Alzheimer Disease and Associated Disorders
Vol. 11, Suppl. 1, pp. 42–47

Attentional Problems and Older Drivers

Karlene Ball

Department of Psychology, Edward R. Roybal Center for Research in Applied Gerontology, University of Alabama at Birmingham, Birmingham, Alabama, U.S.A.

Summary: At a society level, there is a responsibility to meet the mobility needs of a growing population of older adults. Simultaneously, it is understood that some older adults will experience behavioral and/or physical changes that may preclude driving at some point in their lives. Because most older adults rely on the automobile to maintain their mobility and independence, there is sometimes reluctance to stop driving when impairments develop. Recent research has been aimed at finding ways to distinguish those drivers who may pose a threat to their own safety, as well as the safety of other road users, from the vast majority of competent drivers. These studies have indicated that measures of visual attention and cognitive function have been successful in distinguishing between these two groups. Finally, because visual attention skills can be improved with training, these findings have important implications for further evaluation of interventions to enhance the skills that underlie safe driving. **Key Words:** Alzheimer disease—Attention—Cognitive function—Driving—Mobility—Useful Field of View.

Many older Americans are subject to age-related declines in the critical skills that support independence. In particular, sensory and cognitive functions may deteriorate in later adulthood, and it is widely accepted that deficits in these areas contribute to a decline in the ability to carry out everyday activities. The functional impact of such deficits also may make older individuals more susceptible to injuries, producing further reductions in mobility and independence. Driving is one activity that is crucial to maintaining independence and one that can be affected by multiple sensory and cognitive factors. Continued mobility is critical in maintaining social contacts, independent functioning, and a satisfying quality of life. Given that driving is the preferred mode of travel in our society, and that at least a subset of older adults will experience behavioral and biological changes that make mobility (and specifically driving) more difficult in later life, recent research has been aimed at finding ways to differentiate safe older drivers from those who may pose a threat to their own safety and to the safety of other road users. These studies have shown that measures of attention and cognitive function are particularly promising at distinguishing these two groups. Furthermore, because some attentional skills can be improved with training, these findings have important implications for developing methods to enhance the skills necessary for safe driving. Finally, deficits in attention/cognitive function also characterize individuals with dementia [particularly Alzheimer disease (AD)], who may have difficulty driving as well. Therefore, performance-based tests that predict driving difficulty for older adults in the general population are likely also to predict driving capability for those with mild to moderate cognitive impairment.

Address correspondence and reprint requests to Dr. Karlene Ball at Department of Psychology, 415 Campbell Hall, University of Alabama at Birmingham, Birmingham, AL 35294, U.S.A.

ALZHEIMER DISEASE AND DRIVING

The most common dementing disorder in the elderly population is AD, a progressive, degenerative brain disorder that leads to a variety of abnormalities in cognitive functioning and behavior. AD is a relatively prevalent condition, accounting for approximately half of all dementia cases, with conservative estimates suggesting that between 1.5 and 2.5 million persons in the U.S.A. have the disease (Department of Health and Human Services, 1984). Furthermore, the prevalence of dementing disorders is rising, because of changes in population demographics. The risk of dementia is estimated to be as high as 47% among those 85 years and older, an age group whose numbers are projected to increase from 2 million in 1980 to 9 million in 2030 (Evans et al., 1989). In its mild stages, AD can be difficult to diagnose, and therefore prevalence data may be underestimated. For example, Reuben (personal communication) reported that almost 20% of frail elderly drivers in one study (the Southern California–UCLA Hospitalized Older Persons Evaluation) had mild cognitive impairment, but only 4% of these drivers had been diagnosed with dementia.

One of the issues facing our society is what to do about the driving privileges of an individual once that person is diagnosed with a dementing disease (see Drachman, 1988). Several investigators have reported that driving does not necessarily cease after the onset or diagnosis of dementia (Friedland et al., 1988; Lucas-Blaustein et al., 1988; Carr et al., 1990; Gilley et al., 1991; Dubinsky et al., 1992; Logsdon et al., 1992; O'Neill et al., 1992; Cooper et al., 1993), and therefore these individuals may be at increased risk of crashes. Waller (1967) was the first to compare the crash frequency of nondemented drivers with that of drivers with dementia. In this early study, the individuals with dementia had twice the number of state-recorded crashes as the nondemented drivers. More recent studies have also suggested that dementing disease is associated with driving difficulty, as defined by crash frequency (e.g., Friedland et al., 1988; Lucas-Blaustein et al., 1988; Coyne et al., 1990; Kaszniak et al., 1990; Gilley et al., 1991; Cooper et al., 1993). Finally, studies that have evaluated driving performance on the road or in a driving simulator have shown that individuals with AD generally perform less well than age-matched controls (Bylsma et al., 1990; Rebok et al., 1990; Bloedow and Adler, 1992; Tallman, 1992; Donnelly et al., 1994; Tallman et al., 1994). Thus, there is converging evidence that, as a group, individuals with AD do not demonstrate adequate driving ability.

There are several relevant issues in considering the problem of the driver with AD, however. First, AD is a graded process, and the capabilities of an individual with this condition greatly depend on the stage of the disease process. For example, both Drachman and Swearer (1993) and Waller et al. (1993) have shown that during the earliest stages of AD, crash risk is no higher than for the general population. Thus, an individual in the earliest stages of the disease may be functionally similar to an older adult who is free from the condition, whereas a subject from the "normal" population may reveal early symptoms of the disease that have not yet been diagnosed. As AD progresses, it may affect different individuals in diverse ways. At the early stage of the disease, performance on specific functional measures may be more likely to identify driving risk than the general diagnosis. In the later stages of AD, however, impairment is more global and severe, and there is little disagreement that driving is a safety risk to the individual and to others (Lundberg et al.,1997). Given the heterogeneity of the disease, there is a danger in clustering all individuals with AD into one category and simply using the diagnosis as the basis for allowing or denying driving privileges. An analogy can be made to eye disease, also relatively prevalent in the elderly population and also typically marked by deterioration. The diagnosis of eye disease itself is not sufficient for license removal. Rather, the decision is based on performance-based tests that evaluate the person's actual visual function. Similarly, with regard to dementing disease, an objective and nondiscriminatory approach to the problem is to base the licensing decision on the patient's functional characteristics (e.g., cognitive, perceptual).

Measures of both visual attention and cognitive function have been shown to be good predictors of accident frequency in older drivers (Owsley et al., 1991; Ball et al., 1993). Furthermore, Parasuraman and Nestor (1991) found that those AD individuals with attentional deficits, such as impairments in selective attention and attention switching skills, were most likely to have driving problems. An important goal in research on older drivers has been to identify functional tests that can be used to select individuals at risk for crashes and are broadly applicable to all elderly, not just one subpopulation. Etiology is of crucial importance in choosing a medical treatment for the specific disease process at hand or in devising an appropriate intervention program to improve driving skills, but in terms of driver *assessment*, the relevant issue is functional capability, not diagnostic category. Because attentional impairment may underlie driving difficulty in both patients with AD and older adults without cognitive impairment, studies investigating attentional function as a risk factor will now be summarized.

ATTENTIONAL FUNCTION AND DRIVING

Inattention is frequently cited as a cause of accidents, either in the home, in the workplace, or on the road. Indeed, driver inattention has long been cited as an underlying cause of vehicle crashes in the elderly (Shinar, 1978). Many, but not all, older adults have deficits in their attentional skills. Several recent studies have evaluated batteries of potential visual/cognitive predictors of accident involvement and have demonstrated that visual attention deficits are the best predictors of accident involvement in older adults.

Parasuraman and Nestor (1991) examined the ability of older drivers to switch attention from one event to another in relation to their self-reported crash involvement. Attention switching skills would seem crucial for driving because drivers must continuously monitor the visual scene and be ready to shift attentional focus from one critical event or target to another. Parasuraman found that older drivers with selective attention problems were more likely to have higher crash rates than older adults with good attention switching ability. This finding is consistent with earlier studies on various groups of drivers (e.g., bus drivers) showing that selective attention was consistently the most highly perceptual/cognitive skill related to driving performance (Kahneman et al., 1973; Mihal and Barrett, 1976; Barrett et al., 1977; Avolio et al., 1985; Ranney and Pulling, 1989).

Another study (Owsley et al., 1991) examined how state-recorded crash frequency in 53 older drivers was related to visual and cognitive measures at a number of different levels, including ocular disease, visual–sensory function, visual attention, and mental status. The best predictor of crashes was a model incorporating a composite measure of visual attention [the size of the Useful Field of View (UFOV®)] and mental status. This model was much stronger than those reported in earlier studies on vision and driving that assessed only visual sensory function and excluded measures of information processing skills at higher levels.

The UFOV, the best correlate of crash frequency in our studies, refers to the area of the visual field in which information can be rapidly extracted without eye and head movements (Ball et al., 1990). It involves the earliest preattentive (parallel-processing) stage of visual attention that is used to quickly capture and direct attention to highly salient visual events. Although it has been known for some time that the size of the UFOV declines on average with age (Sekuler and Ball, 1986), more recent work (Ball et al., 1990) has established the contribution of three attentional factors as bases for reductions in the UFOV: (1) reduced speed of visual processing (as reflected by a greater impact of reducing stimulus duration on UFOV area), (2) reduced ability to divide attention (as reflected by a greater impact of increasing center task complexity on UFOV area), and (3) reduced salience of the target against its background (as reflected by a greater impact of distractors on UFOV area). Results demonstrated that the bases for reduced UFOV operate independently in that some individuals experience decline in only one of the factors (e.g., divided attention) ,whereas others experienced decline in multiple factors. It was also found that the effects of multiple bases, when they occurred, were additive such that, as a group, individuals with all three effects have a loss of 85% of the field relative to the group experiencing none of the problems. Furthermore, although age accounted for approximately 50% of the variance in the size of the UFOV, the degree of shrinkage due to the three attentional components accounted for 91% of the variance in UFOV. This result indicates that the UFOV shrinkage can be accounted for without knowledge of age. Thus, the general age trends observed in this task are due to a higher prevalence of the three specific problems in the older age group rather than to a general age-related decline in one or more of the three areas.

These results do not imply that overall visual function is irrelevant to safety and driving. A test of visual attention, like the UFOV, makes use of information coming through the visual sensory channel. For example, individuals in the study described above who had serious visual field loss also exhibited an impairment in the UFOV. On the other hand, visual sensory field loss was not a necessary condition for a constricted UFOV. Many older adults who had impairments in the UFOV had normal visual fields. Thus, visual attention ability depends on the integrity of visual sensory information, but it also depends on other attentional mechanisms, as described earlier. In this sense, it is a more comprehensive measure of information processing ability than is visual sensory status alone.

In another study with a larger sample ($n = 294$), it was confirmed that the UFOV is a good predictor of crash frequency (Ball et al., 1993). In this study, there were four parts to the protocol, which were completed in a single visit: visual sensory function, global mental status, UFOV, and eye health. The goal of this study was to test a model designed to predict crash frequency in older drivers on the basis of visual, cognitive, and attentional measures. Using representative measures from each of the different aspects of the visual information processing system, the original model was evaluated using the LISREL VII structural modeling program (Joreskog and Sorbom, 1989). Only two variables, UFOV and mental status, had direct effects on crash frequency.