Performance Differences on Driving and Laboratory Tasks Between Drivers of Different Ages

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A battery of closed-course driving and laboratory tests was developed for evaluating the skills required in routine suburban driving. Twenty-three younger (aged 30 to 51 years) and 21 older (aged 74 to 83 years) adults participated. Driving tests included responding to traffic signals, selecting routes, avoiding moving hazards, and judging narrow gaps. Laboratory tests included measures of perceptual style, selective attention, reaction time, visual acuity, perceptual speed, and risk-taking propensity. Older drivers were generally slower and less consistent in their driving. The groups did not differ from each other on measures of caution. In the laboratory, older drivers scored lower on tasks requiring rapid switching of attention. Differences in laboratory measures were larger, reflecting the greater difficulty of these tasks and the greater precision available in the laboratory. The pattern of greater variability of performance for the older drivers indicates that driving ability should not be judged on the basis of chronological age.

As the general population ages, the percentage of older drivers on the road is increasing. By the year 2020, an estimated 17 percent of the population will be 65 or older, resulting in more than 50 million older persons being eligible to drive (*1*). Furthermore, with the increasing trend toward suburbanization, people of all ages, and especially older people, are becoming more dependent on their automobiles (*2*). At the same time, the total number of registered vehicles is increasing, commuting patterns are changing (*3*), and traffic congestion is becoming a major problem both in suburban and urban areas (*4*). Following recent advances in microelectronics, advanced technology is being investigated as a means of alleviating traffic congestion. Dynamic roadway signs with rapidly changing messages, together with in-vehicle communications systems, including cellular telephones and navigational aids with cathode-ray tube screens, are being combined to transform the driving task into a complex problem of information management. Whether the changing demands of driving combined with technological advances will be of special difficulty for aging drivers, either because of their inability to deal with complex information at a rapid rate or because of anxiety or feelings of alienation associated with their perceptions of the rapidly changing driving environment (*5*), will be of considerable interest in the near future, as the driving population continues to age. Therefore, the changing nature of the driving task and the implications of the changes for drivers of all ages should be examined.

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BACKGROUND

Accident Risk of Older Drivers

Until recently, older drivers were commonly accepted to have higher accident rates than middle-aged drivers (*6–9*). This conclusion was generally based on the use of mileage as a measure of exposure to risk; accident rates for a particular age group were expressed as the number of accidents per miles traveled. Recently, however, people have argued that mileage-based rates are unreliable. One reason given is that mileage estimates have not been validated (*10*). A more common argument is that mileage rates may be misleading, because older people drive considerably less than younger people. According to Evans (*11*), "Greater than any increase in driver risk with increasing age is declining distance of driving." Because older drivers reduce their exposure to conditions of elevated risk and are thus less of a risk to other road users, Evans (*11*) concluded that "the problem of aging may thus be more one of reduced mobility than of reduced safety." However, the average number of miles driven annually by drivers 65 and older increased with each major survey taken between 1969 and 1983 (*1*), and such a compensatory tendency may well be specific to the current generation of older drivers. Because driving will have been a more pervasive and essential part of the daily life of the next generation of older drivers, they may be less willing to give up driving (*1*).

As an alternative to mileage-based accident rates, accidents per licensed driver within specified age groups have been reported. This accident rate may be more relevant for insurance purposes, for which the goal is to establish the accident risk for an individual in a given year. Yanik (*10*) reported that elderly drivers are underrepresented in accident frequencies relative to the number of licensed drivers within their age group. Specifically, although drivers over 65 make up 11.2 percent of the driving population, they are involved in 7 percent of all accidents. Cerrelli (*12*) reported that drivers over 75 have a crash involvement rate (per population) that is 2.5 times lower than that of drivers aged 40 and 5 times lower than that of 20-year-old drivers.

Specific Problems of Older Drivers

Older drivers are involved in different types of accidents than younger drivers. In industrial settings, older people tend to have accidents involving slowness in avoiding moving objects or difficulty in recovering when thrown off balance. Road accidents are characterized by slowness in identifying and reacting to rapidly developing traffic situations (*13*). Complex traffic situations pose problems for the elderly driver. For drivers over age 50, the percentage of multiple-vehicle intersection accidents increases and the percentage of single-vehicle accident involvements decreases correspondingly. More than half the fatal accident involvements for 80-year-old drivers occur at intersections, as compared to 25 percent or less for drivers up to 45 years old (*14*). Similar results have been reported by Waller et al. (*8*), who found that left turns were involved in about 25 percent of the crashes of drivers over 65, almost twice the percentage of the average driver. Changing lanes, merging, and leaving from a parked position, i.e., driving situations that involve complex speed and distance judgments under time constraints, are more evident in the accidents of older drivers than in those of younger drivers. Brainn (*15*) reported that older drivers have difficulty with driving situations requiring backing. More recently, Monforton et al. (*16*) analyzed selected multivehicle accidents of American Automobile Association drivers in Michigan. They found accidents involving stop and yield signs to be more prominent for aging drivers. Rear-end and loss-of-control accidents were less frequent. Their analysis revealed a consistent trend toward increasing culpability with age for drivers over 55 years of age. These accident studies do not have exposure data that correspond to the accident factors; therefore, the reported overrepresentations reflect an unknown combination of risk and exposure factors.

Older and younger drivers differ in the types of precrash behaviors exhibited, and older drivers are cited for violating different traffic laws than younger drivers. Older drivers are more likely than younger drivers not to attempt an avoidance response before an accident. Sussman et al. (*17*) interpreted this as an indication of inattention. Planek and Fowler (*18*) reported the overinvolvement of older drivers in traffic "violations of omission," such as running red lights and stop signs and failing to yield. Drivers over 70 years old were convicted more frequently for sign, right-of-way, and turning violations, but less frequently for speed, equipment, and major violations (*6*).

Older drivers apparently compensate for age-related impairments by limiting their driving and avoiding risky situations and rush hours (*18,12*). Whether this avoidance reflects increased concern about their capabilities or primarily the change in lifestyle that accompanies their withdrawal from the work force is unknown.

Driving Competency

Reliable assessment of driving competency is critical to maintaining the mobility of aging drivers. Whereas drivers' accident histories are most often used for this purpose, their stability has been questioned. Miller and Schuster (*19*) found that past accident history is not a good predictor of future accident involvement and thus may not be a valid indicator of current or future driving competency. The need for an alternative measure of driving proficiency was asserted by McKenna et al. (*20*), who argued that detailed investigations of component skills would lead to better understanding of differences in driving performance than conclusions based on a single criterion, such as accident rate. These authors concluded that "research should concentrate on specific skill deficiencies and their contribution to human error, rather than more immediately attempting to predict overall accident liability." In addition, practical considerations about the availability and quality of accident data, which rarely contain information in sufficient detail for research purposes, underscore the need for alternative ways of evaluating driving competency.

Functional Age

An important aspect of the question of aging impairments is the age at which deterioration can be expected. Barrett et al. (*21*) concluded that information-processing ability begins to decline during the mid-40s. Results from other studies, such as that by Ponds et al. (*22*), suggest that an impairment related to dual-task performance occurs sometime after age 60. According to Willis (*23*), the age factor exhibits the widest of individual differences in pattern of decline, but most people will exhibit at least some age-related decline by age 80. A recent TRB study (*1*) identified age 75 as the point after which accumulated skills are offset by physiological and cognitive changes that accompany aging.

Clearly, as pointed out by Salthouse (*24*), individuals age at different rates. Furthermore, changes over the same number of years may have different meanings on different parts of the scale. For these reasons, the concept of functional age emerged. According to Kausler (*7*), functional age is the level of competence in basic skills that determine overall performance, in this case on-road driving skill. Early work on functional age attempted to develop a single index that could be used instead of chronological age. However, because aging is not unidimensional, a single measure cannot adequately represent the processes of aging. Subsequent work has therefore been undertaken to develop a functional age profile (*21,25*). A profile allows an individual's position on a number of performance measures to be determined.

As implied by the functional age profile concept, different component skills can be expected to deteriorate at different rates for different individuals. Because aging cannot be characterized with a single index, decisions about driving competency cannot be made on the basis of chronological age. Despite increased concern about the practice of special testing for the elderly, the fact that such testing is being advocated is an admission that age per se does not cause increased accidents (*7*). Unfortunately, no functional age profiles of driving capabilities have yet been developed.

METHOD

In response to the need for improved measures of driving competency, one objective of the Liberty Mutual automotive research program is the development of a safe-driving capability profile, which includes a battery of laboratory and driving tasks. Tasks were selected to assess the skills and abilities involved in everyday suburban driving. The driving tasks were implemented on a half-mile closed course that allowed drivers to use their own vehicles. The use of drivers' own vehicles avoided problems of differential adaptation to unfamiliar research apparatus, such as simulators and instrumented vehicles.

The selection of specific driving tasks was based on a pilot evaluation of a number of tasks and reflected perceptions of the skills necessary for adapting to the changing suburban (i.e., relatively low-speed) driving environment together with the capabilities of the data collection facilities. Additional rationale, relating to the importance of decision making in driving and to the theories of driving behavior that motivated task selection, are presented elsewhere (*26,27*). Laboratory tasks included measures of information processing, some of which have previously been shown to be related to accident rates (*21*). In the following paragraphs, the current battery of tasks will be described and the sensitivity of driving and laboratory measures for detecting performance differences between drivers of different ages will be evaluated.

Subjects

Forty-four subjects ranging in age from 30 to 83 participated in driving and laboratory tests. The younger group (15 women and 8 men) were 30 to 51 years old; the mean age was 39.7 years, and the standard deviation was 5.9 years. The older group (9 women and 12 men) were 74 to 83 years old; the mean age was 78.1 years, and the standard deviation was 3.1 years. Subjects were recruited with newspaper advertisements and from local senior citizen activity centers. All were active drivers. Subjects were paid $8.00 to $10.00 per hour for participation, depending on their responses to performance incentives.

Apparatus

An instrumented driving range, including 0.5 mi of two-lane roadway, a signalized intersection, mobile hazards, and various regulatory and destination signs, was developed so that drivers could use their own vehicles. The instrumentation and its rationale are discussed by Ranney et al. (*26*). Traffic signal timing and data acquisition were controlled by a DEC PDP 11/23 computer in a van parked beside the intersection. Spot speed data were obtained from four pairs of inductive loops buried beneath the pavement. The pairs were separated by 36.6 m (120 ft), with three pairs in front of and one pair beyond the intersection. Time of entry into the intersection was obtained from a single loop in each approach lane at the stop line. Traffic signal timing was related to the temporal position, that is, the time the vehicle would take to reach the intersection, which was computed using approach speeds. This computation compensated for differences in vehicle approach speed.

Driving Test

The driving test consisted of three 30-min trips. Each trip, composed of up to 20 laps of the closed course, required the driver to respond to a continuous sequence of driving situations. Primary tasks included responding to traffic signals with varied timing and selecting routes using information presented on traffic signs. A gap-acceptance task required drivers to select one of two routes at a junction on the course. One route was shorter, but it required drivers to drive through a gap formed by two construction barrels. Gap size changed and was determined by the width of each subject's vehicle. Based on pilot work, the following gap sizes were used: +3, −3, +6, −6, +9, and −9 in. Drivers' judgments concerning the width of the gap and their willingness to attempt the gap were evaluated through this task.

Secondary tasks included avoiding unexpected moving hazards, such as a rolling ball or simulated baby stroller, responding to regulatory signs (speed limit and stop signs), and executing maneuvers created by cones and barrels. Drivers were instructed that they would be rewarded for safe driving and for completing each trip faster than a reference time. An experimenter accompanied the driver during instruction and training sessions. Subjects received practice until the experimenter felt that the instructions were understood. During the data collection, the experimenters were in or near the instrumentation van, alongside the intersection. Experimenters were careful not to distract the drivers during their approach to the intersection.

Both subjective ratings and objective measures of drivers' responses to the driving task situations were recorded. Drivers were rated on the following skills:

- Stop-and-go decision making,
- Gap judgment,
- Gap execution,
- Decision speed,
- Route selection,
- Speed maintenance,
- Vehicle control,
- Emergency hazard avoidance,
- Time to destination, and
- Ability to follow instructions.

Ratings were made on a 3-point scale. Drivers were observed by two or three raters, depending on staff availability. Ratings were discussed after each session, and a single consensus rating was recorded for each driver on each of the 10 categories. In cases where disagreement among the raters was not resolvable, a midpoint rating (e.g., 1.5 or 2.5) was recorded for the category. An overall rating of driving performance was computed as the average of the 10 categorical ratings.

Objective driving performance measures included the following:

1. Measures of intersection performance
   —Stopping probability, the proportion of decision trials on which the driver stopped when faced with the yellow traffic signal (STOPPR);
   —Stopping accuracy, the vehicle placement relative to the stopline on stopping trials (STPACC); and
   —Intersection clearance margin, the mean difference between the time the vehicle exited the intersection and the onset of the red traffic signal (MARGIN).
2. Measures of gap performance
   —Number of attempts, the number of trials in which the driver attempted to drive through the gap (NOATT);

—Number of gap judgment errors, including selection of gaps too small and avoidance of gaps of equal or greater width (JUDGERR); and

—Number of gap execution errors, struck barrels or excessively slow speed (EXERR).

3. Speed measures

—Intersection approach speed, the mean speed over all trials (SPEED1), taken approximately 300 ft before the intersection, representing the speed before the traffic signal has changed from green to yellow;

—Intersection approach speed change, the mean over all trials (SPDDIF), measuring the influence of the traffic signal change on speed;

—Mean lap time, the mean time over all trials in one trip (LAPTIME); and

—Speed maintenance errors, instances of speeds over 35 mph (FAST35) or under 27 mph (SLOW) in approach to intersection.

4. Measures of vehicle control consistency

—Approach speed consistency, standard deviation over all trials of approach speed (SSPD1).

Measurement of route selection errors was eliminated because of insufficient data.

Laboratory Tasks

Visual acuity (VISION) was measured with a standard Titmus tester, similar to those used for license renewal. Perceptual style was measured with the embedded figures test (EFT) (*28*). Perceptual speed was measured with three tests of the cognitive factors kit (*29*). The tests required a visual search for letters (VSEARCH), matching numbers (NUMBERS), and matching figures (FIGURES). The digit symbol substitution (DSS) test of the Wechsler adult intelligence scale is also a measure of perceptual speed and short-term memory, and has been used widely in studies of information processing and aging (*30*). Visual selective attention was measured with an analogue of the dichotic listening task developed by Avolio et al. (*31*). The total number of errors (VSATOT) and the number of switching errors (VSATSW) provided a measure of the efficiency of attention switching. The three measures of reaction time included simple (SRT), simple plus movement (MRT), and movement plus (two) choice (CRT) reaction times. Risk-taking propensity (RISK) was measured by the choice dilemmas questionnaire developed by Kogan and Wallach (*32*).

RESULTS

Analyses were conducted to compare the performance of the younger drivers with that of the older drivers on driving and laboratory tasks. Analyses that examine the correlations between the laboratory and driving performance measures are presented elsewhere (*27*). Except for the subjective ratings, the TTEST procedure of SAS (*33*) was used to compare group variances for each measure and then to compute the appropriate *t*-tests to compare the two groups. The results for driving measures and laboratory measures are presented separately.

Driving Performance

Performance Ratings

Overall rated performance represents the most general measure of driving performance. Scores ranged from 1.3 to 2.6. The mean rating for the drivers aged 30 to 51 was 2.21, whereas the mean for drivers 74 to 83 years of age was 1.71. A Mann-Whitney U test revealed differences between the groups to be statistically significant ($z = 4.41$, $p = 0.00003$). Differences between the two groups for each of the 10 categorical ratings making up the overall rating are presented in Table 1. Differences between the two age groups were largest for the following four rating categories: decision speed, gap execution, route selection, and comprehension of task instructions. Smallest differences were apparent for emergency response to moving hazards and speed maintenance.

Intersection Performance

Differences between the two age groups on three measures of intersection performance are presented in Table 2. On the basis of group means, the older drivers were slightly more likely to stop (STOPPR) when faced with a yellow traffic signal than were the younger drivers (0.50 versus 0.36). This difference, however, was not statistically significant. The groups did not differ in the accuracy of stopping (STPACC), which represents the position of the vehicle relative to the stop line on stopping trials. This measure reflects vehicle control in stopping. On trials in which the driver did not stop, the clearance margin (MARGIN) represents the time between the red onset and the time at which the vehicle exited the intersection. The negative clearance margins indicate that vehicles exited before the red onset. Positive margins indicate that the vehicle was still in the intersection as the light turned to red. The group means did not differ; however, the older drivers exhibited a higher variance level than the younger drivers on this measure.

Gap Performance

Differences between the two groups in three measures of gap performance and the results of statistical tests are also presented in Table 2. No difference was observed in the number of gaps attempted (NOATT). For this measure, the level of variability associated with the older group was higher than that for the younger group. The older drivers were more likely to make judgment errors (JUDGERR) with regard to gap size. Again, the level of variability was higher for the older group. The greater likelihood of older drivers to make gap execution errors (EXERR) was also statistically significant, as were differences in group variances.

Speed Measures

Results of speed measures analyses are also presented in Table 2. Intersection approach speeds, which reflect vehicle speed before the traffic signal change, were not different for the two age groups. Mean lap times, which reflect speed over the

TABLE 1 AGE GROUP DIFFERENCES ON RATED DRIVING CATEGORIES

	Mean Younger	Mean Older	% diff[1]	Significance[2]
Stop/go decision	1.3	1.1	15%	.09
Route selection	2.3	1.7	26%	.0006
Decision speed	2.5	1.6	36%	.0004
Emergency response	2.1	2.0	5%	.36
Gap judgment	2.1	1.6	24%	.012
Gap execution	2.5	1.7	32%	.0005
Vehicle control	2.4	1.9	21%	.006
Speed maintenance	2.1	1.8	14%	.28
Time to destination	2.3	1.9	17%	.04
Comprehension	2.5	1.9	24%	.0014

1 Computed as the difference between the two groups as a percentage of the mean for the younger group

2 $p > |z|$, two-tailed significance probability, based on Mann-Whitney U test

TABLE 2 AGE GROUP DIFFERENCES ON DRIVING MEASURES

	Means		Statistical Significance	
	Younger(sd)	Older(sd)	Means[1]	Variances[2]
STOPPR	.36 (.22)	.50 (.29)	.07	.22
STPACC	128.7 (10.4)	129.0 (12.6)	.93	.38
MARGIN	-.10 (.22)	-.23 (.50)	.29	.0004
NOATT	10.13 (2.12)	9.24 (4.36)	.40	.001
JUDGERR	3.61 (1.16)	4.76 (2.36)	.05	.002
EXERR	0.48 (.99)	1.38 (1.56)	.03	.04
SPEED1	29.09 (1.85)	28.52 (2.72)	.42	.08
SPDDIF	1.89 (1.49)	2.74 (1.71)	.09	.53
LAPTIME	90.46 (8.75)	100.76 (12.17)	.003	.15
FAST35	1.87 (4.37)	2.86 (6.03)	.53	.15
SLOW	17.43 (23.38)	30.38 (33.13)	.14	.11
SSPEED	1.40 (.34)	1.79 (.40)	.001	.50

1 $p > |t|$, two-tailed significance probability

2 $p > F'$, where F' is the ratio of the larger to the smaller group variance

entire course, were considerably slower for the older drivers. The differences between the age groups in the maximum speed change in the intersection approach were not statistically significant. Similarly, differences between the groups in the frequency of exceeding 35 mph or driving more slowly than 27 mph in the intersection approach were not statistically significant. The standard deviation of intersection approach speed was computed for each driver as a measure of vehicle control consistency. The large difference indicates that the older drivers were considerably less consistent in their approach speeds than were the younger drivers.

Laboratory Performance

Results of analyses for laboratory measures are presented in Table 3. With the exception of the risk-propensity questionnaire (RISK), all laboratory measures exhibited significant differences between the two age groups at the $p < 0.05$ level. The two age groups' differences in visual acuity (VISION) were apparent. In addition, differences were largest for the EFT, the visual selective attention tests (VSATOT, VSATSW), the figure matching test of perceptual speed (FIGURES), and the DSS task. With the exception of the EFT, these tasks require rapid switching of attention between two or more sources of information. Smaller differences were apparent for the three measures of reaction time (SRT, MRT, CRT) and for the visual search for letters (VSEARCH) and number matching tasks (NUMBERS).

DISCUSSION OF RESULTS

One objective of the current analysis was to determine the sensitivity of the performance measures for detecting impairment effects associated with aging. The selection of drivers between 74 and 83 for the older group was intended to maximize the likelihood that at least some age-related deterioration would be available for detection. The pattern of observed differences, all reflecting the poorer performance of the older group, indicates that both the driving and the laboratory measures are sensitive to age-related performance differences. Because this study is cross sectional, however, differences cannot be directly attributed to the effects of aging. Rather, differences may suggest effects of aging, but they more accurately reflect differences between drivers of different ages in the current driving population. Furthermore, the use of volunteers and recruits from senior citizen activity centers may lead to questions about how representative the sample was. The sample of younger drivers was probably fairly representative of 30- to 50-year-old drivers in this area; however, the difficulty of recruiting older drivers and the number of referrals who declined to participate indicate that the older drivers were probably better than average for their age group. Observed differences between the two age groups may, therefore, understate actual differences in the general driving population.

Overall, the older drivers were given lower ratings than the younger drivers. This lower rating reflects a number of differences, including slower decision speed; errors in route selection, gap execution, and vehicle control; and difficulty

TABLE 3 AGE GROUP DIFFERENCES ON LABORATORY MEASURES

	Means		Statistical Significance	
	Younger(sd)	Older(sd)	Means[1]	Variances[2]
EFT	62.2 (34.5)	108.5 (42.3)	.0005	.38
DSS	67.7 (10.1)	45.7 (12.7)	.0001	.32
VSEARCH	30.3 (8.4)	25.0 (6.8)	.03	.38
NUMBERS	12.45 (3.08)	9.88 (2.16)	.04	.12
FIGURES	33.83 (6.73)	20.36 (7.32)	.0001	.72
RISK	76.2 (12.9)	82.7 (14.5)	.15	.63
VSATOT	136.8 (37.2)	190.2 (21.7)	.0001	.03
VSATSW	62.56 (22.0)	87.63 (11.2)	.0003	.008
VISION	20.85 (7.77)	40.35 (22.76)	.001	.0001
SRT	.31 (.04)	.36 (.07)	.007	.04
MRT	.60 (.08)	.70 (.19)	.03	.0004
CRT	.68 (.09)	.81 (.22)	.02	.0006

[1] $p > |t|$, two-tailed significance probability

[2] $p > F'$, where F' is the ratio of the larger to the smaller group variance

understanding task instructions. No differences between the two groups were observed in drivers' responses to simulated emergency situations.

With regard to measured driving performance, the older drivers were slower overall, as evidenced by longer lap times. Poorer vehicle control for the older drivers was evidenced by differences in gap execution, whereas less consistent vehicle control was indicated by greater approach speed variability. A number of apparently meaningful differences did not reach statistical significance because of the large individual differences between drivers in the older group. This pattern was most evident for measures associated with the gap task, all of which exhibited greater variability for the older group. This finding is consistent with previous work, which indicated that considerable variability exists in the rate at which age-related changes appear (*23*), and underscores the importance of not judging driving ability on the basis of chronological age.

In general, performance on the laboratory tests revealed larger differences than were evident on the driving tasks. These differences were caused by the greater difficulty of some of the laboratory tasks, most notably the visual selective attention task, and the greater precision of measurement available in the laboratory. In the laboratory, the rates for the more complex tasks, which required use of short-term memory and switching of attention between two sources, exhibited larger differences than the more simple tasks. In contrast to patterns for other measures, results on the visual selective attention task revealed larger variances for the younger group than for the older group. The task was so difficult for the older group that virtually all older drivers were unable to perform the majority of the tasks. Variances for the three reaction time measures revealed the more common pattern of greater variability for the older group. To the extent that the consistent differences between the two groups suggest an overall decline on all information-processing abilities, rather than selective differences, the results are consistent with those reported by Panek et al. (*34*).

Several of the analyses provided information about whether older drivers are more cautious than younger drivers. The choice dilemmas questionnaire has been used as a measure of risk-taking propensity, and age effects have been reported in previous work (*35*). The current results revealed no difference between the two groups on this measure. In addition, two performance measures, the number of gaps attempted and the proportion of stops at the traffic signal when faced with a yellow light, provided direct measures of drivers' willingness to take risks. The older drivers were not less inclined to attempt the gap task, but they were slightly (although not significantly) less likely to stop at the traffic signal. Together, these results indicate that the older drivers were not more cautious than the younger drivers.

The current development followed, in part, the theoretical work of Barrett et al. (*36*), whose specification of relevant driving skills was based on accident data collected before and during the 1970s. The changing nature of both the driving environment and driver population make it likely that different types of errors are currently involved in accident causation. Accordingly, analysis of more current accident data, focusing on the behavioral errors related to accident causation, will be necessary for development of a contemporary model of driving behavior, on which a comprehensive test battery can be based. Compromise will always be necessary in implementing such a test battery, because of constraints imposed by simulation capabilities and safety considerations. Validation will also be difficult, because of the questionable suitability of past accident rates as the criterion, and may ultimately require a longitudinal study, where future accident involvement can be predicted by driving test performance. Nevertheless, the present results reveal age-related differences in both laboratory and driving performance and represent the first step toward the development of an assessment tool for use with drivers of all ages. Although previous research documents performance differences on laboratory tasks, few previous studies have examined age-related performance differences using actual driving tasks.

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