COGNITIVE AND PERCEPTUAL FACTORS IN AGING AND DRIVING PERFORMANCE*

Edward J. Rinalducci, Mustapha Mouloua, and Janan Smither

Department of Psychology
University of Central Florida

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Visual Performance Laboratory
Department Of Psychology
University of Central Florida
Orlando, Fl. 32816-1390

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Technical Summary

The report examines cognitive and perceptual factors as a function of age differences in drivers. Three major groups of participants employed in the proposed research. The younger group range from 19 to 34 years of age, the middle-age group range from 35 to 59 years, and the older group were 60 years and above. The research for first phase of the study was carried out in the Visual Performance Laboratory in the Department of Psychology at the University of Central Florida. It consisted of determining various perceptual and cognitive measures. In addition, tests assessing neurological status were carried out in the FASST Laboratory at the same time. The last phase or the simulation phase of the study was also carried out in the Visual Performance Laboratory using a low fidelity simulation of the driving task. In general, it was found that tests such as the UFOV, the Digit Symbol, the Block Design, the Trails B, and Contrast Sensitivity seem to be better able to predict driving performance on the low fidelity simulation task compared to some of the other tests. It was observed that younger drivers had more collisions/crashes than middle-aged drivers, and they had more collisions/crashes than older drivers. Older drivers were less likely to exceed speed limits and younger drivers. It was also found that the various measures of UFOV (useful-field-of-view) increased with the age of the participant. Thus, younger drivers were found to be responsible for more collisions/crashes and lack of obeying of speed limits than older drivers. However, changes in older drivers might best be measured using various neurological measures and the UFOV.

Introduction

There is overwhelming evidence suggesting that older drivers may have more difficulty in attending to the driving task and be slower at processing information, especially when required to make complex decisions. For example, the older driver may be at a disadvantage both perceptually and cognitively in dealing with complex traffic situations (Transportation Research Board; National Research Council, 1988). Traffic accidents caused by elderly drivers have been attributed by investigators to neglect or an inattention to relevant information from road signs, as well as to other cars on the road and to pedestrians crossing or at the side of the road (Ponds, Brouwer, & Wolfelaar, 1988). These accidents have resulted in a significant number of fatalities and financial losses. However, it may be that the rise in accident rates among the elderly is not due only to age-related declines, but also to the additional functional losses resulting from age-related brain diseases. Therefore, the neurological status of the driver needs to be examined.

First, it is noteworthy to mention that cognition does not act in isolation. There is a constant interaction between the physiological system in terms of visual information processing and cognitive performance. It is conceivable that older drivers who suffer from poor vision would ultimately have worse cognitive performance irrespective of the degree of age related cognitive declines. In other words, declines in physiological performance exacerbate the effects of aging on cognitive functioning. Brouwer (1993) contends that impairments that lie both on the level of receptor-effector organs and on the level of cognitive functioning, particularly attention, contribute to the problems older drivers encounter with the driving task. For example, perceptual, cognitive, and motor declines affect an older driver's ability to merge with traffic. On the perceptual level, older adults have difficulty seeing and determining the speed and distance of the traffic they need to merge with. On the motor level, they have difficulty turning their necks and looking back far enough to see that traffic. And, cognitively, they have difficulty maintaining all the information needed to make a decision about joining the flow of traffic because of declines in attention and working memory. When they eventually respond however, they are slower to do so than the situation requires.

Clearly, cognitive performance is critical because driving requires the attentiveness of the individual to the driving environment (Transportation Research Board, 1988a, 1988b). Cognition is also fundamental to other phases of the task in that the driver, after perceiving the stimulus, needs to recognize it, make a choice of a response, and finally execute that response. Driving a modern automobile in light traffic on a clear day may not necessarily overtax many drivers. However, driving in heavy traffic at high speed at night on poorly marked roads or at complex intersections can exceed many drivers' abilities (Rinalducci et al., 1993). This difficulty can be attributed to the decline in reserve capacity with aging. In other words, complex environments produce a need for more cognitive resources than usual. Younger adults are able to use "reserve capacity" to fulfill that need, however, that capacity diminishes with age and is not available in the same way for the older adult. This explains why an older driver has more difficulty in attending to the driving task and is slower at processing information, especially when required to make complex decisions. Older drivers also demonstrate slower motor responses (Rinalducci et al., 1993). Thus, the older driver is at a disadvantage both perceptually and cognitively in dealing with complex traffic situations.

Darzentas, McDowell and Cooper (1980) reported that older drivers differed significantly in judging the length of gap acceptance as compared to younger drivers. In general, older drivers are more cautious about gap acceptance because they often exhibit slow maneuvers; gaps appear to be too short for them to execute comfortable maneuvers.

Spatial abilities are also affected by the aging process. Previous research has shown that age-related deficits in mental rotation tasks have detrimental impact on certain components of the driving task. Albert and Kaplan (1980) reported that older people tend to focus only one piece when asked to identify an object by mentally re-arranging several pieces. Thus, older drivers have major difficulties focusing on more than one source of traffic information in order to judge what a safe gap is at a busy intersection. Also, because older drivers tend to be very slow and not quite physically flexible when turning their bodies and heads when looking around, they often need to rely on mirrors (side and rear-view mirrors) to perceive the world around them. As a result, they have problems with perceiving and interpreting some of the mirrored scenes, as well as viewing moving vehicles in blind spots.

Traffic accidents caused by elderly drivers have been attributed by some investigators to neglect or inattention to relevant information from road signs and from other cars and pedestrians (Ponds, Brouwer, & Wolffelaar, 1988). McDowd and Birren (1990) discuss four commonly used categories of attention as they relate to age. These categories include (1) divided attention, (2) switching attention, (3) sustained attention, and (4) selective attention. Craik (1977), McDowd and Craik

(1988), and McDowd and Birren (1990) suggest that there are age-related differences, especially when more complex tasks are employed. Brouwer (1993) and Brouwer et al. (1990, 1991, and 1992) have demonstrated that performance on divided attention tasks reveal age-related impairments and that the magnitude of the effect depends on the nature of the combined tasks. The above researchers were also able to demonstrate the effect in a combination of tasks in a dynamic driving simulator. Parasuraman and Nestor (1991), however, contend that the component of attention most implicated as a correlate of accident involvement in professional drivers is attention switching. These correlations were found in dichotic listening tasks and were higher for samples including older professional drivers than for samples including only younger subjects (Brouwer, 1993). Overall, levels of performance in a sustained attention or vigilance task seems to be lower for older as compared to younger adults, but there is little difference in the vigilance decrement. However, this does suggest that long stretches of highway or turnpike driving may place the older driver at risk. Rabbitt (1965) concluded that older adults are more distracted by irrelevant information than young adults. Plude and Hoyer (1985) suggest that age-related decrements in selective attention may be related to a decline in the ability to localize task-related information in the visual field. A reduced ability to demonstrate selective attention in a complex traffic situation could easily be a considerable hazard for the older driver. In other words, an older adult may be directing his or her attention to the wrong stimulus in the environment and therefore miss the cues indicating a potential hazardous situation.

Ball and Owsley (1991) and Ball (1997) have attempted to identify functional measures that take into account motor impairments, as well as a slowing of the information processing system in the elderly. They contend that such measures would help to differentiate older drivers from younger ones. These authors discuss several dependent measures of driving performance, which include (1) accident frequency or accident rate, (2) driving simulator performance, (3) actual road tests under controlled conditions, and (4) the application of the concept termed the Useful Field of View (UFOV). Ball, Beard, Roenker, Miller, and Griggs (1988) have defined UFOV as the "total visual area in which information can be acquired without eye and head movements." The mere presence of a foveal stimulus has been shown to reduce the field of view (Liebowitz & Appelle, 1969; Rinalducci & Rose, 1986; Rinalducci, Lassiter, and Rose, 1989; Rinalducci, Lassiter, McArthur, Piersall, & Mitchell, 1989; Williams, 1982, 1985, 1989), and distracting stimuli appearing around a foveally fixated stimulus reduce performance with regards to the foveal task (Sekuler & Ball, 1986). Ball and Owsley and their associates (Ball, Beard, Roenker, Miller & Griggs, 1988; Ball & Owsley, 1991; Ball, Roenker, & Bruni, 1990; Sekuler & Ball, 1986) have developed a task, which involved a central task (from which a measure of stimulus processing speed was obtained by varying duration) combined with a peripheral visual task and with distracters in the visual field. Three measures were obtained from this UFOV performance task. The first was a measure of stimulus processing speed or slowing, the second was a measure of divided attention, and the third was the effect of distracters on information processing.

Ball and Owsley (1991) have developed a predictive model of overall and intersection accidents for older drivers using the factors of accidents, UFOV, visual function, eye health, and mental status. Mental status was assessed using the Mattis Organic Mental Status Syndrome Examination (MOMSEE). They found the best predictors of intersection accidents to be UFOV and mental status. Ball, Owsley, Sloane, Roenker, and Bruni (1993) went on to confirm the findings of the original UFOV research in a study of 294 adults ranging in age from 56 to 90. Once again they found that UFOV was more closely associated with accident risk than any of the other visual measures (Schieber, 1995). Based on this study, Ball et al. (1993) indicated that, assuming a 40% reduction in UFOV as the pass-or-fail cutoff score, their test yielded a sensitivity of 89% and a specificity of 81%.

It is clear from the evidence presented above that the driving task places significant perceptual and cognitive demands on the driver. It is also clear that the normal aging process negatively affects many of the perceptual and cognitive skills necessary for safe driving. So, it is not surprising that older adults' accident rates increase significantly after the age of 70. However, it may be that this rise in accident rates is not due only to age-related declines, but also to the additive effects of functional losses resulting from age-related brain diseases. Several researchers have noted higher automobile accident rates among individuals diagnosed with Alzheimer's Disease (AD or DAT) and other dementing illnesses (Cooper, Tallman, Tuoko, & Beattie, 1993; Drachman & Swearer, 1993; Dubinsky, Williamson, Gray, & Glatt, 1992; Friedland, Koss, Kumar et al., 1988; Gilley, Wilson, Bennet et. al, 1991; Logsdon, Teri, & Larson, 1992; Lucas-Blaustein, Flipp, Dungan, & Tune, 1988; Trobe, Waller, et. al, 1996). Also, in a 1996 investigation, Johansson, Bronge, Lundberg, Persson, Seidman, & Viitanen, compared older drivers who had been convicted of traffic violations with a matched control group. All subjects in the study were subjected to thorough medical evaluations and to a number of cognitive tests. Although the medical evaluations could not distinguish the convicted drivers from the controls, significant differences were found in the cognitive evaluations. Convicted drivers, especially those involved in crashes, scored lower on the cognitive tests than the control group. In another investigation, Johansson and his colleagues (1994) found that a relatively high proportion of older crash victims exhibited Alzheimer-type neuropathology (O'Neill, 1996). Because of findings like these, and also because of the steady growth in the number of very old drivers who are at a higher risk of suffering from Alzheimer's Disease, interest in the relationship between driving and dementia has grown considerably in more recent years (Fitten, 1997).

The neuropsychological assessment of Alzheimer's Disease involves assessing cognition and behavior as they relate to brain function. In other words, the neuropsychologist must go beyond the mere description of the functional or dysfunctional brain to identifying the relationship(s) between such brain states and the cognitive/behavioral state of the individual. As Derix (1994) puts it, "the question for modern clinical neuropsychology is not how to localize cerebral lesions, but rather to consistently relate neuropsychological dysfunctions and functions with findings from other investigations, for instance neuroimaging" (p. 13).

In order to complete this task successfully the neuropsychologist must first identify the strengths and weaknesses of the person on cognitive and behavioral measures. At this level the neuropsychological assessment includes a battery of measures designed to evaluate capacities with diverse neurobiological substrates. These measures should address functions such as mental status, attention, visuospatial ability, learning and memory, intelligence, language and comprehension, and planning and executive function. Various tests, rating scales, and questionnaires are used. And ultimately, the resulting data will provide a profile of the impaired and also of the intact cognitive functions.

Woodruff-Pak (1997) lists a number of measures used for neuropsychological assessment of older adults that have become, for the most part, critical elements of the neuropsychologist repertoire. Examples of some of them are included in the following table adapted from Woodruff-Pak (1997).

Battery of Neuropsychological Assessment of Older Adults

Recommended tests	**Functions evaluated**	*Findings that raise a question of impairment*
Mini-Mental Status Examination	Cognitive mental status	Scores ≤ 23 (Adjusted for age and education.)
WAIS or WAIS-R		
Vocabulary	Verbal intelligence; semantic memory;	Perseveration, paraphasia, marked circumlocution
Digit Span	Attention; primary memory;	Forward span < 5; backward span < 3
Block Design	Nonverbal intelligence; visuospatial abilities; nonverbal problem solving	Stacking or stringing of blocks; grossly inaccurate designs
Digit Symbol	Speeded perceptual-motor integration; sequencing and cognitive flexibility	Inaccurate copies of symbols; inability to adhere to specified sequence
WMS or WMS-R		
Logical Memory	Narrative recall	Complete recall failure; confusing details from the two stories; major extrastory intrusions; marked decline on delayed recall
Visual Reproduction	Recall of designs	Complete recall failure; rotations, perseverations; gross distortions; marked decline on delayed recall
Object Memory Evaluation*	List learning and recall	≤ 7 items stored by Trial 5; ≤ 2 items consistently recalled per trial; multiple intrusion errors; marked decline on delayed recall
Boston Naming Test	Naming; object identification	Perseveration, paraphasia, marked circumlocution, frequent perceptual errors
Controlled Oral Word Association Test	Verbal fluency; semantic memory	Severely reduced output (≤ 7 items per letter); loss of set; perseveration or paraphasia
Trail Making Test	Speeded perceptual-motor integration; sequencing and cognitive flexibility	Severe slowing (> 2 minutes to complete Trails A, ≥ 5 minutes Trails B); any error on A, multiple errors on B

* For high-functioning patients, substitute the Selective Reminding Test, Auditory Verbal Learning Test, or California Verbal Learning Test; for low-functioning or uncooperative patients, the Shopping List Test or Delayed Word Recall Test can be substituted.

The present report systematically examines the perceptual, cognitive, as well as neurological factors affecting older drivers. It was hypothesized that older adults would be more susceptible to driving impairment in a low-fidelity driving environment than would younger adults.

Methods

Participants

In terms of age groups, the youngest group was changed from 16-34 to 19-34. In a college or university, those providing the youngest group range in age usually from 18 on up. It was felt that the starting age performances produced by such a change would be negligible. Instead of 35-64, the middle-age group range was changed to 35-59. Due to a lack of older drivers, especially since those in the first study were lost due to not having a viable simulator. In addition, the report Older Road User Research Plan (2001), indicates that there is considerable inconsistency in the definition of the term older. In one study, middle-aged drivers were ages 25-65, while older drivers were those over 65. In another study, the entire older sample consisted of drivers between 60 and 65 years. It was noted that this inconsistency was understandable, given that certain difficulties such as visual problems may occur at fairly young ages. Therefore, it was felt that the difference from ages of 60 on up would not be that much different from ages of 65 plus. However, it appears that in this study there was only one 60-year old participant with the rest being in their seventies. More changes might be obtained when one gets around 75 to 85 years of age or so.

Therefore, three major groups of participants employed in the proposed research. The younger group range from 19 to 34 years of age, the middle-age group range from 35 to 59 years, and the older group were 60 years and above. The age groupings have been chosen so that they roughly approximate the observed trends in driver fatalities per 100 million miles driven as a function of age. Twenty participants were assigned to each group, and these groups included both male and female. Younger participants (19-34) were, in general, recruited from the student population. Students could elect to receive money or course credit. Middle-aged participants (35-59) were be recruited on a cash and voluntary basis from such populations as graduate students, faculty, and Physical Plant employees. Older participants (60+) were recruited from such places as Life at UCF, Lutheran Haven, or from the faculty at UCF. Their participation was voluntary and was on a cash basis.

Tasks and Materials

Task 1. Perceptual measures: As many perceptual abilities are known to decline with age, therefore there measurement was be determined for each participant. They included the following: (1) a Keystone Telebinocular System which provides for an assessment of the far and near point acuity (i.e., Snellen acuity); (2) stereopsis or a measure of depth perception; (3) a measure of lateral and vertical phoria; (4) color vision; and (5) an approximate measure of the horizontal limits of visibility of a standard target (i.e., perimetry). In addition, spatial contrast sensitivity was determined over a range of spatial frequencies to give a comprehensive visual evaluation. The test measures sensitivity to both low and high spatial frequencies, which correspond to large and small objects, respectively. It provides a contrast sensitivity function, which reflects both the optical and neural mechanisms of the human visual system.

Task 2. Cognitive measures: Cognitive functioning was examined using the Useful-Field-of-View (UFOV) Test. UFOV has been defined as the total visual area in which information can be acquired without eye and head movements (Ball, Beard, Roenker, Miller, & Griggs, 1988). The mere presence of a foveal stimulus has been shown to reduce the field of view, and distracting stimuli appearing around a foveally fixated stimulus reduce performance with regards to the foveal task. It is believed that the UFOV task is predictive of a variety of everyday tasks including driving a motor vehicle. It consists of three parts, which examine speed of visual processing under increasingly complex task demands. In the first subtest, the participant must identify a target presented for varying lengths of time in a centrally fixated box. In the second subtest, the participant must not only identify a target, but must also locate a peripherally presented target. In the third subtest, the participant must not only identify a target, but must localize a peripherally presented target embedded amongst distractors. The last two subtests examine divided and selective attention, respectively. It is expected that decrements in visual processing, particularly in divided and selective attention, will be greater with age and especially with dementia. This task was substituted for one in which a foveal tracking task was to be combined with the awareness of flashing lights in the peripheral visual field. It was felt that the UFOV test was readily available and had considerably more data to support it in terms of its relationship to driving and accidents.

Task 3. Neurological status: The neurological status of the participant has been assessed using tests. These included: (1) the Mini-Mental State Examination (MMSE), which is a global measure of cognitive status; (2) the Trail Making Test Part B, which is a measure of executive function; (3) the Category Fluency Test, a frontal lobe processing task, which is a measure of the ability to hold and monitor information on-line; (4) the Visuospatial Construction Task of MDRS, which is a measure of visuospatial ability; (5) The Digit Symbol Test from the WAIS-R, which is a measure of perceptual speed; and (6) the Block Design Test from the WAIS-R, which is a measure of nonverbal intellect.

Task 4. Driving Habits Questionnaire: Each participant was asked to complete a Driving Habits Questionnaire (DHQ). This test, which was developed by Owsley, Stalvey, Wells, & Sloane (1999) consists of 34 items designed to obtain information about each participant=s driving behaviors for the past year, and is administered by an interviewer. The test examines issues such as current driving exposure, dependence upon others for mobility, difficulty in driving, crashes, and citations, and driving space or where the participant usually drives.

Task 5. Driving Simulation: The then existing driving simulator in the College of Engineering was only operative for a short time, and only a few were able to be run. Consequently, we had to rerun all new participants, the second year. Many of the younger subjects graduated in the same year. Older participants, in particular, are subject to health changes within the period of a year, and therefore could not be run in the second year. This caused the loss of a number of older participants who simply could not be run again. In the second year all age groups were recruited again and run in the various phases of the study. However, the driving simulator again had serious problems, and no participants were run on it. Therefore, a low-fidelity driving simulation was employed in the Visual Performance Lab. Because of these factors and the delay already experienced in completing the study, we used a lower-level simulation involving a computer-game driving situation. We have employed a similar type of simulation in an unrelated study of driver distraction with considerable success. The driving graphics were excellent and a Microsoft Force Feedback steering wheel and foot pedals were employed to add realism. The computerized scene was presented on a 17-inch monitor. The participants' trials were recorded and their responses including crashes, lane changes/maintenance, off-road incursions, maintenance of speed limits, vehicle damage, time to complete a trial, etc. were the dependent variables or measures of driving performance. Each participant was run on a PC-based video driving scenario (*Need-for-Speed III: High Stakes*). The performance of each participant was stored on the computer for each run (four laps in all with two runs per trial) through the driving terrain with the last two laps often video-taped, as well. The driving task dependent variables consisted of elapsed time to complete the second trial, collisions, crossing the median, leaving the roadway, car damage estimates, obeying and maintaining posted speed, top speed for the last two laps, and so on. These were determined for the last two runs in the second trial of the chosen driving scenario employed (the first trial with its two laps were regarded as practice in order to familiarize the participant with the task). It should be noted that the protocol for the simulator is brief, and this should limit or prevent the possibility of simulation sickness in the participants.

Task 6. Recommendations. Recommendations subsequent to data analysis have been made with regards assessment, possible training programs and rehabilitation, and automotive design (i.e., to take into account aging factors).

Procedures

The research for one phase of the proposed study was carried out in the Visual Performance Laboratory in the Department of Psychology at the University of Central Florida. The tests assessing neurological status were carried out in the FASST Laboratory. The simulation phase of the study was also carried out in the Visual Performance Laboratory (VPL).

Upon arrival to the FASST laboratory, all participants were required to fill out a biographical questionnaire and a consent form (see Appendix I) prior to their participation. They then completed the Driving-Habits Questionnaire, which this was followed by taking each of the neurological status tests indicated above. Following this phase of the study, the participants went to the Visual Performance Laboratory, where they completed tests of their visual capabilities including spatial contrast sensitivity. The participants were then evaluated using the UFOV test for visual processing time, divided attention, and selective attention. Finally, participants were run in the low-fidelity driving simulation. Several rest periods were given during all aspects of test administration. The entire experiment lasted approximately two and one-half hours.

Data Collection and Analysis

Data were collected from the visual tasks using a Keystone Telebinocular System which provides an assessment of Snellen far and near point acuity, (2) stereopsis , (3) lateral and vertical phoria; (4) color vision; and (5) and perimetry. In addition, spatial contrast sensitivity was determined over a range of spatial frequencies to give a comprehensive visual evaluation. Cognitive measures were obtained using the UFOV tests, which measured visual processing time, selective, and divided attention. Data was also obtained from neurological status tasks, which included (1) the Mini-Mental State Examination (MMSE), (2) the Trail Making Test Part B, (3) the Category Fluency Test, (4) the Visuospatial Construction Task of MDRS, (5) The Digit Symbol Test from the WAIS-R, and (6) the Block Design Test from the WAIS-R. In addition, data was obtained from the Driving-Habits Questionnaire and performance on the low-fidelity driving simulation task. All data were entered into a computer program and subjected to several statistical analyses including correlation and analysis of variance (ANOVA). The results are presented below.

Results and Discussion

In total, 60 participants were run (20 in each of the three age groups) in the entire study. However, a number of subjects were not able to finish the video driving scenario due to a type of simulator sickness. This gave us 19 participants in the younger group, 18 participants in the middle-age group, and 16 participants in the older group. In general, older participants show more proneness to simulator sickness than do younger subjects, so the trend in this study is in the expected direction. The increased frequency of motion sickness in the video driving task with older participants may have been due to their lack of experience with video games, as well as the longer time it seemed to take them to complete the driving task.

The first approach (1) involves an analysis of the data presented in terms of the correlations among the different variables. The first part of the data reduction and analyses in the present report consists primarily of a correlational approach. The second approach (2) involves analyzing the data using analysis-of-variance procedures (ANOVA), descriptive statistics, multivariate tests, and tests for between-subjects effects, and is presented subsequent to the correlational analysis.

Correlational Analysis

(1) With regard to attentional and cognitive functions with aging and using a data analysis based primarily on *correlations*, several findings were obtained. They are listed below.

•In the video driving task, it appeared that younger participants drove too fast and the older participants drove too slowly. Driving too fast usually resulted in more collisions and crossing the median (r = -.391, p 〈 .01 for age group and obeying speed limit for 50 mph , r = .400, p 〈 .006 for obeying speed limit and crashes/collisions, r = .385, p 〈 .01

for obeying speed limit and crossing the median). Speed limit data was for both 30 and 50 mph.

•The older participant was more likely to obey the posted speed limit (r = -.391, p 〈 .01 for age group and obeying speed limit at 50 mph).

•The poorer the participant's divided attention and selective attention as measured by the UFOV test, the more likely they were to leave the road (r = .348, p 〈 .05 for UFOV3 or selective attention and leaving the road,), have crashes (r = .390, p 〈 .01 for UFOV2 and crashes/collisions), and cross the median (r = .371, p 〈 .05 for UFOV2 or divided attention and crossing the median and r = .377, p 〈 .05 for UFOV3 or selective attention and crossing the median) in the low-fidelity driving task. In addition, the poorer the person's contrast sensitivity the more likely they were to the leave the road and cross the median (r = -.340, p 〈 .05 for contrast sensitivity and leaving the road and r = -.317, p 〈 .05 for contrast sensitivity and crossing the median).

•The older participant was more likely to have shorter selective attention, poor acuity, and contrast sensitivity (r = .545, p 〈 .001 for age group and UFOV3, r = -.521 and r = -.522 for left and right eye contrast sensitivity and age group with p 〈 .001 and p 〈 .001, respectively).

•The Digit Symbol, Block Design, and Trail B tasks were all related to selective attention, to the extent that if you are better in one, you are better in them all (r = -.508, p 〈 .001, for UFOV3 and Digit symbol, r = -.297, p 〈 .05 for UFOV3 and block design, and r = .616, p 〈 .001 for UFOV3 and Trails B).

•It was also found, that the more one disobeys the speed limit, the higher the Digit Symbol score tends to be (r = .334, p 〈 .05 for obeying speed limit at 30 mph and Digit symbol and r = .388, p 〈 .01 for obeying speed limit at 50 mph and Digit symbol) . This may possibly relate to a higher cognitive functioning allowing some individuals to drive fast or deviate more from the posted speed limits.

•In general, tests such as the UFOV, the Digit Symbol, the Block Design, the Trails B, and Contrast Sensitivity seem to be better able to predict driving performance on the low fidelity simulation task compared to some of the other tests.

Analysis of Variance

(2) ANOVAs, descriptive statistics, multivariate tests, and tests for between subject effects were done, which support the correlations and their conclusions indicated above. These comparisons are based on the data obtained in this study. F values and p levels are given for tests of *between-subjects effects.*

•UFOV1, UFOV2, and UFOV3 show a relationship with crashes/collisions with a F = 4.052, p < .052 (indicating a trend), F = 8.161, p < .007, and F = 8.8277, p < .004, respectively for each UFOV measure.

•Age group also showed a relationship with the obeying of the 50 mph speed limit (F = 5.797, p < .006) and crashes (F = 4.343, p < .020). Older drivers participants tended to obey the speed limits (or drive more slowly) and have less crashes.

•Age group was also found to be related to scores on UFOV1, UFOV2, and UFOV3 (F = 22.462, p < .000), with older participants showing increased times for visual processing, divided, and selective attention. Age group x UFOV2 gave a F = 6.863, p <

7.043 and age group x UFOV3 gave a F = 28.998, $p < .000$. Therefore, scores on the UFOV test are clearly related to the age of the participants in the study.

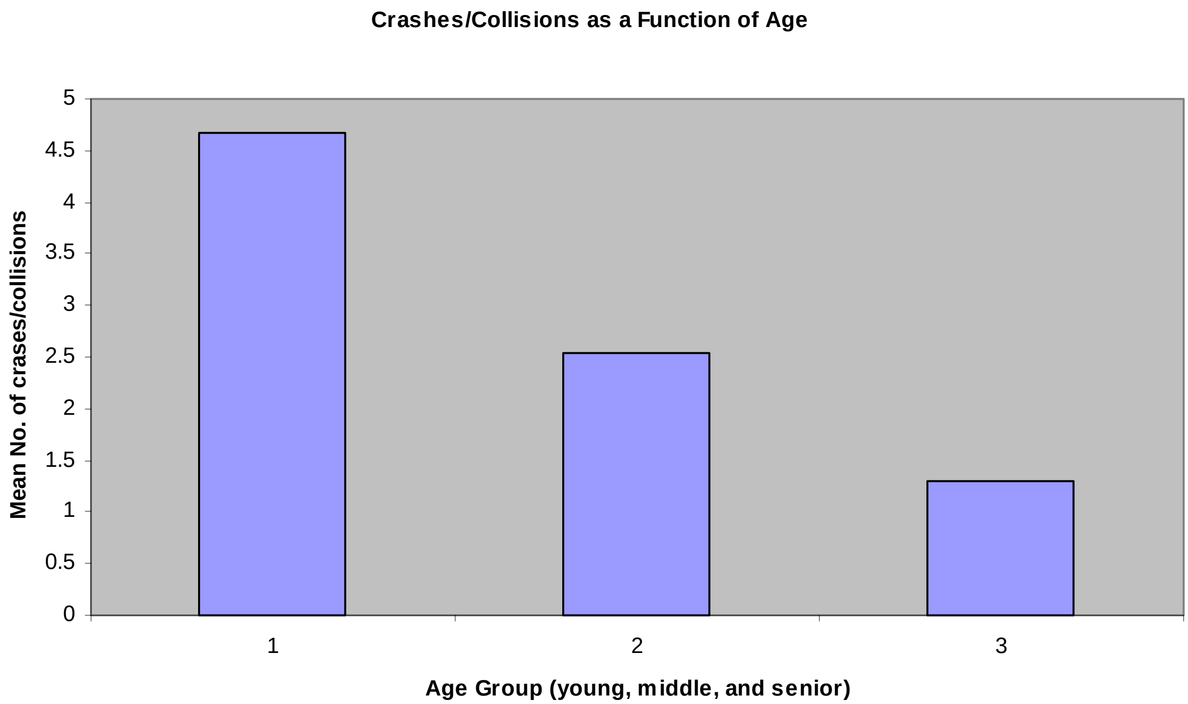

Figure 1. The mean number of crashes/collisions as a function of age, with 1 referring to young, 2 referring to middle-age, and 3 referring to older participants.

Figure 2. Obeyance of the 50 mph speed limit as a function of age.

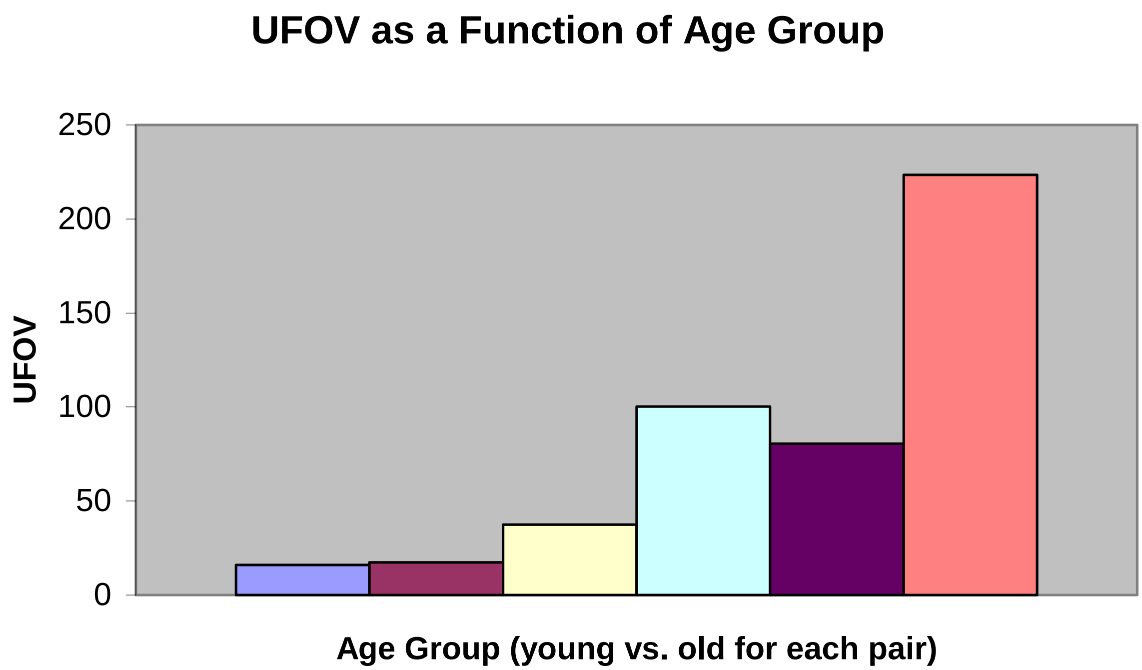

Figure 3. UFOV1 (visual processing), UFOV2 (divided attention), and UFOV3 (selective attention), respectively, as a function of age for young and old participants, and in that order.

In general, it can be seen in Figure 1, shown above, that older drivers have less crashes/collisions than their younger counterparts (young and middle-aged). They also obey the 50 mph speed limit in the low-fidelity driving simulation to a greater extent (See Fig. 2), and indeed, the often drive below the limit. However, they appear to be at a greater risk as a function of age, as a result of a degraded divided and selective attention compared to the younger drivers (See Fig. 3). Because of this decrement in the Useful-Field-of-View, they should have a greater potential of eventually having an accident.

The present results indicate that certain tests such as the UFOV test, Digit Symbol, Block Design, and Trails B show a relationship to obeying of speed limits, crossing the median, crashes/collisions, and leaving the road in the low fidelity video simulation of the driving situation, and to the age of the participants.

General Conclusions

These findings clearly suggest that several practical recommendations should be taken in order to remedy the driving impairments as a function of age. Following are some practical remedies for drivers at risk, which involve training interventions and design guidelines for automobiles.

- Poorer or shorter attention spans in older or even younger drivers can be improved. The distributors of the UFOV test offer a version which aids improvement in attention performance. This type of training may well alleviate some to the driving problems with at-risk drivers of any age.

- A design change in automobiles that could produce a safer driving environment for all drivers, particularly drivers-at-risk, might well employ *in-vehicle warning systems*. Such systems could acquire a driver's attention when another car moved into the blind-spot area, was passing the driver's car, or when the driver was following to closely to a vehicle in front of the car in question. These displays might be primarily visual, but could be accompanied by auditory signals as well (auditory alarms and synthesized speech).

•Training of an older or at risk driver in a simulator using scenarios that often cause problems could be useful. However, as this alternative is not often available, the two previous recommendations would be particularly useful.

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APPENDIX

I. Consent Form and Debriefing Form

II. Driving Habits Questionnaire

III. Description of Tests of Neurological Status and Samples, Perceptual Abilities Forms, and Data Sheet for Driving Task

APPENDIX

I. Consent Form and Debriefing Form

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APPENDIX I

I. Consent Form and Debriefing Form

II. Driving Habits Questionnaire

III. Description of Tests of Neurological Status and Samples, Perceptual Abilities Forms, and Data Sheet for Driving Task

I. Consent Form and Debriefing Forms

Informed Consent

I understand that I will be asked to participate in three sessions for this driving study. During the first session, I will be asked to complete a series of cognitive ability tasks as well as a questionnaire about my driving habits. This session should take approximately one hour.

I understand that during the second session, I will be asked to complete a series of visual ability tasks, an attention task and a simulated, PC-based driving task. This session should take approximately one hour.

I understand that during the third session I will be asked to operate a simulated motor vehicle through a specified course while obeying traffic laws and interacting with other traffic. I will complete this task three times and each task will last approximately two minutes. I understand that I will be given twenty-minute periods of rest in between runs through the course. I also understand that, after each run and ½ hour after the final run, I will be asked to complete a questionnaire in which I will describe any physical symptoms I may feel. This session should last approximately 80 minutes. I understand that the purpose of this study is to determine which cognitive and visual abilities are most closely related to driving performance.

I also understand that my participation in this study is completely voluntary and is greatly appreciated. I understand that I have the right to withdraw from participation at any point, during either session, without penalty.

I understand that any information I give will be kept strictly confidential. My name will not be kept with my data and my individual information will not be shared with anyone. This consent form will be kept separate from the rest of my data.

I have been given the opportunity to ask any questions I may have, and they have been answered to my satisfaction.

I understand the information given above and consent to participate in this study.

______________________________ ______________

Name Date

Debriefing Sheet

Although driving is very important to the quality of life of older adults, the driving task places strong demands on one's perceptual, physical and cognitive abilities. It is logical to expect older drivers to be more challenged by the driving task than younger drivers, because of normal age-related changes in these abilities as well as those changes induced by disease-related memory disorders.

This research will enable us to compare results from specific visual and cognitive ability tests to performance on the driving simulator. These results will show us which changes in older and memory-impaired older adults are most closely related to driving ability.

The results of this study will provide useful information about the factors associated with poor driving performance. The information obtained can then be used to develop objective criteria by which individuals who may have problems with the driving task can be identified and appropriate interventions may be applied.

Thank you very much for your participation in this study. Please feel free to contact Dr. Janan Al-Awar Smither at 407-823-5859, Dr. Edward Rinalducci at 407-823-5860 or Dr. Mustapha Mouloua at 407-823-2910 if you have any questions about this study.

If you have any problems with this study or feel that your rights have been violated in any way, please contact Dr. Jack McGuire, Chair of the Psychology Department, at 407-823-2216.

II. Driving Habits Questionnaire

Subject Number____

Name ______________________________ Date __________ Visit Number ________

Driving Habits Questionnaire

Interviewer: "Now I'm going to ask you some questions about driving."

Current Driving

1. Do you currently drive?

______ (1) yes (go to question #4)
______ (0) no (go to questions #2 and #3 only)

1. ☐

2. Why did you stop driving?
(Wait for the subject's spontaneous reply; write it in space below.)

____
____
____
____

2. Copy text

3. When is the last time you drove? ______________ (month/year)
(If within 1 year, go to question #25)

3. ☐

4. Do you wear glasses or contact lenses when you drive?

______ (1) yes
______ (0) no

4. ☐

5. Do you wear a seatbelt when you drive? Would you say:

______ (1) always
______ (2) sometimes
______ (3) never

5. ☐

Subject Number________________ Visit Number ____________________

Exposure

11. In an average week, how many days per week do you normally drive?

_______ number of days per week

11. [ ]

12-14. Please pause for a moment and consider all the places you drive in a typical week. (Pause) Now tell me those places.

Place	How many times a week		Estimate Miles from home (one-way)		Total Miles
______Store	________	X	________	=	________
______Church	________	X	________	=	________
______Work	________	X	________	=	________
______Relative's House	________	X	________	=	________
______Friend's House	________	X	________	=	________
______Out to eat	________	X	________	=	________
______Appointments (e.g., doctor, hair)	________	X	________	=	________

Now, are there any other places you go in a typical week?

Others

________	________	X	________	=	________
________	________	X	________	=	________
________	________	X	________	=	________
				subtotal	________
					X 2

(12) [ ] Total # of places traveled to

(13) [ ] Total trips

(14) [ ] Total Miles Driven

Subject Number______________ Visit Number ________________

Avoidance "Now I am going to ask you some more questions about your driving."

Interviewer: Use Answer Sheet A for questions 17 thru 24

17a) During the past 3 months, have you driven when it is raining?

________Yes (go to 17b) ________No (go to 17c)

17b) Would you say that you drive when it is raining with:
(Please check only one answer)

5______No difficulty at all
4______A little difficulty
3______Moderate difficulty
2______Extreme difficulty

17c) Is it mostly because of your visual problem that you do not drive when it is raining?

1________Yes (go to 18a) ________No (go to 18a)

17. [ ]

18a) During the past 3 months, have you driven alone?

________Yes (go to 18b) ________No (go to 18c)

18b) Would you say that you drive alone with:
(Please check only one answer)

5______No difficulty at all
4______A little difficulty
3______Moderate difficulty
2______Extreme difficulty

18c) Is it mostly because of your visual problems that you do not drive alone?

1________Yes (go to 19a) ________No (go to 19a)

18. [ ]

19a) During the past 3 months, have you parallel parked?

________Yes (go to 19b) ________No (go to 19c)

19b) Would you say that you parallel park with:
(Please check only one answer)

5______No difficulty at all
4______A little difficulty
3______Moderate difficulty
2______Extreme difficulty

19c) Is it mostly because of your visual problems that you do not parallel park?

1________Yes (go to 20a) ________No (go to 20a)

19. [ ]

Subject Number________________ Visit Number ____________________

23a) During the past 3 months, have you driven in rush-hour traffic?

_________Yes (go to 23b) __________No (go to 23c)

23b) Would you say that you drive in rush hour traffic with:
(Please check only one answer)

5______No difficulty at all
4______A little difficulty
3______Moderate difficulty
2______Extreme difficulty

23c) Is it mostly because of your visual problems that you do not drive in rush-hour traffic?

1________Yes (go to 24a) _________No (go to 24a)

23. ☐

24a) During the past 3 months, have you driven at night?

_________Yes (go to 24b) __________No (go to 24c)

24b) Would you say that you drive at night with:
(Please check only one answer)

5______No difficulty at all
4______A little difficulty
3______Moderate difficulty
2______Extreme difficulty

24c) Is it mostly because of your visual problems that you do not drive at night?

1________Yes (go to 25) _________No (go to 25)

24. ☐

Crashes and Citations

25. How many accidents have you been involved in over the past year when you were the driver? Please tell me the number of all accidents, whether or not you were at fault.

____ accidents

25. ☐

26. How many accidents have you been involved in over the past year when you were the driver where the police were called to the scene?

______ accidents

26. ☐

III. Description of Tests of Neurological Status and Samples, Perceptual Abilities Forms, and Data Sheet for Driving Task

<u>Neuropsychological Tests:</u> These will include (1) the MMSE which is a global measure of cognitive status; (2) Trail Making Test Part B which is a measure of executive function; (3) Category Fluency Test, a frontal lobe processing task, which is a measure of the ability to hold and monitor information "on-line;" (4) the Visuospatial Construction Task of the MDRS which is a measure of visuospatial ability; (5) the Digit Symbol Test from the WAIS-R which is a measure of perceptual speed; and (6) the Block Design Test from the WAIS-R which is a measure of nonverbal intellect.

(1) *Mini-Mental State Examination (MMSE)*
A simplified, scored form of the other, more lengthy cognitive mental status examinations that includes eleven questions. It requires only 5-10 minutes to administer, and is therefore practical to use serially and routinely. It is "mini" because it concentrates only on the cognitive aspects of mental functions, and excludes questions concerning mood, abnormal mental experiences and the form of thinking. But within the cognitive realm is thorough.

(2) *Trail Making Test Part B*
This test requires the connection, by making pencil lines, between 25 encircled numbers randomly arranged on a page in proper order (Part A) and of 25 encircled numbers and letters an alternating order (Part B). The test has two forms: the Children's ("Intermediate") Form and the Adult Form. The intermediate form is used for children 9 through 14 years of age. The adult form is used from age 15 years and older.

(3) *Category Fluency Test*
Animal naming is frequently used with dementing patients who are no longer able to name much that is scorable when the stimulus is as abstract as a letter. The 60-second animal naming task is incorporated in the assessment protocol used by the Consortium for the Establishment of a Registry for Alzheimer's Disease. Additionally, subjects will be asked to write as many words as they can beginning with the letters "F", "A", and "S" allowing one minute for each letter.

(4) *Visuospatial Construction Task of the MDRS*
This subscale is composed of six tasks that generate a maximum of 6 points. The tasks require reproduction of stimulus designs that vary in difficulty from copying a diamond within a square to producing a signature.

(5) *Digit Symbol Test from the WAIS-R*

This test uses a Digit Symbol worksheet where each digit "0" through "9" is paired with a special mark. The subjects are allowed 90 seconds to write under each digit the special mark corresponding to that digit. At the end of the 90 seconds 1 point is given for each item paired correctly. A figure is scored correct if it is clearly identifiable as the keyed figure, even if it is drawn imperfectly or if it is a spontaneous correction of an incorrect figure.

(6) *Block Design Test from the WAIS-R*
This test makes use of 9 blocks (cubes) colored red on two sides, white on two sides, and red/white on two sides. The subjects use these blocks to construct 9 models printed in cards that are bound into a booklet. Time limits for designs 1 through 5 is 60 seconds each while 120 seconds are allowed for designs 6 through 9. The test is discontinued after 3 consecutive failures.

MINI-MENTAL STATE EXAM

Hi, Mr/Mrs ________, I'm _________, it's nice to meet you. How are you today? Would it be alright if I asked you a few questions now?

(Max score=10)

I. ORIENTATION

What is the date today? 1__
What year is it? 1__
What month is it? 1__
What day of the week is it? 1__
Can you also tell me what season it is? 1__
Can you tell me the name of this place? (UCF, Phillips Hall, psy bldg.,etc) 1__
What floor are we on? (3^{rd}) 1__
What city are we in? (Orlando, Oveido) 1__
What county are we in? (Orange, Seminole) 1__
What state are we in? 1__

(Max score=3)

II. IMMEDIATE RECALL

Okay, now I'm going to say three words and after I've said the last word I want you to repeat all three words back to me. Please wait until I've said all three words before you begin. Slowly and clearly say, Ball, Flag, Tree.

Ball...1__
Flag...1__
Tree...1__

(Max final score=5)

III. Attention and Calculation

A. Counting Backwards Test

Now I'm going to ask you to count backwards by 7 beginning with the number 100. So please start with 100 and count backwards until I tell you to stop. 100.....93....Any response 7 less than the previous response is correct. Record responses.

Responses
____....1__
____....1__
____....1__
____....1__
____....1__

B. Spelling Backwards Test

Now, can you please spell the word, "WORLD," backwards. Score a point for each correct letter until the first mistake. For example, DLORW scores only 2, although 3 of the letters are in the correct position.

____....1__
____....1__
____....1__
____....1__
____....1__

Final Score.....____

C. Final Score is the greater of the two scores.

(Max score=3)

IV. RECALL

Now, can you please tell me what were the three words I asked you to repeat earlier?

Ball...1__
Flag...1__
Tree...1__

Digit Symbol Instruction Sheet

Hand the participant a pencil without an eraser. Place the worksheet in front of the participant, point to the key above the test items, and say
Look at these boxes. Notice that each has a number in the upper part and a special mark in the lower part. Each number has its own mark.
Point to 1 and its mark, then 2 and its mark.
Now look down here where the boxes have numbers in the top part, but the squares at the bottom are empty (point to the sample items).
In each of the empty squares, put the mark that should go there, like this. Here is a 2; the 2 has this mark (point appropriately from sample to key). **So I put it here, like this** (put appropriate symbol in first sample square). **Here is a 1; the 1 has this mark** (point) **so I put it in this square** (put appropriate symbol in 2nd sample box). **Here is a 3; the 3 has this mark** (point) **so I put it in this square** (write).

Now you fill in the squares up to this heavy line (point). If the participant makes an error on a sample item, correct the error immediately and review the use of the key. Continue to help, if necessary, until the seven sample items have been filled in correctly. Do not proceed with the test until the participant clearly understands the task. When the participant fills in the sample item correctly, off encouragement by saying, **Yes** or **Right** and after completion of all the sample items, **Yes, now you know how to do them.**

Okay, when I tell you to start, you do the rest of them. Point to the first item and say **Start here and fill in as many squares as you can, one after the other, without skipping any. Keep working until I tell you to stop. Work as fast as you can without making mistakes.**
Sweep across the first row with your finger and say, **When you finish this line, go on to this one.** Point to the first item in row 2. **Ready, start!** Start timing.

If the participant omits an item or starts to do only one type (e.g. only the 1's) say **Do them in order without skipping any.** Point to the first item omitted and say **Do this one next.** If necessary, remind the participant to continue until instructed to stop.

At the end of 90 seconds say **Stop!**

10. DIGIT SYMBOL

1	2	3	4	5	6	7	8	9
—	⊥	⊐	L	⊔	O	Λ	X	=

SCORE

SAMPLES

2	1	3	7	2	4	8	2	1	3	2	1	4	2	3	5	2	3	1	4	5	6	3	1

1	5	4	2	7	6	3	5	7	2	8	5	4	6	3	7	2	8	1	9	5	8	4	7

6	2	5	1	9	2	8	3	7	4	6	5	9	4	8	3	7	2	6	1	5	4	6	3

9	2	8	1	7	9	4	6	8	5	9	7	1	8	5	2	9	4	8	6	3	7	9	8

Block Design Instructions

Have the blocks and design pad ready. For designs 2-9 the participant works from the design pad. Make sure the unbound side of the design pad is nearest the participant and is centered in front of him/her. Never allow participant to rotate design card.
Scoring: In order for a design to be considered correct it must match the model precisely and not be rotated by more than 30 degrees. The design must also be completed within the time limit. For designs 1 and 2, if a mistake is made, show the participant and allow a 2nd chance, restarting the time and again allowing 60 seconds.

Design 1—4 blocks Trial 1 ____ Trial 2 _____
Put 4 scrambled blocks on the table and say, **You see these blocks? They are all alike. On some sides they are all red; on some, all white; and on some half red and half white.** (Turn the blocks to show the different sides). **I'm going to put them together to make a design. Watch me.**
Arrange the 4 blocks into the design shown on card 1, without letting the participant see the card. Then, leaving the model intact, give the participant 4 other blocks and say, **Now make one just like this.** Start timing and allow 60 seconds. If the participant tries to duplicate the model exactly, including sides, inform him/her that **Only the top needs to be duplicated.** If the participant successfully completes the design within the time limit, proceed to Design 2.
If the participant fails, say **Watch me again.** (Demonstrate again using the participant's blocks, leaving your model intact and say, **Now you try it again and be sure to make it just like mine.** Start timing again (60 sec), whether participant succeeds or fails, move on to Design 2.

Design 2—4 blocks Trial 1 ____ Trial 2 ____
Remove the model for Design 1 and scramble the participant's blocks. Place card 2 in appropriate position and say, **This time we are going to put these blocks together to make them look like this picture** (point). **Watch me first.** Demonstrate slowly with participant's blocks and say, **You see, the tops of these blocks look the same as this picture.** Scramble blocks. **Now look at the picture and make one that looks just like it with these blocks. Go ahead.** Allow 60 seconds, if successful proceed to Design 3, if fails scramble and say **Watch me again.** Demonstrate, scramble and say, **Now try it again.** 60 secs, proceed to Design 3 upon success or failure.

Designs 3-5—4 blocks; 60 seconds 3 ___ 4 ____ 5____
Scramble blocks and place appropriate card before participant and say, **Now make one like this. Try to work as quickly as you can and tell me when you have finished.** Record exact time for successful completions. No 2nd chances are given. Move to next design & administer in same manner.

Designs 6-9—9 blocks; 120 seconds 6___ 7_____ 8_____ 9 _____
Scramble and present appropriate card and say, **Now make one like this using nine blocks. Be sure to tell me when you have finished.** Again, record precise time for successful completions and move to next card.

Animal Naming

I want to see how many different animals you can call to mind and name in about a minute, while I count them. Any animals will do; they can be from the farm, the jungle, the ocean, or house pets. For instance, you can start with dog.

Start timing from this point and continue for one minute. Record animal names below.

<u>0-30 secs</u>	<u>31-60 secs</u>

Instruction Sheet for Trail Making Part B

Sample Instructions

Start with sample side up. Point as you go along and say,
On this page are some numbers and letters. Begin at number 1 and draw a line from 1 to A (point), **from A to 2** (point), **2 to B** (point), **B to 3** (point), **3 to C** (point), **and so on, in order until you reach the end** (point to circle marked "End"). **Remember, first you have a number** (point to 1), **then a letter** (point to A), **then a number** (point to 2), **then a letter** (point to B), **and so on. Draw the lines as fast as you can. Ready! Begin!**

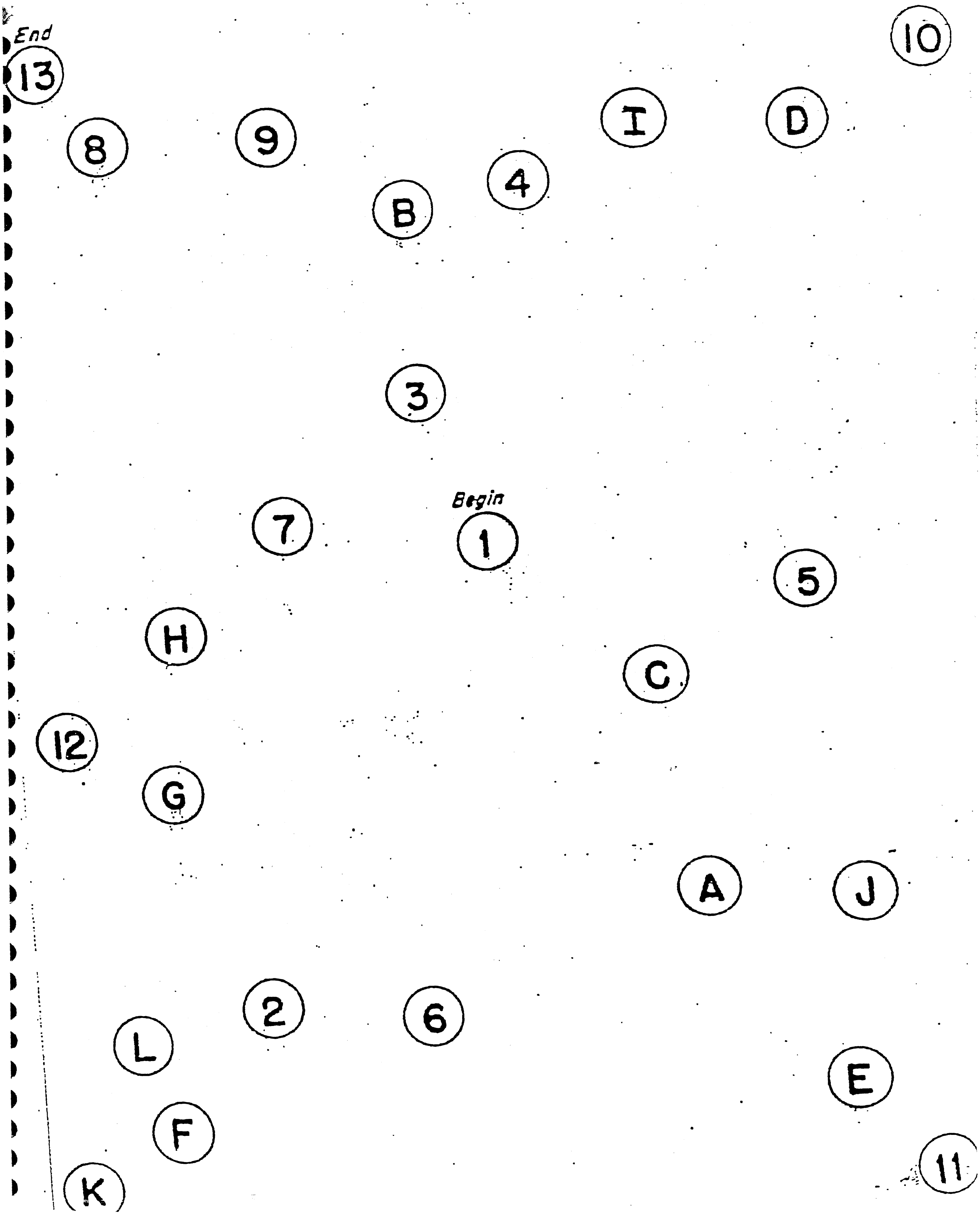
1. If the participant completes the sample correctly, say,
   Good. Let's try the next one. Proceed immediately to Part B.
2. If the participant makes a mistake on the sample, point it out and explain it. The following explanations of mistakes serve as explanations:
   1). **You started with the wrong circle. This is where you start** (point to 1).
   2). **You skipped this circle** (point). **You should go from 1 to A** (point), **A to 2** (point), **2 to B** (point), **B to 3** (point), **and so on until you reach the end** (point).
   --If it's clear that the participant intended to touch a circle, but missed it, do not count it as an omission, but say, **Make sure you touch all the circles.**
3. If the participant still cannot complete the sample, take his hand and guide the pencil (eraser down) through the circles. Then say, **Now you try it, remember you begin at number 1** (point) **and draw a line from 1 to A** (point), **from A to 2** (point), **2 to B** (point), **from B to 3** (point), **and so on until you reach the circle marked "End."** (point). **Ready! Begin!**
4. If the participant succeeds this time, go on to Part B. If not repeat the procedure until he does succeed or it becomes evident that he cannot.

Part B Instructions

On this page are both numbers and letters. Do this the same way. Begin at number 1 (point) **and draw a line from 1 to A** (point), **from A to 2** (point), **2 to B** (point), **B to 3** (point), **3 to C** (point), **and so on, in order, until you reach the end** (point). **Remember, first you have a number** (point to 1), **then a letter** (point), **then a number** (point), **then a letter** (point), **and so on. Do not skip around, but go from one circle to the next in proper order. Draw the lines as fast as you can. Ready! Begin!**

Start timing as soon as the participant is told to begin. Be alert for mistakes. If the participant makes an error, call it to his attention immediately and have him proceed from the point the mistake occurred. Do not stop timing. When the participant completes part B, remove the test sheet. Record the time in seconds.

Again, if it becomes clear that the participant will be unable to successfully complete the task in any amount of time, discontinue the activity and move on.


End
13
10
I
D
8
9
4
B
3
Begin
1
7
5
H
C
12
G
A
J
2
6
L
E
F
11
K

Construction

P. Construction Design 1

Present Card 5 in stimulus booklet. Turn paper over. **Copy this** (point to vertical lines). **Put it here** (point to paper).

reproduction of "vertical lines" (1pt) _____ Score P_____★ (0-1)

Q. Construction Design 2

Present Card 6 in stimulus booklet. **Copy this** (point to diamond in box). **Put it here** (point to paper).

reproduction of "diamond in box" (1pt) _____ Score Q_____★ (0-1)

IF SCORE Q = 1, GO TO V
ENTER MAX SCORE FOR R-U

R. Construction Design 3

Present Card 7 in stimulus booklet. **Copy this** (point to square and diamond). **Put it here** (point to paper).

reproduction of "square and diamond" (1pt) _____ Score R_____★ (0-1)

S. Construction Design 4

Present Card 8 in stimulus booklet. **Copy this** (point to diamond). **Put it here** (point to paper).

reproduction of "diamond" (1pt) _____ Score S_____★ (0-1)

T. Construction Design 5

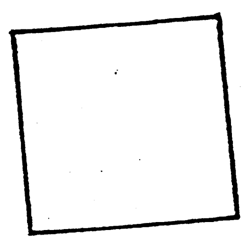
Present Card 9 in stimulus booklet. **Copy this** (point to square). **Put it here** (point to paper).

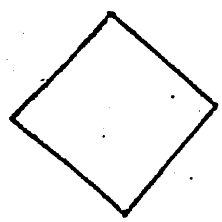
reproduction of "square" (1pt) _____ Score T_____★ (0-1)

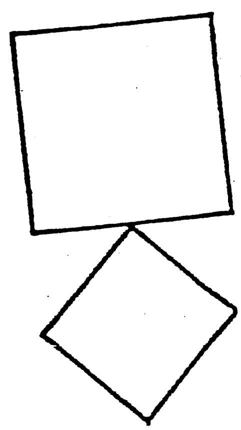
U. Construction Design 6

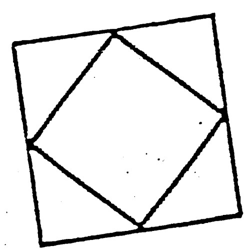
Write your full name here (point to paper).

produces signature (1pt) _____ Score U_____★ (0-1)





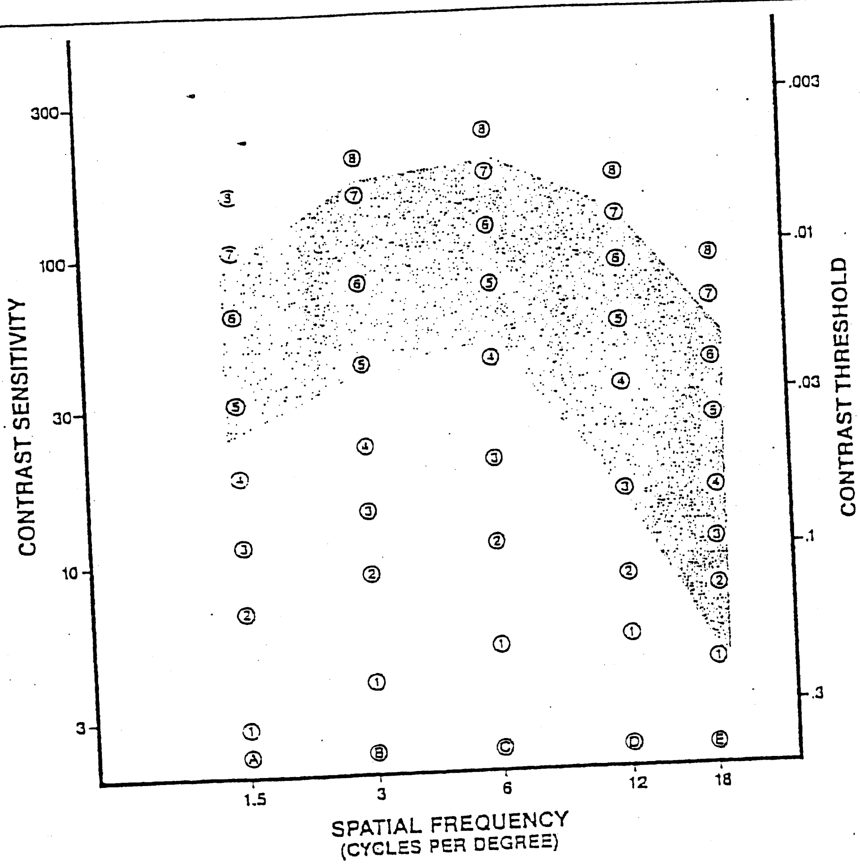




VISTECH CONSULTANTS, INC.

Contrast Sensitivity

EVALUATION FORM



OBSERVER NAME ______________________ DATE ________

VCTS® SYSTEM USED ____________ TESTING DISTANCE ________

COMMENTS: ______________________________

____

Tested by: ______________________________

The normal range of contrast sensitivity is shown in the gray area. The normal range is only relevant if proper lighting is used as described in the Instruction Booklet. It is provided to help AID in the diagnosis of optical, neurological, or pathological disorders and should not be used as a sole criterion for diagnosis and treatment. In some cases, depressed contrast sensitivity is due strictly to normal variation and not to an optical, neurological, or pathological problem. For this reason, contrast sensitivity should be used in conjunction with other diagnostic techniques.

VISTECH FORM 00984

Physicians' Visual Rating System Record Form

Name ______________________ Sex ________

Address ______________________

Date of birth ______________ Date this test ______________

Wearing glasses? Yes: For reading only ___ ; for distance only ___ ; both ___ No ___

Snellen standard (if desired)

With glasses RE ______ LE ______

Without glasses: RE ______ LE ______

(For uncorrected vision: Circle last item read correctly. For corrected vision: Check mark last item read correctly.)

SET CARD HOLDER AT FAR POINT.

TEST	LEFT EYE ONLY	RIGHT EYE ONLY	UNSATISFACTORY Overconvergence, or left eye turns upward, poor acuity, and/or astigmatism	RETEST	EXPECTED RESPONSE	RETEST	UNSATISFACTORY Underconvergence, or right eye turns upward.
CARD 1 Acuity Read the letters as far as you can. Column A first, then B, then C.	Column A Both eyes		F 20/200; LPE 20/100; ED FCZ 20/70; FE LOP 20/50; PE CFD 20/40	DF CZP 20/30	DEFPOTE 20/20		
	Column B Right eye		P 20/200; LFP 20/100; PE DFC 20/70; DL OPZ 20/50; PO TEC 20/40	LE FOD 20/30	TECDEFP 20/20		
	Column C Left eye		E 20/200; PED 20/100; CZ PDF 20/70; FO PZD 20/50; DE FPO 20/40	OD PCT 20/30	OTECEFD 20/20		
CARD 2 Lateral Phoria Near which number does the yellow line pass?	Line only	Numbers only	12 13 14 15 16 17 18	19 20	21 —— 29 The difference between adjacent numbers is one prism diopter	30 31	32 33 34 35 36 37 38
CARD 3 Vertical Phoria Near which number do the dots pass?	Dots only	Numbers only	1 2 3 4 5 6 7 8 9 10	11	12 The difference between adjacent numbers is one prism diopter	13	14 15 16 17 18 19 20
CARD 4 Stereopsis Which symbol stands out?	+ only	only ●	+ 4%; ○ 5%; * 6%; ○ 7%; □ 8%; □ 10%; ♡ 20%; + 30%	* 35%	+ 45%; ♡ 50%; ○ 60%		
CARD 5 Color Perception Read the numbers	Top 32	Left 79	Right 23; None correct; 1 out of 3	2 of 3	All correct		
CARD 6 Color Perception Read the numbers	Top 63	Left 92	Right 56; None correct; 1 out of 3	2 of 3	All correct		

SET CARD HOLDER AT NEAR POINT

TEST		UNSATISFACTORY	RETEST	EXPECTED RESPONSE	RETEST	UNSATISFACTORY
CARD 7 Acuity Read the letters as far as you can. Column A first, then B, then C.	Column A Left Eye	R 20/200; DCV 20/100; VC ZRS 20/70; VZ NOS 20/50; DS CHV 20/40	ZO NSH 20/30	DVCNZOR 20/20		
	Column B Right Eye	D 20/200; SHR 20/100; HO NCZ 20/70; DC RHV 20/50; ZN ORD 20/40	CN ZOR 20/30	VNSCHOD 20/20		
	Column C Both Eyes	S 20/200; NOZ 20/100; ZD SVR 20/70; SZ OND 20/50; VZ ONS 20/40	RS DCV 20/30	SDCVNOZ 20/20		

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340 WESTERN RD. #1, RENO, NV 89506
PHONE (702) 324-2799 • FAX (702) 324-5375
...@SIERRA.NET

737-017

DATA SHEET FOR VIDEO DRIVING TASK

Name:______________________ Participant No._____ SS#:__________ Date:_________

First Trial:
Practice: 1st Lap:

a. Crashes/collisions:__________________

b. Leaving road:_____________________

c. Crossing Median:__________________

d. Obey speed limit: 30mph___50mph___

2nd Lap:

a.______________________

b. _____________________

c. _____________________

d. 30mph___50mph__

e. time to complete trial #1. ________

f. Top speed: __________________

g. % damage:____________________

h. Other information:______________

____

Second Trial:
1st Lap:

a. Crashes/collisions:__________________

b. Leaving road:_____________________

c. Crossing median:___________________

d. Obey speed limit: 30mph___50mph___

2nd Lap:

a.______________________

b.______________________

c.______________________

d. 30mph___50mph___

e. Time to complete trial #2:________

f. Top speed:___________________

g. % damage:____________________

h. Other information_______________

____

Notes:____