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Pilot's Sunglasses: Mystique or Mandate?

Aviators' sunglasses are more than the symbol of a profession; they can play an important part in safeguarding a pilot's most important asset — vision.

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Sunglasses are as much a part of flying as the legendary white scarf and leather jacket. The stature imparted by the classic shape of aviation glasses with subtle gold frames is widely imitated outside the aviation world. The sunglass choices available are mindboggling. Plastic or glass. Gray, green, brown, yellow or the newest addition to the family, rose. Heavily or lightly tinted. Coated or uncoated. Mirrored or plain. Polarized or unpolarized. Blue-blockers or regulars. Self-darkening or fixed color. With or without anti-reflective coatings.

In the movie "Top Gun," sunglasses were the hallmark for the fighter pilot who was a winner. (They were even worn in the bar!) Not surprisingly, an unsubtle competition is evolving in the market place to develop the "coolest" form of sunglasses without regard for the adverse effects of diminished light presentation to the retina. The price being paid " to look cool" may be impaired visual acuity. Visual acuity is irrevocably tied to available light, and the indiscriminate use of sunglasses to "protect" from high ambient light conditions impairs pilot performance by compromising the retina's ability to present a decipherable cerebral image.

There are several excellent reasons to wear sunglasses. It is generally accepted that glare is harmful to the eye, and that protection from glare is therefore therapeutic, even though studies show that only 22 percent of the population reacts adversely to glare. Eye fatigue is offered as a reason to wear sunglasses, but the biggest contributor to eye fatigue is not light, but refractive error, primarily uncorrected astigmatism. Exposure to heightened levels of potentially harmful ultraviolet light reflected from the aviator's favorite milieu, blue sky and clouds, is also listed as a reason to wear sunglasses. The most convincing reason, however, is the averse effect on night adaptation when unaltered high ambient light levels are endured during the day.

The older eye compares unfavorably with the younger one. Since visual performance is directly related to image luminance, it follows that the older eye, which is less responsive to changes in light levels, is at a disadvantage. There are several reasons for this. First, there is less increase in pupilary size with decreased luminance. Second, changes in the lens and vitreous humor make the older eye more sensitive to glare. Third, there is an overall reduction in the transmission of light. This translates directly to a need for more light to be able to see, and to age-related problems with visual acuity in diminished light. Behind their sunglasses, younger pilots will have more pupil dilation than those who are older. Older pilots, therefore, should wear sunglasses that allow the passage of more light to the retina. It has been reported that to obtain the same contrast detection performance as a 20-year-old, a 40-year-old needs 40 percent more light, and a 60-year-old needs 100 percent more light.

Visual performance is not a constant, even across a population segment that passes the same visual acuity tests. The individual diversity present within a specific age group shows sufficient statistical variability to suggest that no one pair of sunglasses will answer the needs of all members of that age group at the same time, and that these needs change according to ambient light conditions.

A high-level light source, such as glare, causes pupilary constriction. The smaller the aperture through which the eye must see, the darker is the image created on the retina. Nearly 25 percent of the population is exquisitely sensitive to glare. Their pupils are nearly pinpoints under such exposure. Diminished retinal luminance causes measurable visual decrements. Sunglasses will improve this visual acuity problem by counteracting the amount of available light. Conversely, another 11 percent are at the opposite end of the sensitivity spectrum. These people actually have improved acuity under high glare conditions, and seem to have no need for sunglasses. The remainder of the population does not care one way or the other. Glare for them is a non-event in terms of altered visual acuity.

Eye fatigue can be a genuine issue if glare sensitivity includes eyelid spasm, tears, photophobia and squinting. The astigmatic eye, because of its commonality in the population and the amount of effort required to "neutralize" it's flawed imagery (however incompletely), is statistically a more important culprit. Both victims will appropriately complain of eye fatigue. Prescription lenses will be required to correct the exquisite sensitivity problem. Where both problems coexist, prescription sunglasses answer the need.

Sudden Light Changes

Glare also has the capability to produce other transient problems with visual acuity. A sudden change in image luminance such as experienced when driving into a dark tunnel, or when exiting a movie theater into bright sunlight, or as experienced when first putting on sunglasses, will produce a brief interval of reduced vision requiring increased caution.

Ultraviolet light (UV) with a wave length of less than 315 nanometers is a known cause of premature cataract formation. Cataracts cloud an otherwise clear ocular lens, presenting a physical obstruction to the passage of light through the eye to the retina. Impaired light passage equates to impaired image formation without regard for where the impairment originates. UV light with a wave length between 300 and 400 nanometers interferes with vision by causing fluorescence of the cornea and lens, recognized as a bluish haze especially when the light source is obliquely directed. Thus, a low lying sun need not be in the direct line of vision to compromise performance. UV light sources include both the sun's direct galactic radiation and a clear blue sky, where these rays have been scattered as they pass through the earth's atmosphere. At the earth's surface, six percent of the sun's radiation is UV light. This percentage increases by four percent for each additional 1,000 feet of altitude, clearly presenting special hazards to aviators. There are three recognized subsets of UV light: A, B and C. UV-A passes through many types of glass and is the cause of sun-related drug reactions. UV-B is the sunburn-inducing, cataract-causing carcinogenic segment. Ordinary glass will block UV-B passage. UV-B will penetrate to a depth of three feet in water, and will pass through a thin cloud layer to produce sunburn on an overcast day.

It is not necessary to wear lenses inside the aircraft to protect a pilot from the injurious part of the UV spectrum because canopy or cockpit windows made of polycarbonate will also block UV-B. Acrylics, however, will not block UV effects. (Open cockpit and ultralight fliers have a problem readily solved by wearing either glass or polycarbonate sunglasses.) UV-C is absorbed by atmospheric ozone and is not supposed to reach the earth.

Bright Day — Dim Night

A day at the beach or on snowy bright ski slopes without attenuation provided by sunglasses will provoke a memorable evening drive home because vision will be severely flawed at night. This deleterious effect commonly lasts for hours, even though under normal conditions full night adaptation is achieved in about a half hour. This failure to wear sunglasses on any day having high ambient light bleaches the retinal pigments to a point that their restoration for night use the same day is significantly delayed.

The amount of light blocked by sunglasses is the key to how much decrement takes place in visual acuity while the glasses are actually in place. This adverse effect exists only while the glasses are actually in place, and does not persist after the glasses have been removed. Generally, the darker the lenses, the larger the loss. This is the reason why baseball players delay flipping down their sunglasses from beneath their cap visors until they have located the arcing ball.

The "strength" of sunglasses is measured by how much light is allowed to pass though the lens. A product that blocks 85 percent of available light, (the U.S. military specification standard for aviator's sunglasses and tinted visors which may have had its scientific origins in a "best guess" scenario more than 50 years ago), allows 15 percent pass through for retinal image formation. If ambient light levels are extreme, such as from an overhead sun in a partly cloudy sky with reflectance from water or snow below, such sunglasses should be adequate for the needs of the average pilot. The same circumstances later in the day for the same person may block too much light because the angle of the sun allows for shadows that attenuate light exposure, unless one looks directly at the source, or if presented tangential to the eye. Thus, the sunglasses needed for mid-morning or late afternoon may not be the ones best suited at high noon. A lens that darkens or lightens according to the intensity of ambient light, or truly photosensitive lens, would appear to be the most desirable, especially since the pilot needs metered light abatement that is based on the severity of the exposure. However, those lenses that require UV-B to make them darken will not darken when worn inside the airplane since UV-B does not penetrate the canopy or windows. Thus, what appears to be the best answer to the changeable needs of the cockpit, photochromatic lenses, turns out not to be an answer at all.

The range of light transmission blocked by a photochromatic lens varies from a low of 20 percent to a high of 85 percent, and outside the cockpit these lenses appear to be a wonderful solution to the glare problem. Department store sunglasses made of soft plastic do not inhibit UV passage. These products commonly block 75 percent of available light but none of the potentially harmful UV-B.

Lens colors alter what is seen in different ways. Green or gray are said to give the least color distortion, and are available singly or in combination. Yellow has the capability of filtering reflected shortwave blue which is found in air contaminants such as fog, haze, smoke or smog; these airborne particulate suspensions blur images by reflecting shortwave blue light in such a way that the image on the retina is diffuse instead of sharp, a phenomenon called chromatic aberration. In certain conditions, therefore, yellow "blue-blockers" can improve visual acuity, but not because it protects from glare. Yellow glass that cuts out more than 30 percent of ambient light will so alter colors that the distinction between green and red lights could be a hazard on the airport. Many pilots dislike the world as seen through yellow lenses, but a daylight flight in poor visibility caused by smog, while wearing light yellow lenses, can be an "eye-opening" experience. Military pilots who fly low-level missions complain that depth perception is adversely altered while using yellow lenses.

Brown will enhance contrast as well a doing a modicum of blue blocking if it is not too dark. Rose also increases contrast and blue-blocking; it is offers a niche in specialized applications for automobile use.

The Height of Cool

Mirror coated lenses represent the height of cool by the use of attention-getting metallic deposits on the surface to produce the desired mirror effect. Aside from being fragile, such coatings substantially decrease the amount of light transmission with resultant loss of visual acuity if applied to an already dark lens.

Anti-reflective coatings on the inside surface of lenses are designed to prevent the user from seeing an image of his own eye reflected on the back side of the glass. Such images are a nuisance under certain lighting conditions and present an unwanted distraction to a busy pilot.

Polaroid lenses should be left in your boat. Their chief attribute is that quality polaroid lenses will completely eliminate reflected glare coming from a flat surface that is at an angle of approximately 53 degrees. A pilot wearing polarized lenses sees the world as constantly changing according to his angle of bank, or the tilt of his head, as the angle of the reflected glare is altered. Looking through a polarized window while wearing polarized glasses can result in no retinal image.

Infrared rays should only be a problem only for sun gazers at eclipse time. However, any Lockheed C-130 pilot can attest to the elevated temperatures on the flight deck that result from the greenhouse effect in a cockpit with a large window area. It is not known to be an eye hazard.

The Bottom Line

The amount of light that passes thorough a lens is the most critical factor in selecting sunglasses to effect a compromise between visual decrement, color distortion and glare or high ambient light protection. Lenses are categorized as being between a one and a four according to percent of light transmission and its basic color. Thus, you can have a Brown 3, Gray 4, Yellow 1, Green 2 or any combination of a color and a number. A Number 1 lens cuts 20 percent of available light, barely enough to be noticed, and except for yellow, useful only in the world of fashion. A Number 2 lens blocks 70 percent. A Number 3 lens blocks 85 percent and a Number 4 lens blocks 95 percent. There is no place in aviation for a Number 4 lens of any color because of the severe decrement in visual acuity, (though such lenses are available). A pilot with 20/20 vision wearing Number 4 glasses has a visual acuity between 20/40 and 20/60 while airborne in his cockpit, even though he could be a comfortable 20/20 on the sunbathed ski slopes using the same glasses.

A Number 3 lens has utility only in unusually high light situations such as flying into the sun, or flying VFR just on top in bright sun. Interestingly, it is Number 3 lenses that are in common usage without regard for whether acuity suffers. Visual acuity while wearing Number 3 lenses can be degraded to an average of 20/30.

The Number 2 lens should be the aviator's friend, and then only when judiciously worn. A 30 percent light transmission presents the world with the same amount of light as that found in a 70 percent eclipse of the sun. That is what these glasses do. Subdued light is the result. Visual acuity is reduced minimally. Wearing Brown 2 glasses, the 20/20 pilot remains almost 20/20. Looking for traffic, the pilot should remove them. As soon as meteorological conditions permit, they should be returned to the case or pocket. Wear Yellow 1 glasses in haze or in the soup, and then only if they improve vision.

"The effect of even a small difference in acuity on visual performance is commonly underestimated." So say the investigators at the U.S. Naval Aerospace Medical Research Laboratory in their December 1986 report on the use of sunglasses and visors by U.S. Navy fighter pilots. Visor wearers were at a 1.8 nautical mile disadvantage in sighting a target compared to those not so encumbered.

Sunglasses should not be worn merely because they are available. Ambient light translates directly into visual acuity. Losses in the former impact the latter.

Aviator's sunglasses should be glass or polycarbonate; should transmit not less than 25 percent of available light; should not distort colors, distances or shapes; should nullify the blurring of shortwave reflected blue; and should increase contrast without misrepresentation. Their adverse effect of visual acuity must be known and they should not be worn during conditions of diminished light. There can be special times when an adjunct pair of Yellow 1 glasses (that are not sunglasses) can improve vision. Remember, being cool has a price. ♦

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Retiring with the rank of Captain from the U. S. Navy after nearly 25 years of service as a flight surgeon, he identified personality profiles and life style markers of high-risk aviators. His experiences afloat include tours of duty aboard destroyers and aircraft carriers with the First Marine Aircraft Wing and with the Pacific Fleet Carrier Force staff. Dully has been the director of training and commanding officer of the Naval Aerospace Medical Institute and has been both on teaching faculty and a practicing physician at the Naval Postgraduate School's aviation safety program.

Dully has an undergraduate degree from Holy Cross, an M.D. from Georgetown University and a Master's from the University of California. He is a board-certified aerospace medicine specialist and a Fellow in The American College of Physicians and other medical societies. He is also a three time past president of the Society of U.S. Navy Flight Surgeons.

**There are old pilots and there are bold pilots,
but there should be no old pilots wearing bold pilots' sunglasses.**

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