The Effect of Aging of the Visual System on the Pilot

L.G. Hart
O.D., F.A.A.O.
Beaconsfield, Quebec

The effects of aging of the visual system are encountered daily by the practising optometrist. How these visual changes can affect the mature pilot (over age 40) is not so well-documented.

Optometrists will have the opportunity to examine more people who fly as the field of aviation becomes more accessible to the average person. We are also now encountering more professional pilots in their late 50's and 60's as the men and women who started flying at the end of the Second World War reach retirement age. Retirement age for the commercial pilot is 60, but people can continue flying privately into their 70's, as long as they remain healthy and can pass the physical requirements for flight.

Up to the present time, aviation research has not isolated all the visual factors used in flight. Therefore, it is quite difficult to determine how aging affects these factors, and thus affects flying ability. For the purpose of this paper, we will assume that there is a steady deterioration of our visual abilities with age. It is, therefore, important to determine when this deterioration will affect the ability to perform a certain task or, in our case, at what point safety in flight will be compromised.

It is important for the practitioner to understand the stress placed on the visual system in flight. The pilot, at all times, has to be able to locate other aircraft in his/her vicinity and estimate their altitude and direction. (S)He must also try to visualize where other aircraft are as (s)he listens to their conversation with ground control. Instruments are checked, the horizon is scanned and then attention turns back again to the cockpit environment. All of this is accomplished in varying lighting conditions at various distances ranging from optical infinity (the horizon) to the approximately twelve (12) — inch distance to the overhead switches in the Boeing 767 aircraft. Specific instrument distances will vary from aircraft to aircraft and from pilot to pilot. It is important for you, as an optometrist, to ask your pilot patient to measure the distance from his or her eyes to i) the instrument panel; ii) the overhead dials and iii) where his or her flight charts are normally kept. Some charts are clipped to the steering column, a distance of 18 inches and, in other aircraft, the charts must be placed on a shelf beside the pilot approximately 33 inches away. Backman and Smith, in their publication, **Vision in the Aircraft Cockpit**[1], have compiled the distances used by most pilots in the different types of aircraft.

A large amount of visual, auditory and somatic information must be quickly assimilated and interpreted, and the pilot must react accordingly. These demands on a pilot become greater during landing and take-off, increase further around high-density airports and become even more intense and stressful under bad weather conditions. In all of these circumstances, peak efficiency of his or her visual and reflex systems must be maintained.[9]

Since reaction time also slows with age,[4] the diminishing ability of the brain to react quickly enough to process and analyse the information received through the visual senses can produce a dangerous situation. It is also increasingly difficult to disregard distracting stimuli which might be present in the cockpit,[4] for example, the second officer making slight engine corrections, or the distraction of a malfunctioning dial.

One of the first visual changes a pilot will complain about as he or she approaches 40 is a loss of focussing ability. As the crystallin lens becomes harder and more yellow with age, glare becomes more of a problem, and the transmission of light to the retina will gradually diminish. Therefore, operating under low illumination levels, e.g., in clouds or at dusk, might present some problems[9].

The reason for the loss of focussing ability has to be carefully explained to the pilot and an appropriate prescription given when the reading of charts becomes difficult. The optometrist must make sure he or she knows the particular distance used.

The reduction of glare with coated lenses is an even more complex problem. Some of the parameters to be considered include the tint, which must not change the real colour of the environment, nor can it impede vision when the pilot looks at the dials in the cockpit.

I have found that the most

successful prescription arrangement is "Half-eye" frame for cockpit use and bifocals, with the upper distance area tinted grey #4 and the lower segment clear, as the sunglass prescription. I have used the photogray lens, but with very little success, because not enough ultraviolet light penetrates the cockpit. Polaroid lenses are excellent but I have found that the labs will not, or cannot make the lower segment clear.

One might also expect to find a drop in dark adaptation with age,[2,9] but research on this question has given us conflicting results. We can only say at this time that there is a high correlation between good health, lack of ocular disease, and good dark adaptation. On the other hand, the ability to recover from the effects of bright light does deteriorate with age.[2] The senior pilot will experience this deterioration when flying near lightning storms, or when encountering the bright lights of a city during a night approach. Dark adaptation, and the ability to recover from the effects of bright lights, are not exactly the same. Recovery from bright light is the very early portion of the dark adaptation curve. To lessen these effects, the dial illumination system should be turned up high. Conversely, when approaching poorly-lit airfields, (and these still exist), the dial illumination system should be turned up just enough to give good near vision, but not high enough to impede distance vision.

Much experimentation is done in controlled laboratory conditions, and the findings applied to the real world. This can be subject to grave distortions, as in the case of visual acuity. The visual acuity obtained in the office is used to determine what the acuity of the pilot will be in flight. While this is a proper technique for most of the people we examine, it can be very misleading when testing flying personnel. The visual acuity needed to perceive a moving object in space is quite different from the acuity needed for a stationary letter on a chart.[5]

For example, prescribing a +1.00 o.u. for driving will be used with no complaint, but will have to be reduced to +0.50 o.u. to be worn comfortably when flying, even though we found the +1.00 o.u. in our subjective and it gave us a perfect 20/20 acuity. It has been found that the measure of static visual acuity has very little relevance to the dynamic visual acuity needed in flying.[5] The rule of thumb in prescribing at distance for aviators is minimum plus to see the 20/20 line less 0.25 o.u. This formula has worked very well for me through the years. I suspect that the reason pilots feel more comfortable with the results using this technique is because of the effects of both space and night myopia phenomena.

The proper functioning of the oculo-motor system is essential for the rapid scanning of the area within and outside the cockpit, the identification of moving objects, such as birds and other aircraft, and is most important in aiding the pilot in determining the position of the aircraft on landing. There is a definite diminution of this ability with age,[10] but it can be maintained at peak efficiency with the appropriate training.

Central and peripheral fields are also reduced with age,[7] the reduction coming most rapidly after age 50. Emotional and physical stress can also tend to constrict the fields. To limit the effects of this constriction, the aviator must be taught to keep moving his/her eyes, constantly scanning the total flying environment. Visual exercises such as rotations and fixations, peripheral awareness training and especially tachistoscopic training can be used. The constriction of the senior pilot's visual field can become quite extensive when one combines stress conditions, poor lighting, physical fatigue and age[3]. Interestingly, tests have shown that field reduction in the pilot population lags behind that of the general population.[7,10] This, I suppose, is due to the constant exercise of this aspect of vision in the course of pursuing this vocation.

Excellent depth perception is also important in flying.[8] It is used to determine range, rate of closure and motion in depth. Complaints of deterioration begin around age 40, but, again, seem to be less extensive in healthy individuals.[8]

The optometrist must teach his or her older pilot patients to compensate for the deterioration of their visual skills. Visual deterioration due to the aging process seems to occur more slowly in the pilot population, possibly due to the constant exercising of these skills and abilities in flight, and the constant practice in flight simulators. Therefore, the key to maintenance of peak efficiency of the visual system is constant exercise and good health.

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