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ABSTRACT

Physical changes in and conditions of the eye associated with the normal aging process are discussed with reference to their impact on performance in physical and recreational activities. Descriptions are given of characteristic changes in visual acuity in the areas of: (1) presbyopia (inability to clearly focus near images); (2) sensitivity to glare; (3) contrast sensitivity; (4) light-to-dark adaptation; (5) depth perception; (6) glaucoma; (7) maculopathy; (7) eye movement reaction time; and (8) cataracts. Each condition is described, and the effects of the condition on vision is reviewed. It is noted that these conditions should be considered when planning physical and recreational activities for older adults. Suggestions are made on ways to minimize visual problems for physically active older adults, including: (1) encouraging older adults to have regular eye examinations and to wear corrective lenses if needed; (2) choosing well-lit areas for activities; (3) increasing contrasts in the visual environment; and (4) understanding problems older adults may have with glare. (JD)

# AGE-RELATED VISUAL CHANGES AND THEIR IMPLICATIONS FOR THE MOTOR SKILL PERFORMANCE OF OLDER ADULTS

by

Kathleen M. Haywood, Ph.D., Physical Education

and

Linda R. Trick, O.D., School of Optometry

University of Missouri-St. Louis
8001 Natural Bridge Road
St. Louis, Missouri 63121

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In recent years older adults have been made aware of the importance of physical activity and exercise throughout life. As any student of motor learning can recount, however, vision plays a critical role in most physical activities: the responses we make in performing motor skills are most often based on information gathered through the visual system. So, ones success in performing physical skills, and therefore the enjoyment one realizes, is related to the proper functioning of the visual system. With aging there are naturally occuring changes in the visual system, as well as conditions and diseases which are more prevalent in older age groups. It is beneficial to keep these changes in mind when planning activities for older adults. An activities leader may be able to make small changes in the environment which may increase the participant's enjoyment of the activity; or, the leader may work with the participant to adapt to visual conditions, thus reducing frustration for the older adult. The purpose here is, first, to describe physical changes and conditions in the eye which are associated with aging, to review their effect on vision, and to outline the effects these visual conditions may have on the performance of skills. In addition, original research on eye movement reaction times in older adults will be reported.

Presbyopia, the inability to clearly focus near images, is considered a normal aging process. The inability to focus first becomes clinically significant around the age of 40 and becomes progressively worse until about the age of 65 at which time the older adult has almost totally lost this ability. For the presbyopic patient distance vision remains unchanged while near vision becomes progressively worse. For a while, the older adult may be able to compensate by holding near objects further away. Some patients who are myopic (nearsighted) can function at near by removing their glasses. In the majority of cases, however, presbyopic patients are prescribed bifocals, so that the patient's habitual prescription, present in the top part of the lens, will provide good distance vision while the bottom part of the lens will compensate for the patients inability to focus and will allow clear vision at near. Wearing bifocals requires an adaptation process, especially for situations like walking down stairs. The wearer cannot simply lower his eyes to glance down at the steps since they would be blurred in the bifocal segment of the lens. In activity settings a bifocal wearer may have to exaggerate head movements to keep an object in view without crossing into the bottom lens. In those activities where the speed and location of objects must be judged accurately, the wearer must deal with the perception of an object disappearing and then reappearing suddenly. This occurs when a wearer notices something through the upper lens and then turns to look at it more closely through the bifocal segment. The object is therefore imaged in one location when viewed through the upper part of the prescription and in another location when viewed through the bifocal segment. This change in apparent location is perceived as the object jumping from one place to another in the visual field.

Bifocals come in a variety of types and sizes and it is important for the patient to get the type which will best satisfy his visual needs. Some bifocal segments are very small. This might be ideal for a patient who works outdoors and does very little reading. The same type of lens would be poorly suited for the attorney who works at a desk and reads extensively. In addition to obtaining the correct type of lens for the individual's needs, it is important that the lens be fit properly. A bifocal segment line which has been set either too high or too low is annoying at best and probably accounts for the reason that so many people are dissatisfied with their glasses.

While bifocals are the most commonly prescribed correction for presbyopia, other forms of correction exist and may be better for the individual. Half eyes, contact lenses, trifocals, and reading glasses are other available options. Those who have only reading glasses amy have to forego wearing them in an activity which requires both near and far vision. Either situatuion may cause special problems in performing some motor skills, especially those requiring accurate interceptions. Activity leaders might be sure an individual is wearing the proper prescription for the activity and might also work closely with participants who wear bifocals, giving attention to head positioning and line of gaze.

One of the changes in the eye with advancing age is senile miosis, a reduction in the pupil's resting diameter. This reduction results in diminished retinal illuminance, such that at age 60 illumination is about one-third of the value at age 20 (Weale, 1961). This trend probably tails-off between ages 70 and 80. The older adult is placed at a particular disadvantage under low illumination conditions. To overcome this disadvantage, activity environments should be well illuminated whenever possible.

Glare refers to a dazzling sensation of relatively bright light which interferes with optimal vision. Glare can be due to optical or neural factors and an abrupt increase in sensitivity to glare has been shown to occur at about age 40 (Wolfe, 1960). Pupillary miosis and yellowing of the crystalline lens increase the visual disability caused by glare (Reading, 1968) and it has been shown that light intensities which are insufficient to produce glare in young subjects can significantly affect older observers.

Another help to the older adult may be to accentuate contrasts (Owsley et al, 1981). Contrast sensitivity has received considerable attention in the literature in recent years and refers to an individual's ability to resolve spatial structures varying from fine to coarse at various levels of contrast. Although one study reported no aging effect (Arden & Jacobson, 1978), many others have shown that contrast sensitivity declines with aging. Some of these studies have shown the loss at all spatial frequencies, i.e., throughout the fine-to-coarse continuum (Skalka, 1980; McGrath & Morrison, 1980), a few at the higher frequencies (above 4 cycles/degree)(Arundale, 1978; Derefeldt et al, 1979), and one at just lower frequencies (Sekuler et al, 1980). Further research is needed to identify the variables leading to the differences in these findings, but it is clear that contrast sensitivity changes with age. What is of particular interest regarding changes in contrast sensitivity is that they may not be simply related to visual acuity. That is, performance on a standard Snellen acuity test may not reflect contrast sensitivity at low or intermediate spatial frequencies. Until more is known about contrast sensitivity, it seems reasonable to provide as much contrast as may be practical in activity settings for older adults.

The eye is capable of automatically adjusting to varying light intensities. For example, dark adaptation occurs when the eye is exposed to a dark environment after previous exposure to light (LeGrand, 1957; Pitts, 1982). There are changes in the ability to undergo dark adaptation with aging, probably as the result of senile miosis and yellowing of the lens. Changes in retinal metabolism and amount of light reaching the retina may play a role as well. It is known that older adults are less sensitive to light than younger adults at all stages of dark adaptation (McFarland et al, 1960; Domey et al, 1960). As to the practical significance of these findings, it would be well for activity leaders to avoid settings such as outdoors at dusk or dim gymnasiums for older adult programs and to allow time for the older adult to adapt when changing from one lighting environment to another.

It has been shown that depth perception based on tests of stereopsis decreases after age 40 (Bell et al, 1972). This could be of great significance to the performance of activities in which objects approach the participant. Yet, the decline in depth perception may be related to decreasing visual acuity, and the loss of accomodative power. Those with good visual acuity, then, may not have reduced depth perception (Hofstetter & Bertsch, 1976). Adequate correction of acuity losses by prescribed lenses and the wearing of such lenses during activity should be stressed to older adults by activity leaders.

In addition to the primarily optical changes experienced by the older adult, such as senile miosis and presbyopia, aging is often accompanied by physiological changes which are more difficult to treat. One of the most common is the occurrence of cataracts. A cataract is an opacity in the crystalline lens which interferes with vision. Cataracts are the third leading cause of blindness in the U.S. with approximately 60% of the population between the ages of 65 and 74 showing some signs of cataract and 3.3 million people disabled by this condition (Vision Research, 1982). Most cataracts that occur with aging are gradual in their development. The patient may experience blurred vision, diplopia or glare and may exhibit mild to severe visual dysfunction. In the early stages, altering the illumination or changing the spectacle prescription may improve performance. As the cataract progresses, the patient may become significantly impaired at which time surgical intervention becomes necessary.

Post surgically the patient is not without problems. The removal of the crystalline lens necessitates a strong optical correction which may take one of several forms. Traditionally, aphakic patients have been corrected with a strong spectacle prescription. This produces a greatly magnified image which make judging distances quite difficult. The spectacle corrected aphake also experiences optical jump and a ring scotoma in which an image will disappear briefly before reappearing in a slightly different location. This Jack-in-the-Box effect can be quite distressing when noting the presence of an object peripherally. Patients wearing strong prescriptions also experience peripheral field distortion. This causes straight lines to appear curved when viewed peripherally causing a further decrement in perceptual judgements in the peripheral field. The correction of aphakia with contact lenses greatly eliminates the above problems. Recently, the implantation of intraocular lenses at the time of cataract extraction has become popular. Intraocular lenses provide the best optical correction of aphakia since magnification and distortion are greatly reduced. Work continues toward the development of even better intraocular lenses and safer surgical procedures.

Glaucoma also has a predilection for the older patient. It has been estimated that 1.2 million Americans suffer from this disorder with 62,000 of them being legally blind (Vision Research, 1982). Glaucoma can, in general, be characterized by an increased intraocular pressure which damages the optic nerve thereby producing a progressive destruction of the visual field.

The most common form of glaucoma has a slow insidious onset. The symptomless patient is often unaware of his visual deficit until late in the disease process at which time his visual field has constricted leaving him with tunnel vision. While many patients with glaucoma are unaware of their diagnosis, they may begin to have problems related to their shrinking visual field. They often find themselves bumping into objects and frequently report difficulty in driving. Many patients unconsciously adapt to their visual field defect by turning their eyes and head rather than relying on their deficient peripheral vision. As the disease progresses, the visual field defects worsen, with central vision often becoming ultimately involved. Presently many additional visual characteristics of the glaucomatous patient are being investigated.

The leading cause of new blindness in people age 65 and older is aging-related <u>maculopathy</u> (<u>Vision Research</u>, 1982). This disease process affects the macula which is responsible for ones fine detailed central vision. This disorder presents a variety of clinical appearances which correspond to various stages of the disease process. The disease often begins modestly, producing only mild symptomatology. In the early stages, the patient may have slightly reduced visual acuity, a prolonged dark adaptation time, and mild central distortion or <u>metamorphopsia</u>. Many patients never progress past this early stage. Those who do progress often have marked reductions in their visual functions due to the accompanying hemorrhaging and fibrotic tissue proliferation present in these eyes. The most debilitating symptom is markedly reduced central vision which often results in legal blindness.

Recent research at the University of Missouri-St. Louis has shown that older adults exhibit a slowing of the <u>eye movement reaction time</u>. In the first of two studies (Haywood, 1982) subjects age 62-77 (N=12) were asked to follow and respond to a moving stimulus on a Bassin Anticipation Timer. The eye movement reaction time, before their initial eye movement to follow the stimulus, was measured and averaged across 12 trials. The mean eye movement reaction time of the older group was about 45 msec slower than that of the younger group, $280.5 \pm 63.9$ to $235.7 \pm 52.5$ msec. A t-test showed that the difference was significant, $t(22) = 1.88$, at the .05 level. No instructions about eye movement had been given in this study, so it was not clear that mean reaction time values would be the same if subjects were specifically instructed to look at a target as quickly as possible.

Consequently, a second study (Whitaker et al, in preparation) was undertaken to provide normative eye movement reaction time data in older adults on the straightforward task of looking at a target stimulus as quickly as possible. Subjects age 57-72 (N=18) and 18-32 (N=18) were tested on a series of 80 trials, half with prior knowledge of the target location, and half when the target could appear 2.8 degrees to either the left or right of the fixation point. The mean eye movement reaction time was about 29 msec slower for the older adults than the younger adults, 284 msec to 255 msec, and simple reaction time trials were not faster than choice reaction time trials for either age group. The practical significance of these findings remain unclear since the image of an object moving across the retina can yield information about location and speed. On the other hand, inspection by an older adult of a complex environment by many successive eye movements could be significantly slowed by repeated latencies longer in length than those of younger adults.

It is clear that continued research on visual changes with aging is needed, both because unanswered questions remain in some areas of research and because some areas have remained virtually untouched. Oculomotor behavior and dynamic visual acuity are examples of the later. Yet, activity leaders do well to be aware of visual problems among their older participants. These problems may be indicated by the participants showing coordination difficulties, squinting of the eyes, under- or over-shooting in reaching for objects, a preference for brightly colored objects over dull ones, and unusual head movements to place an object at a particular line of gaze. Some of the steps which can be taken by activity leaders to minimize visual problems are: 1) to encourage older adults to have regular eye examinations and to wear corrective lenses during activity, if needed, 2) to choose well-lit areas for activities and avoid scheduling outdoor activities at dusk, 3) to increase contrasts in the visual environment as much as practical, and 4) to understand that glare may be problematic for the older adult in outdoor water settings, bright sunlight, or night driving, but that polaroid lenses may be helpful in these situations.

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