or worse for either eye. This criterion is more stringent than that
used by the Oregon Department of Motor Vehicles, which requires an acuity of 20/40 when using both eyes.\textsuperscript{9}

38.3\% of those tested had visual acuity of 20/30 or worse in at least one of their eyes, including those wearing corrective lenses. This group would likely benefit from further professional testing. Participating subjects were also asked if they used corrective lenses while hunting. Of the group that did not use corrective lenses while they hunted, 10.1\% failed the distance visual acuity screening criteria. One out of ten hunters currently afield without corrective lenses could possibly benefit from wearing a prescription. None of the hunters failed the Department of Motor Vehicles criteria of 20/40 using both eyes. While many hunters could benefit from an eye exam, the number of individuals with poor vision, by DMV standards, is low. There were, however, some individuals who needed corrective lenses to pass the Department of Motor Vehicles screening criteria but reported hunting without the use of corrective lenses. Of the total screened population, 0.1\% fall into this category. For whatever reason, this small percentage of the population chooses to hunt without their glasses even though they have better acuity with them.

Stereopsis is one of the cues the mind uses to judge position and distance.\textsuperscript{19} Using criteria outlined in the methods section, 26.3\% of the screening population were found to have reduced stereopsis. A person that is aware of difficulty in judging depth can learn to use other cues more accurately.

CONCLUSION:

Figure 1 compiles the data from the screening and shows the failure rate for each category for each ability screened. 43.2\% of the screening population failed at least one of the visual skills criteria. Near visual acuity had the highest failure rate, 38.8\%. Most of the subjects were more aware of problems with distance acuity. The distribution of those that failed at least one area is shown in Figure 24. It should be noted that at least 33.3\% of each age group failed in at least one area. The reasons for failure in some areas cannot be corrected, but most can, at least, be compensated for. Appropriate identification of game as well as the safety of fellow hunters is the responsibility of each and every hunter. For this reason, any hunter suspecting they may be deficient in a visual skill, should have a thorough vision exam. This study shows that large percentages of hunters are unaware of their deficiencies in several visual skill areas. Regular vision exams are suggested as an effective means of protection against poor vision. A hunter has a responsibility to others involved in the sport to make sure that their vision is at its full potential. Hunting is a very visually demanding sport. By maximizing a hunter’s visual abilities he may enjoy more efficient and successful hunting and have safer hunting trips.
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