Vision

C T Scialfa and D W Kline, University of Calgary, Calgary, AB, Canada
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Glossary

Acuity – Ability to resolve fine detail, usually in stationary, high-contrast targets.

Age-Related Maculopathy (ARM) – A visual disorder involving atrophy of the photoreceptors and neurons within the central retina; also known as age-related macular degeneration.

Contrast Sensitivity – Ability to detect luminance differences, usually between spatially contiguous surfaces.

Dark Adaptation – Increase in the visual system’s light sensitivity in low illumination.

Glaucoma – An age-related visual disorder involving the loss of peripheral vision due to excessive pressure within the eye.

Optic Media – Transparent anterior components of the eye responsible for focusing images on the retina.

Presbyopia – Age-related loss of the ability to alter the refractive power of the lens to focus objects at varying distances.

Retina – Sensorineural structure in the posterior of the eye that contains the photoreceptors (rods and cones) and neural elements that transform retinal images into neural code.

Saccades – High-velocity, largely ballistic eye movements used to fixate different objects in visual scenes.

Useful Field of View – Visual area over which targets can be recognized and localized without eye or head movements.

Introduction

The normal, progressive changes that occur in vision as we age can make it more difficult to perform everyday visual tasks, especially those that have to be carried out under demanding viewing conditions such as dim lighting or low contrast. Some of the changes are due to age-related alterations in the optic media of the eye, others to sensorineural changes in the retina, visual pathways, and brain. The effects of the latter, however, are likely to be observed later in age (45 to 55 or so) than the former.

Although far less common than the visual changes experienced as a normal aspect of aging, serious visual disorders that can degrade well-being and mobility are also more prevalent in old age. Disorders such as these presumably account for research showing that vision loss is a commonly reported fear of aging.

The Aging Visual System

Optical Changes and the Retinal Image

A curved, transparent continuation of the sclera, the cornea at the front of the eye provides approximately two-thirds of the optical power needed to focus an image on the retina. Age-related changes in the cornea are usually moderate in extent. There tends to be some increase in corneal curvature and thus refractive power, primarily along the horizontal axis, and some increase in the cornea’s tendency to scatter light.

The primary purpose of the pupil is to maximize the eye’s depth of focus by maintaining the minimum size needed for ambient light levels. It also plays a secondary role in adjusting the level of light admitted into the eye. As we age, the diameter of the pupil decreases, a change referred to as pupillary or senile meiosis. As a result, the older eye admits less light than its younger counterpart under comparable illumination conditions. Because the difference in pupil size is more pronounced under dim light than bright light, older observers are especially prone to be disadvantaged by reduced lighting relative to their younger counterparts. A smaller pupil, however, also
enhances retinal image quality in the older eye by reducing light scatter and optical aberration and by increasing depth of focus.

By changing its sphericity via the ciliary muscle, the lens of the eye is able to adjust its refractive power to focus on closer or more distant objects. This adjustment process, known as accommodation, is steadily eroded with age by age-related hardening of the lens (lenticular sclerosis). Whereas a young child may be able to adjust the eye’s focus by 18 to 20 diopters, by age 60, virtually all accommodative power is lost. Unless the observer was already quite near-sighted (i.e., myopic), the associated recession of the near point of vision (presbyopia) will demand added focusing power in the form of reading glasses, bifocals, or trifocals for near tasks. The lens also yellows and becomes less transparent with age, especially so for short wavelength light (i.e., blues and greens).

Around age 60, the average retina receives only about one-third as much light as it did at age 20. About two-thirds of this loss appears to be due to the older eye’s smaller pupil, and about one-third to the increased opacity of the lens. Lens changes also increase light scatter markedly, an effect that makes older observers more sensitive to glare from strong light sources such as the headlights of oncoming vehicles at night.

Optically correctable errors in image formation, in particular far-sightedness (i.e., hyperopia) and astigmatism, are increasingly likely with age and contribute to the prevalent use of corrective lenses in older observers. Hyperopia results when the optic media are weak relative to eyeball length, making it difficult to focus on nearby objects. Large-scale epidemiological studies show that the prevalence of hyperopia increases with age; some also report the increase to be greater among women than men. Conversely, the prevalence of myopia or nearsightedness tends to decline with age.

In astigmatism, the eye’s focus is irregular, usually because the refractive power of the cornea is greater for one orientation (i.e., axis) than another. Astigmatism is labeled depending on the orientation along which the eye has its greatest refractive power and clearest vision. If the eye has more power at vertical orientations it is termed with-the-rule astigmatism; if power is greater along the horizontal plane, it is termed against-the-rule astigmatism. Eyes with greatest focusing power between the vertical and horizontal are said to manifest oblique astigmatism. Epidemiological studies indicate an increase in the prevalence and severity of astigmatism among both men and women in the later years. There also appears to be a fairly consistent change toward greater rates of against-the-rule and oblique astigmatisms and a reduced likelihood of with-the-rule astigmatism. These changes likely reflect the age-related increase in the cornea’s horizontal curvature. Without an appropriate cylindrical lens correction, older observers will have difficulty seeing vertically oriented target elements clearly.

The Aging Retina and Response to Light

Aging is associated with a pronounced loss of rods, the photoreceptors that predominate in the peripheral retina and are responsible for low-light (scotopic) sensitivity. Cones, the receptors that mediate fine detail vision and color perception at high ambient light (photopic) levels, are concentrated in the central area (macula) of the retina. Their density appears to be much less affected by aging than that of rods. Consistent with the loss of rods and their supporting retinal structures, scotopic sensitivity declines with aging about twice as fast as photopic sensitivity. Dark adaptation, the increase in visual sensitivity with falling light level due to the regeneration of cone and rod photopigments, also appears to progress more slowly in the older eye.

Photoreceptor response is processed initially in a retinal neural network of bipolar, amacrine, and horizontal cells and then is passed on to the retinal ganglion cells that compose the optic nerve for transmission to the brain. Several studies have reported significant age-related reductions in the number of retinal ganglion cells serving the macular region of the retina, and also in the number of axons in the optic nerve. These neuroanatomical changes appear to be accompanied by corresponding reductions in the retina’s electrophysiological response.

The Visual Pathways and Brain

The optic nerve carries the neural information from the retina on to the lateral geniculate nucleus (LGN), the relay station for visual information in the thalamus. From there, it is conveyed to the primary visual cortex (V1). In the healthy older brain, there seems to be relatively little change in the density or size of LGN and V1 neurons. There is some evidence of functional deficits, however. These include slowing in visual transmission, reduced capacity to track rapidly changing stimuli, and in cortical cells, reduced selectivity for stimulus orientation and direction. Alterations in the neurochemical characteristics, synaptic organization, diminished intracortical inhibition, and/or demyelination in the visual pathways have been suggested to explain these deficits. Such neural changes may also contribute to a functional decline in the extrastriate areas responsible for
higher-level visual functions. Even when no cell loss is apparent, imaging research reveals a tendency toward reduced efficiency and less specialization in the extrastriate cortical areas responsible for higher-level visual processing.

**Color Vision**

Although color vision losses can be severe in the presence of an eye disease (e.g., cataract, age-related maculopathy), a moderate linear increase in errors on color discrimination tests is characteristic of the healthy aging eye. Such errors tend to occur along the so-called blue-yellow rather than the red-green axis. This means that the typical older observer is most likely to experience difficulty distinguishing between colors that contain trace levels of blue or yellow, especially under conditions of low illumination. Much of this loss appears to be due to yellowing and darkening of the crystalline lens. Senescent changes in each of the three cone types (red, green, and blue) also appear to contribute to the age-related decline in color discrimination.

Age-related color vision changes are often sufficient to affect everyday visual tasks. Older observers report colors as less colorful or saturated, and tasks that depend on color coding (e.g., discriminating medicine bottles) can be more difficult for older observers, particularly in dim lighting.

**Eye Movements**

Three sets of extraocular muscles allow us to move our eyes to optimize different aspects of visual function, including fixation and acuity, balance, and the allocation of attention. Some eye movements are reflexive, while others are the result of goal-directed intent. Two generally voluntary eye movements that have been investigated in the elderly are smooth pursuit and saccades. Smooth pursuit movements, as the name implies, are those fluid movements made to track a moving object. Saccades are quasiballistic, high-velocity movements made to change the direction of gaze and attention. Smooth pursuit eye movements are slower in the elderly, with the result that there is more retinal blur for quickly moving objects. Saccadic eye movements are slowed in onset latency and are less accurate, at least when distractors are present and upward movements are required. What follows is a more detailed discussion of recent work in saccadic behavior.

Saccadic eye movements are readily executed in response to a peripheral onset (e.g., a flash of light) that elicits a prosaccade. In what is called an antisaccade task, observers are asked to move their eyes in the direction opposite this peripheral onset. This requires inhibition of the reflexive prosaccade. Some studies have found that the elderly make more errors and have slower correct responses in the antisaccade task. There is continuing examination of whether this reflects a lack of inhibitory control or a failure to hold in working memory the parameters for the correct eye movement.

In what is known as oculomotor capture, saccades are made to a unique stimulus, even when observers know that they are irrelevant to the task. The most robust capture obtains for rapid peripheral onsets. Older and younger adults show equivalent oculomotor capture when a single onset distractor is presented during visual search.

It is not only unique items that interfere with the accurate execution of saccadic eye movements. Saccadic averaging, also known as the center-of-gravity effect, occurs when saccades to an intended target are pulled toward neighboring objects. Older adults demonstrate greater saccadic averaging, with the result that they will need to program a second, smaller-amplitude eye movement in order to fixate a target. Thus, if rapid and accurate saccades are needed, visual clutter should be reduced.

**Aspects of Visual Function**

**Spatial Vision**

One of the more frequently studied aspects of spatial vision is acuity, the smallest detail that can be reliably resolved, usually in a high-contrast target or optotype. Under ideal viewing conditions, the best acuity for a human observer can be as low as 0.5 minutes of arc; under normal conditions, acuity averages 1 minute in younger people. This corresponds to 20/20 vision. Older adults who are wearing appropriate optical correction for the test distance (this is not the usual case) can typically obtain 20/20 vision until their 60s, at which point detail vision deteriorates. Age differences in acuity are magnified at near distances because of the lack of accommodation. Additionally, acuity in older adults is relatively worse when the stimuli are of lower luminance contrast.

A more comprehensive index of spatial vision involves measuring an individual's contrast sensitivity function, sensitivity to small differences in luminance for coarse, intermediate, and fine detail (i.e., spatial frequency). For humans, contrast sensitivity is at a maximum between approximately three and five cycles per degree of visual angle under daylight viewing conditions. The high frequency cutoff under these same conditions, corresponding to acuity, is about 30 cycles per degree.

Older adults, even those wearing their best optical corrections for the viewing distance, show systematic
declines in contrast sensitivity (CS) that are more pronounced for intermediate and higher spatial frequencies. In low luminance conditions, age deficits emerge at low spatial frequencies as well. Age-related changes in contrast sensitivity do not appear to be caused by optical aberrations. Instead, they are related to changes in retinal illuminance and neural integrity. Interestingly, recent research shows that age-related losses in CS are predictive of later acuity decline.

Another facet of spatial vision is depth perception, which is critical for a variety of actions including walking, grasping, and collision avoidance. There are a myriad of cues, both environmental (e.g., texture gradient) and physiological (e.g., stereopsis), that mediate depth perception. Several studies suggest that the elderly are less able to make use of binocular disparity to judge depth at near distances, but there has been little additional work in this area.

Human spatial vision has evolved so that details are seen best when they are imaged on the foveal (i.e., central) portions of the retina. However, a great deal of important visual information is obtained from peripheral vision. This information is used to guide eye movements and attention, to facilitate the perception of depth and motion, and to maintain balance and postural stability. Traditional measures of peripheral function often assess a person's visual field when the stimulus is a small target (e.g., a light onset) presented in an otherwise empty field. Static visual fields are diminished from approximately 180 to 140 degrees, but this may be an artifact of low luminance in the perimeter. Perhaps more important functionally are age-related differences in the useful field of view (UFOV), the area over which peripheral processing occurs in cluttered scenes, often when attention is divided over more than one task. The UFOV is quite task dependent, often very small relative to classically measured visual fields, and can predict performance on everyday tasks such as driving. Current research centers on whether age-related declines in the UFOV are best described as a general loss in sensitivity or one that is exacerbated as targets are presented more peripherally.

Hyperacuity is a term applied to a range of visual tasks involving the discrimination of relative location, motion, or shape that produce thresholds as low as a few seconds of arc. Exceeding the optical resolution of the eye as well as the limits of cone size and density, such precision is attributable to the neural pooling of photoreceptor information at higher levels of the visual system. Thus, hyperacuity tasks can be useful for measuring the effects of age-related sensorineural change separate from those due to optical losses.

Age differences on static hyperacuity (e.g., vernier acuity) tend to be small relative to those seen for dynamic tasks (e.g., oscillatory motion discrimination). Vernier hyperacuity refers to the judgment of the alignment of two or more clearly visible targets; when the targets are separated rather than abutting, the task is also referred to as extrapolation acuity. Everyday examples include reading a thermometer or aligning a ruler with an edge. Although most studies have reported that aging has little or no effect on Vernier or extrapolation tasks, some recent studies have reported an age deficit.

There is no such conflict in the findings from studies of age differences on dynamic hyperacuity tasks. They show that the minimum displacement of a target needed to discriminate it from a stationary stimulus is increased among older observers, even when no age difference is seen on a static version of the same type of task.

**Processing Visual Events: Sensitivity to Time and Motion**

The traditional technique for measuring the ability of visual system to track rapidly changing visual events is to measure the critical flicker frequency (CFF), the minimum frequency at which a bright pulsating light patch appears to be on steadily rather than flickering. The CFF threshold declines gradually to about age 60 and more rapidly thereafter. A large part of this loss appears to be due to reduced retinal illumination associated with normal age changes in the optic media and pupil. Indicative of reduced temporal resolution in the senescent visual system, however, changes in the visual nervous system also contribute to the age-related deficit on the CFF task.

Because it provides a more comprehensive assessment of the visual system's temporal sensitivity than the CFF task, more recent studies measure the effects of aging on flicker sensitivity using the temporal contrast sensitivity function (tCSF). The temporal analog of the spatial CSF, the tCSF task varies the depth of luminance change (i.e., contrast) of a small (2–5 degrees) target sinusoidally around a mean baseline luminance level over a wide range of frequencies. Initial research on age effects on the tCSF reported that the age deficit increased with flicker rate. There was also a leftward shift of the overall function toward lower flicker rates, suggestive of a decline in the speed of visual functioning. Subsequent research, however, provided evidence that this shift is explained by reduced retinal illumination. When this was controlled for, most of the age difference was eliminated; the remainder has been attributed to reduced sensitivity in the temporal visual channels.
Older adults are less capable of detecting the onset of motion, the direction of motion, and motion-defined surfaces as well as discriminating differences in speed under near-threshold conditions. However, for stimuli well above contrast thresholds, there appear to be no meaningful age differences in detecting the direction of a single, directional ‘jump.’ Additionally, estimates of subjective speed appear to be age invariant for suprathreshold speeds, at least under relatively simple viewing conditions.

Responses to moving stimuli can be primed by prior exposure. In contrast to directionally sensitive motion phenomena such as the waterfall illusion, visual motion priming is an enhancement of perception in which the primed stimulus is more likely to be seen as moving in the same direction as that of the priming stimulus. Older adults show less two-dimensional (2D) and three-dimensional (3D) visual motion priming than the young, and it has been suggested on the basis of psychophysical and imaging studies that this deficit reflects changes in temporal sensitivity in middle temporal regions of visual cortex.

Motion parallax refers to the fact that when we fixate on a particular distance while moving through a stationary world, retinal image velocity is inversely related to the distance of an object from fixation. Parallax is a powerful monocular cue to depth and also plays a critical role in the perception of 3D shape. While older adults are able to use parallax to mediate depth perception, they exhibit deficits in detecting the presence of 3D surfaces and identifying 3D shape via parallax.

Signals arising from several sources (e.g., the extraocular muscles and the brain) help us to maintain the veridical perception of a motion. However, there are circumstances in which these mechanisms fail. The Filehne illusion refers to the observation that stationary objects appear to move opposite to an eye movement. The Aubert-Fleischl phenomenon occurs when objects appear to move more slowly when we smoothly pursue them. Older adults appear to show the same Aubert-Fleischl effect as the young, at least for low image speeds at which age differences in pursuit gain would not be a factor. However, at least for stimuli of short duration, the aged demonstrate a reduced Filehne illusion. The reason for this deficit is unclear.

Biological motion refers to the motion pattern that unfolds as people engage in activities such as walking and running. Although relatively little work has been done in this area, it appears that older adults can accurately perceive biological motion associated with gross activities such as walking, even at durations of only 0.25s and when the moving object is occasionally occluded.

Another ecologically important type of motion perception involves time to contact (TTC), a subjective estimate of the time remaining before two objects in relative motion would cross paths. Clearly, TTC judgments are important for avoiding collisions while driving. Several studies indicate that the elderly consistently underestimate TTC, a difference that should put them at less risk for accidents. However, it also appears that the elderly are less accurate in judging whether a collision will occur. It is unclear how these two trends interact to influence safety.

Finally, there are practical reasons for asking whether aging affects the ability to perceive detail in motion. Conventionally, research involving dynamic visual acuity has found that the elderly age differences in acuity increase at high rates of target motion. Dynamic contrast sensitivity is also negatively correlated with age, particularly for higher spatial frequencies. While age differences in smooth pursuit gain could account for these findings, the observation that age deficits are minimal under high contrast/luminance conditions suggests that the problem lies within the optic media.

**Attention**

Attention can be thought of as the deployment of processing resources to task-relevant objects, locations, or subtasks. It can be stimulus driven, as when we orient to a loud sound, or goal directed, as when we selectively attend to signage because we are trying to locate an office building. Short-lived attentional demands are common. Generally, we attend to the contents of our clothes closet for only a moment or two in order to pick out a shirt to wear. On other occasions – over-the-road driving is one example – we must maintain an attentive state for long, dull periods of time.

One of the most frequently employed tasks for investigating age differences in selective attention is visual search, which is often executed in complex and cluttered scenes containing a great amount of distraction. For many search tasks, performance slows and becomes more error prone as the number of distractors increases – the display size effect. In some instances, however, search is relatively independent of the number of items in the display. This occurs when targets are defined by only one salient feature or when people have been provided with a great deal of practice.

A substantial body of research, anecdotal, experimental, and applied, documents the difficulties that older adults experience with visual search. These problems tend to increase with display size, particularly when the object being sought is visually complex
and similar to the distractors. They are also exacerbated when there is limited time to search the scene, when targets are presented in the periphery, and when other tasks must be performed simultaneously. Aging effects under these conditions are manifested often as a proportionate increase in reaction time, consistent with generalized slowing.

There are numerous ways in which the use of attention appears to be age invariant. Older adults have little difficulty attending selectively to simple features like orientation, color, direction of motion, and depth. They also make as much or more use of advance information about where to search. Additionally, they seem to learn simple search tasks at the same rate as their younger counterparts and seem to be relatively flexible in modulating the features to which they attend, as long as some higher-order rule can be used to guide search.

Most attention tasks demand that observers allocate processing resources over relatively short periods of time when targets occur regularly and frequently. In contrast, vigilance, or sustained attention, demands a longer duration of attentional allocation when signals are uncommon. Most of the gerontological research on vigilance indicates that there are no age differences in overall vigilance performance or the vigilance decrement, the decline on performance with increased time on task. There is some indication that the elderly are more prone to vigilance problems when event rates are high and visual quality is low, but this is not a consistent finding. A few recent studies suggest that age differences in vigilance may emerge in ecologically valid tasks such as driving. There are no data on inhibitory control, goal maintenance, or task-switching in sustained attention tasks.

Age-Related Visual Disorders

As we age, the likelihood of a disabling visual disorder increases, dramatically so after age 65 or so. Two levels of visual disability are generally distinguished: low vision and legal blindness. Low vision refers to a vision loss of sufficient severity to interfere with the ability to carry out everyday tasks and is often defined as a best corrected acuity level between 20/40 and 20/200. Legal blindness is defined as a corrected acuity of 20/200 or worse in the better eye and/or a visual field smaller than 20 degrees. Epidemiological studies indicate that low vision or blindness affects more than 3 million adults aged 40 and over in the United States alone and that the future prevalence of such disabling losses will increase markedly as the proportion of elderly people rises. Age-related losses of sight can result from a primary eye disease or can occur as the secondary consequence of some other age-related illness. The four disorders that most commonly threaten sight in old age are cataract, age-related maculopathy (ARM), glaucoma, and diabetic retinopathy.

Cataract or opacification of the lens is the leading cause of visual impairment among older adults. Cataracts appear to be a near-universal outcome of old age; close to 70% of adults in the United States exhibit clinically significant cataracts by age 80. By absorbing and scattering light, cataracts reduce image luminance and contrast. This in turn impairs acuity, color discrimination, and contrast sensitivity and increases susceptibility to glare. Risk factors for cataract in addition to age include exposure to sunlight, steroid use, previous intraocular surgery, smoking, and diabetes. Fortunately, cataracts are readily treated by the replacement of the natural lens with an artificial version (i.e., an intraocular lens [IOL]).

Age-related macular degeneration (ARMD), the leading cause of irreversible visual blindness among the elderly in developed countries, causes a loss of central vision. Although the specific cause is not known, it results from the loss of photoreceptors associated with changes in the underlying retinal pigment epithelium (RPE) and Bruch’s membrane that support their metabolic needs. The ‘dry’ or early form of ARMD leads to some impairment of acuity; the late form causes severe acuity loss. When the late form of ARMD is accompanied by a proliferation of fragile and often leaky new retinal blood vessels, it is referred to as the exudative or ‘wet’ form of the disease. While laser photocoagulation, photodynamic, and/or antioxidant treatment may slow the neovascularization, they cannot reverse the vision loss. The severe loss of acuity, color perception, and contrast sensitivity with ARMD can impair the patient’s ability to carry out even the most basic tasks of everyday life.

Glaucoma is a progressive loss of peripheral vision due to damage to the optic nerve where it exits the eye. Although there are marked individual differences, glaucoma usually occurs in association with elevated intraocular pressure. There are two types of the disease, both of them associated with a buildup of aqueous humor that is produced continuously by the ciliary body. In open angle glaucoma, the aqueous humor is prevented from exiting the anterior chamber of the eye via the canal of Schlemm. In closed angle glaucoma, the prolapse of the iris against the lens prevents aqueous humor from circulating from the ciliary to the front of the eye. The patient is often unaware of the presence of glaucoma until quite late in its progression. In addition to a narrowing of the visual field, or ‘tunnel vision,’
glaucoma can cause loss of contrast sensitivity, night vision, motion perception, and color vision. Regions of blindness (scotoma) can accumulate and eventually may lead to complete blindness. Tasks needing effective peripheral vision such as walking, obstacle avoidance, and driving can be impaired early in the disease. Moderate glaucoma often responds well to drugs that reduce aqueous production or enhance its outflow; closed angle glaucoma is also sometimes treated by creating a small hole in the iris (an iridectomy) to equalize pressure on either side of the iris.

Diabetic retinopathy (DR), the fourth leading cause of legal blindness in adults over 65 in the United States, is caused by diabetes-induced changes in the retinal vasculature. In its common initial form, DR is associated with a swelling and some leakage from the retinal capillaries, which impair vision. For a minority, these changes can progress to rapid retinal neovascularization with bleeding into the vitreous humor, retinal scarring, and even retinal detachment. This outcome is more likely for those who need to take insulin. The loss of acuity, color, and contrast sensitivity, scotoma, and reduced visual fields that can result from DR can make everyday tasks difficult. In addition to management of the underlying diabetes, lasers can be used to anneal leaking blood vessels. If necessary, preretinal photocoagulation can be used to reduce neovascularization by lowering the overall metabolic demands of the retina.

Low vision and blindness can make it exceedingly difficult to carry out such instrumental activities of daily living (IADLs) such as handling money, shopping, or taking medication and can even affect the basic ADLs such as bathing, feeding, or dressing. In assisting low-vision patients it is important to address both their visual loss and their adaptation to that loss. For example, visual functioning may be improved through the use of low-vision optical aids, good lighting, large-print materials, and simplified floor plans and marking the edges of stairs with high-contrast strips. Social service interventions that foster peer and family support in combination with psychosocial and rehabilitation programs can help to reduce social isolation and enhance overall quality of life.

**Vision in Everyday Life**

Age-related visual pathologies such as glaucoma and ARMD often have a profound impact on a person's ability to participate in important activities such as walking, reading, driving, and engaging in a variety of work-related and leisurely activities. Even in the absence of pathology, the elderly report visual problems with everyday tasks such as driving and use of the World Wide Web. Their self-reports are often highly insightful and generally consistent with the findings from lab and clinical studies.

Surveys conducted over the past two decades have asked healthy older people about the visual problems they experience in common tasks such as driving. The difficulties that emerge are consistently related to events occurring too quickly vis-à-vis their ability to respond, search, and deal with unexpected events, light sensitivity (e.g., dim displays and glare), and near vision. The self-reports of older drivers are consistent with changes in their driving habits. For example, older adults reduce driving distances generally and are particularly reluctant to drive at night, in poor weather, during high-volume times of day, and along higher-speed roadways and unfamiliar routes. The self-reports are also consistent with the accident profile of older drivers, in which merging, yielding right of way, and negotiating intersections weigh heavily. Certainly, many of the changes in visual function that have been summarized previously should be related to driving performance. These include dynamic acuity and contrast sensitivity, glare recovery, peripheral vision, motion and depth perception and visual attention. Unfortunately, with relatively few exceptions such as in studies of the U'OV (see Driving Behavior), attempts to use measures of visual function to predict accident involvement in the aged have not met with much success, and so the critical issue of licensure for at-risk older drivers remains a research and policy challenge.

Older adults represent the fastest-growing group of users of the Internet and World Wide Web. They use these resources to communicate with family and friends, plan activities, develop and maintain interests, obtain health information, and find psychosocial support. Several studies have suggested that access to the Internet and web can enhance self-efficacy, build social support, and reduce depression and isolation. Still, even a cursory examination of websites leads to the conclusion that usability issues abound and that age-related declines in visual function can interact with poor web design to readers usage error prone and frustrating. A small but growing literature indicates that the elderly have difficulties with font size and style, color usage, clutter and crowding, finding links, recovering from 'broken links,' and navigation in general. There are a few empirical studies linking web performance with visual function, and guidelines have been proposed by various agencies to reduce visual demands of web resources so as to make them more accessible to the elderly. It will be important in future years to evaluate the usefulness of these guidelines and to build a
stronger empirical base for directly testing the influence of individual difference variables and design features on elder use of these important tools.

See also: Driving Behavior.

Further Reading


Volunteer Activity by Older Adults

R A Harootyan, American Association of Retired Persons, Washington, DC, USA

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Glossary

Formal Volunteering – Any activity intended to help others that is freely provided through a charitable, religious, civic, or similar organization and for which no pay or other type of material compensation is received.

Independent Sector – A non-profit coalition of over 800 foundation, corporate, and voluntary organization members with interests in philanthropy and voluntary action.

Informal Volunteering – Any activity intended to help others that is freely provided on an ad hoc basis by an individual and for which no pay or other material reward is received.

Intensity of Volunteering – Hours spent per week or per month in either formal or informal volunteer activity.

Volunteer Participation Rate – Incidence of volunteer activity within a specified population or group.

Introduction

Volunteer activity is generally defined as any activity intended to help others that is provided without obligation and for which the volunteer does not receive pay or other material compensation. Volunteers usually provide such assistance through a religious, charitable, or civic organization, but their assistance also can be given on an ad hoc or non-organizational basis. This article uses the broader definition of volunteer activity that includes assistance to others (except immediate family members or relatives), which is either organized and formal or episodic and informal in nature. Because there is no standard definition of what constitutes volunteer activity, it is somewhat difficult to provide a precise picture of trends in volunteerism in the United States. I use data from national surveys as well as information from studies on various aspects of volunteering to provide some general trends and findings about volunteerism and the older population in recent decades. The article concludes by looking to prospects for expanded volunteerism among older Americans in the future.