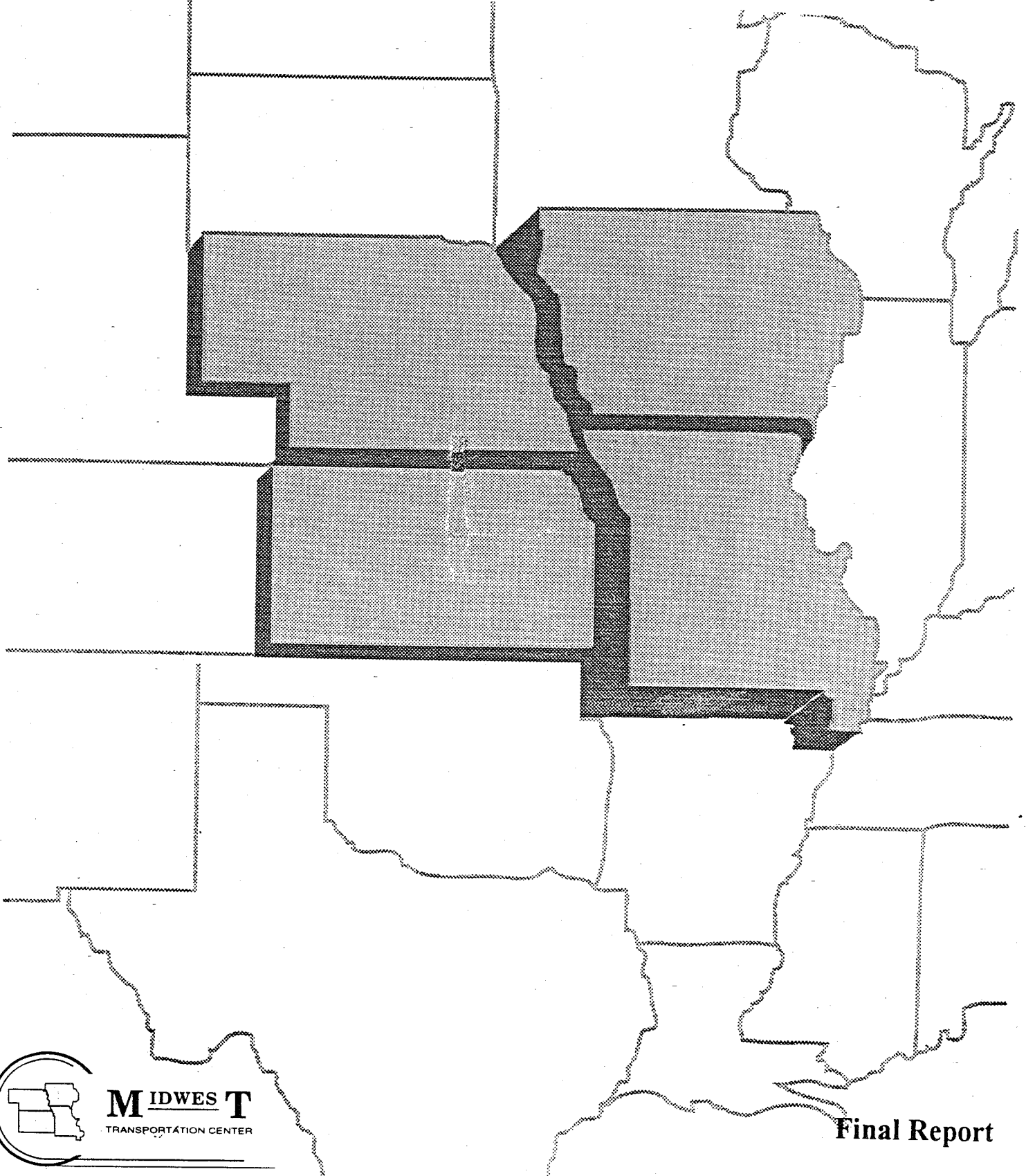


# Strategies for Improving the Safety of Elderly Drivers Second Year Report of a Two-Year Study



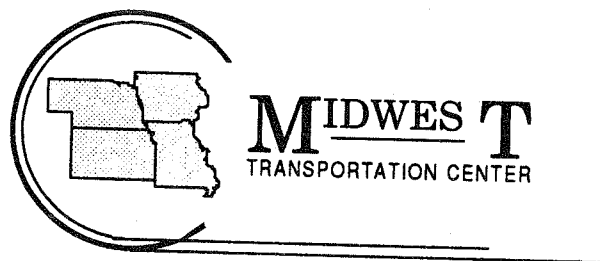
**M** IDWES **T**  
TRANSPORTATION CENTER

**Final Report**

**Strategies for Improving the Safety of Elderly Drivers  
Second Year Report of a Two-Year Study**

Prepared by  
The University of Nebraska-Lincoln  
in conjunction with the  
Midwest Transportation Center

June 1992



Commissioned by the  
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## PREFACE

This report is the product of a research project in the University Transportation Centers Program. The Program was created by Congress in 1987 to "contribute to the solution of important regional and national transportation problems." A university-based center was established in each of the ten federal regions following a national competition in 1988. Each center has a unique theme and research purpose, although all are interdisciplinary and also have education missions.

The Midwest Transportation Center, one of ten centers, is a consortium that includes Iowa State University (lead institution) and the University of Iowa. The Center serves Federal Region VII which includes Iowa, Kansas, Missouri, and Nebraska. Its theme is "transportation actions and strategies in a region undergoing major social and economic transition." Research projects conducted through the Center bring together the collective talents of faculty, staff, and students within the region to address issues related to this important theme.

The research presented in this report reflects the key mission of the Midwest Transportation Center by examining ways to improve the safety of elderly drivers in the region. The research was conducted by an interdisciplinary team of researchers in driver education, gerontology, and highway/traffic engineering from the University of Nebraska-Kearney, The University of Nebraska Medical Center, and the University of Nebraska-Lincoln.

Patrick T. McCoy, Professor of Civil Engineering at the University of Nebraska-Lincoln, was the Principal Investigator. Richard D. Ashman, Associate Professor of Driver Education at the University of Nebraska-Kearney, Betty G. Foster, Assistant Professor of Gerontology at the University of Nebraska Medical Center, and Ramaratnam R. Bishu, Associate Professor of Industrial & Management Systems Engineering at the University of Nebraska-Lincoln, were co-investigators. They were assisted by Husham N. Abdulsattar, Timothy A. McCoy, and Mohammed S. Tarawneh, graduate research assistants in civil engineering at the University of Nebraska-Lincoln.

## ABSTRACT

In 1989, a two-year multidisciplinary study of the problems of older drivers was funded by the Midwest Transportation Center, with matching funds from the state highway agencies of Iowa, Kansas, Missouri, and Nebraska. The study was conducted by a team of researchers from the areas of traffic engineering, gerontology, and driver education. The objective of the research was to develop and evaluate strategies for improving the safety of older drivers. During the first year, the problems of older drivers were examined and countermeasures were designed to address these problems. The countermeasures designed were: physical therapy, perceptual therapy, driver education, and engineering countermeasures which consisted of the application of signs, pavement markings, and traffic signal displays to address the problems of older drivers with left-turn and right-turn maneuvers at signalized intersections and approaches to unsignalized intersections. In the second year, the countermeasures were evaluated by measuring their effects on the driving performance of older drivers. The procedures and results of the second year are presented in this report.

A total of 105 older drivers between the ages 65 and 88 years were used to evaluate the effects of the countermeasures on the driving performance of older drivers. The subjects were randomly assigned to six experimental groups which received different countermeasures. The on-road driving performance of the subjects was measured using the driver-performance-measurement technique developed at Michigan State University.

All of the countermeasures significantly improved the driving performance of older drivers. Combining driver education with physical or perceptual therapy tended to increase the improvement in driving performance, but none of the increases were statistically significant. Likewise, the engineering countermeasures did not add significantly to the improvement that was achieved by the other countermeasures. The combination of perceptual therapy and driver education provided the greatest improvement followed by the combinations of engineering countermeasures with driver education and either physical or perceptual therapy. However, there were no statistically significant differences among the improvements provided by the countermeasures either individually or in combination. The average improvement provided was 7.9 percent.

Physical therapy was more cost-effective than perceptual therapy or driver education. The engineering countermeasures were more cost-effective than the other countermeasures on high-volume roadways, but not on low-volume roadways.

## ACKNOWLEDGEMENTS

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The researchers would like to thank the Project Advisory Committee for the direction and guidance during the course of the research. Members of the committee were: Ken Sieckmeyer (Project Monitor), Nebraska Department of Roads; Gordon Switzer, Iowa Department of Transportation; Warren Sick, Kansas Department of Transportation; Kent Van Landuyt, Missouri Highway and Transportation Department; Rex Lutz, American Association of Retired Persons; and Jill Moon, Immanuel Rehabilitation Center.

The researchers would also like to thank the Engineering Countermeasures Review Panel for its assistance in reviewing the engineering countermeasures. Members of the panel were: Monty Fredrickson, Ken Gottula, Bob Grant, Gerald Grauer, Richard Ruby, and Walter Witt with the Nebraska Department of Roads; and Mike Gorman, City of Omaha.

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## Chapter 1

### INTRODUCTION

In 1989, a two-year multidisciplinary study of the problems of older drivers was funded by the Midwest Transportation Center, with matching funds from the state highway agencies of Iowa, Kansas, Missouri, and Nebraska. The study was conducted by a team of researchers from the areas of traffic engineering, gerontology, and driver education. The objective of the research was to develop and evaluate strategies for improving the safety of older drivers.

#### FIRST YEAR

During the first year, the problems of older drivers were examined and ways to improve the safety of older drivers were identified.

#### Problems of Elderly Drivers

The problems of elderly drivers were defined in terms of the accident situations in which they are over-involved, deficiencies in their knowledge of driving, and deficits in their physical, perceptual, and cognitive abilities.

#### Accidents

The accident records maintained by the Nebraska Department of Roads for all reported accidents that occurred in Nebraska during 1988 were analyzed to identify the accident situations in which older drivers were over-involved. The data were analyzed with respect to five driver-age groups: a younger age group (less than 25 years), a middle age group (25 to 54 years), and three older-driver age groups (55 to 64 years, 65 to 74 years, and 75 years and older). The accident rates and patterns for each age group were determined and compared with those of the other age groups.

The results of the accident data analysis were consistent with the findings of previous studies [1,2]. In general, older drivers were over-involved in multivehicle accidents, accidents at intersections, and accidents in urban areas. Compared to drivers in the middle age group, older drivers had significantly higher percentages of their accidents in daylight, between the hours of 9:00 am and 3:00 pm, on weekdays, in clear weather, on dry roads, and on straight and level roadways. Significantly higher percentages of older drivers involved in accidents were females, residents of the local area, and driving four-door sedans.

Older drivers were over-involved in right-angle, left-turn, backing, and parking collisions. Older drivers were more likely than drivers in the middle age group to have right-angle and left-turn collisions involving *failure to yield*, *ran stop sign*, *disregarded traffic signal*, and *made improper turn* as contributing circumstances. Also, in these types of collisions, older drivers were more likely than younger drivers to be making a left turn.

The most serious problems of older drivers were those of drivers 75 years and older. Among the three older-driver age groups, only the 75-and older age group had a significantly higher accident rate than the drivers in the middle age group. All three older-driver age groups had higher percentages of multivehicle accidents than the younger age groups. But drivers 75 years and older had the greatest likelihood of being involved multivehicle accidents.

Review of the traffic and roadway conditions at high older-driver accident locations indicated that these locations were typically found at higher volume intersections controlled by either traffic signals or stop signs. The older drivers were usually the driver at fault, especially in the case of right-angle and left-turn collisions. The most commonly cited contributing circumstances in these cases were *failure to yield* and *disregarded traffic signal*. The intersection sight distances at most of these locations were adequate. However, the right-angle accidents involving older drivers at the signalized intersections seemed to be frequently associated with signal displays that were competing with visual clutter for the attention of the drivers. The left turns at most of the high older-driver accident locations were made from opposing left-turn lanes that were either uncontrolled or else controlled with permitted left-turn phases. In many cases the left-turn lanes were positioned in such a way that the sight distance of left-turn drivers was obstructed by vehicles in the opposing left-turn lanes. Also, the placement of the signal displays often created wide angles between the signal heads controlling the left turns and the opposing through traffic. A review of the backing and parking-related accident locations indicated that these types of collisions involving older drivers were more often found on streets with angle parking. However, this is probably because older drivers prefer angle parking and therefore tend to avoid using parallel parking stalls.

### **Driving Knowledge**

The driving knowledge tests taken by over 2,000 older drivers who were renewing their Nebraska driver's licenses were analyzed to determine if there was any relationship between the test scores and the accident pattern of older drivers. A score of 80 percent was required to pass the test. However, the average score of the older drivers was below 80 percent, and the average

score decreased with increasing driver age. The average scores for the three older-driver age groups were: 79 percent for drivers 55 to 64 years, 76 percent for drivers 65 to 74 years, and only 69 percent for drivers 75 years and older.

Only a few of the questions on the tests were relevant to the accident problems of older drivers. There were just three questions related to right-angle accidents, and only four questions related to left-turn accidents. None of the questions pertained to backing or parking-related accidents. The percentage of correct answers to the questions related to right-angle and left-turn accidents are shown in Table 1-1. In each case, the percentage of correct answers decreased with increasing driver age. Drivers 75 years and older had the most difficulty answering these questions.

Table 1-1. Driving knowledge test scores.

Questions	Age Group		
	55-64	65-74	>74
Right-Angle Accident Related	83 %	78 %	72 %
Left-Turn Accident Related	86 %	82 %	73 %

The average scores of the three older-driver age groups were below the 80 percent required to pass the test. In addition, the average scores of the drivers 75 years and older on the questions related to right-angle and left-turn accidents were below the 80 percent. Thus, test scores indicated that older drivers, especially those 75 years and older, need a driver education program.

### Abilities

Literature in the fields of medicine, allied health professions, and social science were reviewed to determine the abilities of older persons relative the driving task. In addition, patient records from the driver rehabilitation program at the Immanuel Rehabilitation Center in Omaha, Nebraska were analyzed to determine the relationship between driving performance and a



number of sensory, perceptual, and cognitive factors. Also, a survey of older drivers was conducted to determine their perceptions of their own driving abilities.

Older drivers themselves as well as other observers have reported unsafe driving practices as a result of the loss of one or more visual capabilities, but it has been difficult to determine which deficits among many tend to cause the most difficulty. Considerable research has been done on physiological changes that occur as people age yet little of this information has been scientifically tested as it relates to the task of driving. Substantial literature exists reporting the slowing of reaction time with aging. Studies [3] of reaction times among older persons have found correlations between physical fitness and psychomotor speed. Reaction time were fastest among those who were the most physically fit. Also, regular exercise therapy has been studied to some extent with indications of improvement in cognitive performance and retrieval activity [4]. However, there has been little research on the relationship between physiological changes with age and specific driving tasks. A considerable body of literature [5] exists that suggests decline in cognitive functioning of older persons, but its relationship to the performance of older drivers is yet to be determined.

Data for 117 impaired older drivers, 55 to 88 years old, were obtained from the Immanuel Rehabilitation Center in Omaha, Nebraska. The data included the results of on-the-road driving tests and measures of far and near visual acuity, depth perception, peripheral vision, reaction time, and visual perception. A discriminant analysis technique was used to classify the drivers based on their driving performance into two groups, *satisfactory* and *unsatisfactory* drivers. The resultant discriminant functions were statistically significant and showed a classification accuracy much higher than that achieved by chance alone. The variables included in these functions were depth perception, peripheral vision, reaction time, figure-ground perception, and visual discrimination.

The survey of older drivers was conducted in Omaha, Nebraska and included responses from 425 drivers 75 years and older. About 75 percent of these respondents reported no difficulty in renewing their driver's license the last time. Ninety-two percent reported receiving no traffic citations within the last two years, and 86 percent indicated that they had not been involved in a traffic accident within the last two years. They indicated that the most common problems they had at traffic signals were: (1) turning right on red, (2) knowing the proper lane to be in, and (3) seeing the traffic signal. The most common problems at stop signs were: (1) having enough time to cross the intersection, (2) deciding when it is safe to cross, and (3) seeing traffic on the cross street. With regards to making left turns at intersections, the most frequently cited problem was having their view blocked by vehicles in the opposing left-turn

lane. Other common problems turning left were: (1) knowing the proper lane to be in, (2) seeing when it is safe to turn, and (3) knowing when and where to turn. Twenty-five percent indicated that they had trouble seeing street name signs far enough in advance, and 12 percent reported that they had trouble turning that heads to look over their shoulder when driving in reverse.

### **Perception-Reaction Times**

The perception-reaction times of older drivers are longer than those of younger drivers because older drivers require more time for each of the components of perception-reaction time. The major increases in time are associated with the information processing components: fixation, recognition, and decision. Highway and traffic engineering design criteria include driver perception-reaction times. Therefore, to assess the problems of older drivers with respect to highway design and traffic control, the effects of aging on the components of driver perception-reaction time found in the literature were used to derive older-driver perception-reaction times for the driving tasks associated with right-angle and left-turn collisions in which older drivers are over-involved.

Four driving tasks associated with right-angle and left-turn collisions were examined:

Task 1 - stopping in response to an unexpected hazard.

Task 2 - stopping in response to a traffic signal.

Task 3 - crossing an intersecting roadway.

Task 4 - turning left through opposing traffic.

The first three tasks are associated with the problems of older drivers involved in right-angle collisions, and the fourth one is associated with the problems of older drivers involved in left-turn collisions. In each case, the perception-reaction times were derived using both the sequential and parallel models of information processing.

The perception-reaction times derived for older drivers are shown in Table 1-2. The current design values of the perception-reaction times associated with the tasks are also shown. The ranges in the derived values resulted from the variation in the effects of aging reported in the literature as well as from the use of both information processing models. The upper limits of the ranges resulted from the use of the sequential model and the lower limits resulted from the parallel model.

The design values for Tasks 1 and 2 were within the ranges of the derived values. Since both of these tasks are stopping maneuvers, drivers with perception-reaction times longer than

the design values could compensate by traveling below the design speed. The design value for Task 3 is below the derived range, and the design value for Task 4 is just above the lower limit of the derived range. Both of these tasks involve gap acceptance, and the design values are used to provide adequate intersection sight distances. Therefore, drivers with perception-reaction times slower than the design values could not easily compensate for such deficits and would have difficulty in performing the tasks safely when the available sight distances were not long enough to accommodate their longer perception-reaction times. Thus, highway design may create gap acceptance problems for older drivers by not providing adequate sight distances.

Table 1-2. Perception-reaction times.

Task	Design Value (seconds)	Older Drivers (seconds)
1 - stopping in response to an unexpected hazard.	2.5 <sup>a</sup>	1.5 - 3.4
2 - stopping in response to a traffic signal.	1.0 <sup>b</sup>	1.0 - 2.1
3 - crossing an intersecting roadway.	2.0 <sup>a</sup>	2.6 - 4.6
4 - turning left through opposing traffic.	2.0 <sup>a</sup>	1.9 - 3.8

<sup>a</sup> Reference 6.

<sup>b</sup> Reference 7.

### Countermeasures

Countermeasures designed to improve the safety of older drivers were identified and selected for demonstration and evaluation during the second year of the research. The countermeasures were intended to address the problems of older drivers that were determined as a result of the accident data analysis and the assessment of the driving knowledge and abilities of older drivers. In addition, the results of a review of the literature and current practice relative to methods of improving the safety of older drivers were considered in the identification and selection of the countermeasures. The countermeasures selected were ones that were determined to be feasible and provide the greatest potential for reducing older driver accidents without reducing the mobility of older drivers. The countermeasures selected were driver education, physical and perceptual therapies, and engineering countermeasures.

## **Driver Education**

The results of the evaluation of the driving knowledge of older drivers indicated that they have deficiencies in their driving knowledge with respect to the following: (1) right-of-way rules and procedures for crossing and turning left at intersections, (2) safe following distances, (3) correct lane positioning and selection, and (4) proper procedures for backing and parking maneuvers. Therefore, driver education to correct these deficiencies was needed.

There are three nationally prominent older driver education programs: (1) the National Safety Council (NSC) *Coaching the Mature Driver*, (2) the American Association of Retired Persons (AARP) *55 Alive/Mature Driving*, and (3) the American Automobile Association (AAA) *Safe Driving for Mature Operators*. All three programs were examined and found to provide adequate coverage of the information needed to address the driving knowledge deficiencies of older drivers and the accident situations in which they are over-involved. Therefore, it was not necessary for the research team to develop another older-driver education program.

The AAA *Safe Driving for Mature Operators* was selected as the driver education countermeasure to be used in the second year of the research. It was one of the lowest cost programs. In addition, AAA was the most willing of the program sponsors to have its program used in the research.

## **Therapies**

Previous research and the experience of therapists at the Immanuel Rehabilitation Center and the University of Nebraska Medical Center in Omaha, Nebraska indicated that physical and perceptual therapies might improve the performance of older drivers. Overall physical fitness and flexibility have been demonstrated to improve reaction time, cognitive performance, and energy level. Perceptual therapies have been found to improve visual scanning, spatial perception, visual discrimination, and figure-ground perception.

The physical therapy involved exercises designed to improve trunk rotation, shoulder flexibility, and posture. The perceptual therapy involved visual perception exercises designed to improve spatial orientation, visual discrimination, figure-ground perception, visual closure, and visual memory. Therapies administered at health care facilities by professional therapists are expensive, and it would not be feasible to provide such therapies to the general population of older drivers. Therefore, for practical purposes, the therapies were designed as self-administered home-based programs of physical and perceptual exercises.

## **Engineering**

The engineering countermeasures were designed to address the accident situations in which older drivers were found to be over-involved. Of the collisions types in which the older drivers were over-involved, the right-angle and left-turn collisions were the most susceptible to elimination by cost-effective engineering countermeasures. These collisions are usually more severe than the other types of collisions in which older drivers are over-involved (i.e., backing and parking-related collisions). Consequently, they offer greater potential accident cost savings. Also, right-angle and left-turn collisions are often concentrated at intersections, whereas the backing and parking-related collisions usually occur at widely scattered locations, making them more difficult to address cost effectively. Therefore, the engineering countermeasures selected for demonstration during the second year of the study were designed to address the problems of older drivers involved in right-angle and left-turn collisions. In addition, the engineering countermeasures were limited to those that only involved signs, pavement markings, or traffic signal displays. It was not possible to select countermeasures that involved roadway reconstruction or expensive traffic control devices because of the budget and time constraints of the study.

The problems of older drivers involved in right-angle collisions were associated gap acceptance and stopping. The longer perception-reaction times of older drivers require longer sight distances and larger gaps for them to travel safely through intersections. The problems they have in stopping at intersections are concerned with: (1) not knowing when and where to stop at stop signs and traffic signals and (2) slower perception-reaction times in response to the vehicle change intervals at signalized intersections. These problems require that traffic control devices have greater conspicuity. At some intersections, older drivers may often stop in positions that do not provide them with sufficient sight distance to see the arrival of vehicles on the cross street far enough in advance to allow them to safely enter the intersection. In such cases, the addition of stop bars would help older drivers stop in positions that provide enough sight distances and facilitate their selection of adequate gaps. Larger stop signs, improved signal displays, and the addition of side-mounted signal heads would improve the conspicuity of intersection traffic control devices and reduce the chances that they would not be seen by older drivers.

The problems of older drivers involved in left-turn collisions were associated with gap acceptance, field of view, and turning path. The longer perception-reaction times of older drivers require longer sight distances and larger gaps for them to turn left safely. Widening the left-turn lane lines in opposing left-turn lanes would improve the sight distance for left turns by causing the opposing left-turn vehicles to move to the left side of their lanes and reduce the sight

distance obstruction they cause each other. The placement of the traffic signal heads at some intersections creates a wide-angle field of view between the signal controlling the left turns and the opposing traffic, which in turn increases the perception-reaction times and difficulty involved in selecting adequate gaps through which to turn. The addition of a far left-side signal head would reduce the angle of the field of view and facilitate the acceptance of adequate gaps by drivers turning left. Older drivers also often have problems turning left at wide intersections because they have difficulty identifying the proper path to follow through the large unmarked area within the intersection. The addition of turning path lines would help drivers follow the proper left-turn paths through the intersections.

## **SECOND YEAR**

During the second year of the research, the countermeasures selected in the first year were demonstrated so that their actual effectiveness could be evaluated. Based on the experience of the demonstrations, the cost-effectiveness of the countermeasures was evaluated and the most cost-effective ones were identified.

This report documents the procedures, findings, and conclusions of the research during the second year. The overall study procedure is outlined in Chapter 2. The DPM technique used to evaluate the driving performance is presented in Chapter 3. The countermeasures and their evaluation are described in Chapters 4 and 5, respectively. The conclusions and recommendations of the research are presented in Chapter 6.

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## Chapter 2

### STUDY PROCEDURE

The countermeasures identified during the first year of research were evaluated by measuring their effects on the driving performance of elderly drivers. The subjects, experimental design, and testing procedures used in the evaluation are described in this chapter.

### SUBJECTS

The elderly drivers who participated in the study were volunteers solicited through the AgeWell Program at Immanuel Hospital in Omaha, Nebraska. Letters of invitation to participate in the study were sent to 1,500 members of the AgeWell Program who were 75 years or older. The letters explained the objective of the study, the eligibility requirements for participation in the study, the study procedure and time requirements, and the benefits of participation. The eligibility requirements were: (1) age 75 years or older, (2) good health, (3) valid driver's license, (4) driving on a regular basis, (5) evidence of financial responsibility, (6) vehicle to use in the study, (7) not taken an older driver training course, and (8) medical release from physician to participate in the study. Potential subjects were offered \$25 and a free older driver training course in return for participating in the study. Two weeks later, a second letter was sent the 1,500 members reminding them of the request to participate in the study and the registration deadline. About 20 members volunteered to participate in the study. However, this was much too small a sample size for the purposes of the research.

The minimum age requirement was initially set at 75 years, because the results of the first year of the research indicated that the drivers 75 years and older had the most serious driving problems. But, in order to obtain a sufficient sample size, it was necessary to reduce the minimum age requirement to 65 years. Letters were then sent to 1,000 members of the AgeWell Program who were between 65 and 75 years old. As a result, a total sample size of 105 drivers 65 years and older was obtained.

The 105 subjects ranged in age from 65 to 88 years. The average age was 71.8 years. There were 51 males and 54 females. The males ranged in age from 66 to 88 years with an average age of 72.6 years. The females ranged in age from 65 to 84 years with an average age of 70.9 years. The distribution of the subjects by age and sex is shown in Table 2-1.



Table 2-1. Distribution of subjects by age and sex.

Age	Male	Female	Total
65 - 69	19	22	41
70 - 74	17	24	41
75 - 79	9	6	15
80 - 84	4	2	6
85 - 89	2	0	2
Total	51	54	105

## EXPERIMENTAL DESIGN

The subjects were tested before and after the countermeasures were implemented. The tests examined the following subject attributes: (1) vision, (2) visual perception, (3) cognition, (4) range of motion, (5) brake reaction time, (6) driving knowledge, and (7) on-road driving performance. The change in the on-road driving performance test scores was the primary measure of the effectiveness of the countermeasures. The changes in the other test scores were used to monitor and control for changes in the physical/mental condition and driving knowledge of the subjects.

The subjects were divided into six study groups. Each study group received a different countermeasure. The first group received the physical therapy program, the second group received the perceptual therapy program, and the third group received the driver education program. The fourth and fifth groups received a combination of therapy and driver education. The fourth group received the physical therapy and driver education programs, and the fifth group received the perceptual therapy and driver education programs. The sixth group was the control group, which did not receive either of the therapies or the driver education program.

The engineering countermeasures were incorporated into the on-road driving performance test route. Therefore, each of the six study groups was divided into two subgroups. The subjects in one of the subgroups were given both their before and after driving performance tests before the engineering countermeasures were installed on the test route. The subjects in the other subgroup were given their first driving performance test before the engineering

countermeasures were installed and their second driving performance test after the engineering countermeasures were installed.

The subjects were randomly assigned to the 12 subgroups. In an effort to avoid a biased assignment with respect to driving performance, the subjects were first ranked according to their scores on their before on-road driving performance test and divided into four quarters. The subjects were then randomly assigned to the 12 subgroups using the four quarters as a blocking factor. The number of subjects assigned to each subgroup is shown in Table 2-2. A Kruskal-Wallis test of the on-road driving performance test scores indicated that there were no significant differences among the subgroup mean driving performance test scores at the 0.05 level of significance.

Table 2-2. Sample sizes.

Countermeasure	Second On-Road Driving Performance Test Route <sup>a</sup>		Total
	A	B	
1 - Physical Therapy	9	9	18
2 - Perceptual Therapy	9	8	17
3 - Driver Education	8	9	17
4 - Physical Therapy and Driver Education	9	8	17
5 - Perceptual Therapy and Driver Education	9	9	18
6 - None	9	9	18
Total	53	52	105

<sup>a</sup> A - Before engineering countermeasures were installed.

B - After engineering countermeasures were installed.

## TESTING PROCEDURES

The before and after testing of the subjects was conducted at the Rehabilitation Center of Immanuel Hospital in Omaha, Nebraska. The testing included measurements of vision, visual perception, cognition, range of motion, brake reaction time, driving knowledge, and on-road driving performance. A brief description of each test follows.

### Vision

The vision of the subjects was measured with a Keystone telebinocular testing device. The measurements were taken by a registered occupational therapist as shown in Figure 2-1. Four vision measurements were taken: (1) near acuity, (2) far acuity, (3) depth perception, and (4) peripheral vision.

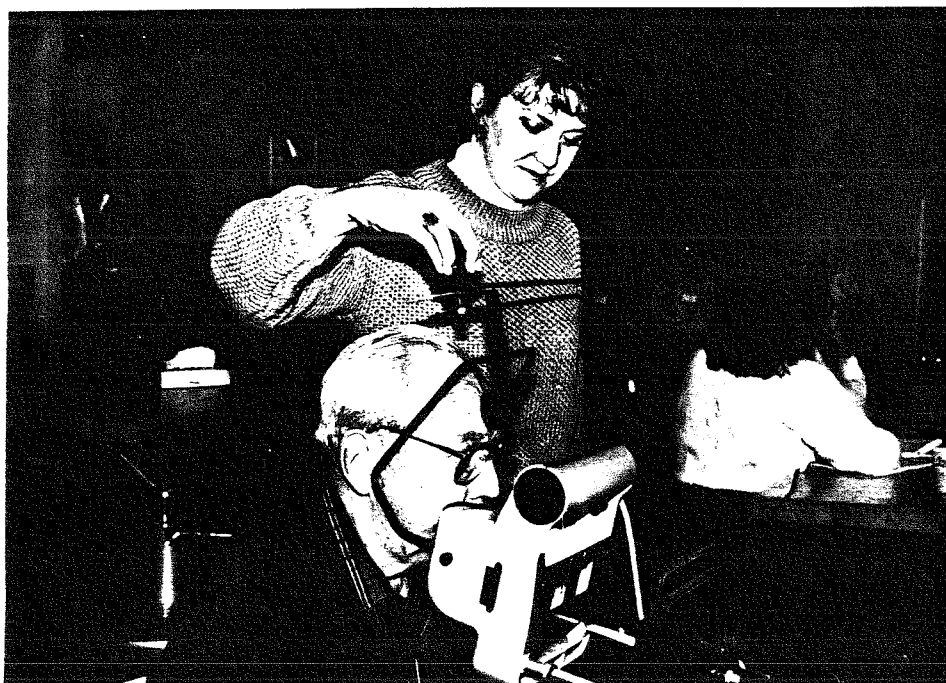


Figure 2-1. Vision test.

## Visual Perception

The Motor-Free Visual Perception Test (MVPT) was used to measure the visual perception and speed of visual processing of the subjects. The Immanuel Rehabilitation Center has used the MVPT extensively to evaluate visual perception. The MVPT was originally designed and standardized for children, but it has since been validated for adult population [1]. The MVPT consists of 36 multiple-choice questions designed to measure five components of visual perception: (1) spatial relationships, the ability to orient one's self in space and perceive the positions of objects in relation to one's self and to other objects; (2) visual discrimination, the ability to differentiate dominant features among different objects; (3) figure-ground, the ability to distinguish an object from its background; (4) visual closure, the ability to identify objects when only portions of them are visible; and (5) visual memory, the ability to recall dominant features or sequences of objects.

The MVPT test was administered individually to each subject by a trained examiner under the supervision of a registered occupational therapist as shown in Figure 2-2. The answer and the response time to each question were recorded by the examiner.



Figure 2-2. Visual perception test.

## Cognition

Three tests were used to assess the cognitive state of the subjects. The first test was the mini mental status exam. This exam consisted of 11 questions which addressed the following aspects of the subject's cognitive state: (1) orientation, (2) registration, (3) attention and calculation, (4) recall, and (5) language. The subject was scored on the exam based on the number of correct responses to the questions.

The other two tests were trail-making tests, Trails A and Trails B. Trails A consisted of 25 small circles distributed randomly on an 8½" x 11" sheet of paper. The circles were numbered randomly from 1 to 25. The subject was asked to draw a line connecting the circles in numerical order. Trails B also consisted of 25 small circles distributed randomly over an 8½" x 11" sheet of paper. But instead of being numbered from 1 to 25, the 13 of the circles were numbered randomly from 1 to 13, and 12 of them were lettered randomly from A to L. The subjects was asked to draw a line connecting the circles numerically and alphabetically by alternating between numbers and letters. The time required for the subject to correctly connect the circles was recorded for each test.

The three cognitive tests were administered by staff of the Geriatric Assessment Program at the University of Nebraska Medical Center. The administration of one of the trail-making tests is shown in Figure 2-3. Copies of the tests are shown in Appendix A.

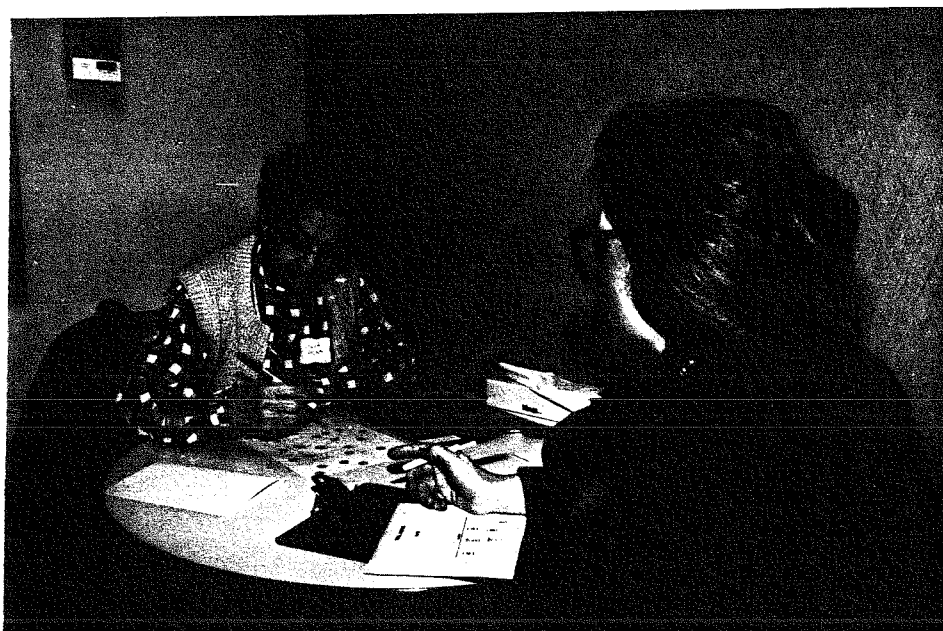


Figure 2-3. Cognition test.

## Range of Motion

Both indoor and in-car measurements of range of motion were taken. The indoor measurements were taken with the subject seated upright in a straight-back chair with both feet on the floor. The following 10 range-of-motion measurements were taken indoors: (1) neck flexion, (2) neck extension, (3) neck rotation to the left, (4) neck rotation to the right, (5) neck lateral bend to the left, (6) neck lateral bend to the right, (7) left shoulder flexion, (8) right shoulder flexion, (9) trunk rotation to the left, and (10) trunk rotation to the right. The in-car measurements were taken with the subject seated behind the steering wheel in one of two test vehicles parked outside the Immanuel Rehabilitation Center. The subject's seat belt was fastened and the subject's hands were in their normal driving position on the steering wheel. The following six range-of-motion measurements were taken in the car: (1) neck flexion, (2) neck extension, (3) neck rotation to the left, (4) neck rotation to the right, (5) neck lateral bend to the left, and (6) neck lateral bend to the right.

The measurements were taken by physical therapy students from the University of Nebraska Medical Center under the supervision of a registered physical therapist. Goniometers with 2-degree precision were used to take the measurements. Each of the 16 range-of-motion measurements was taken three times and the mean value was used in the analysis of the data. Examples of the indoor and in-car measurements are shown in Figure 2-4.



Figure 2-4. Range-of-motion measurements.

## Brake Reaction Time

Brake reaction time was measured using a Doron-L225 driving simulator. The simulator had an adjustable driver's seat, steering wheel, dash board, accelerator pedal, and brake pedal. The stimulus was a display consisting of two, 2 x 3 centimeter, rectangular red lights mounted 4 centimeters apart on the dash board. The red lights flashed in alternating fashion until they came on simultaneously, at which point the subject was to release the accelerator pedal and step on the brake pedal. The simulator measured the brake reaction time as the time interval behind the subject's release of the accelerator pedal and depression of the brake pedal.

The subjects were given two practice trials to become familiar with the simulator. Then six measurements were taken and the mean value was used in the analysis of the data. The measurements were taken by a registered occupational therapist. The therapist is shown recording a brake reaction time for one of the subjects in Figure 2-5.



Figure 2-5. Brake reaction time measurement.

## Driving Knowledge

Two driving knowledge tests were given to the subjects. The first test was given before the countermeasures were implemented, and the second test was given after the countermeasures were implemented. The tests were written by a certified driver education expert. They were prepared at the same time and were designed to be of the same degree of difficulty. Each test was composed of 50 multiple-choice questions, which addressed the aspects of driving knowledge related to the problems of older drivers defined in the first year of the research. The number of questions on each tests related to a subject was based on the distribution of accident types and contributing circumstances which was found to be associated with the accidents of older drivers.

The distribution of accident types and contributing circumstances of older-driver accidents and the number of questions on the tests related to each combination of accident type and contributing circumstance are shown in Table 2-3. For example, 50 percent of the older-driver accidents were left-turn accidents in which the older driver failed to yield the right of way. Therefore, nearly one half (24) of the 50 questions on each test pertained to the rules of the road, traffic control devices, and motor vehicle operations associated with making left turns and right-of-way assignment. Copies of the two tests are Appendix B.

Table 2-3. Distribution of driving knowledge test questions.

Contributing Circumstance	Accident Type								Total
	Right Angle	Rear End	Side Swipe	Head On	Left Turn	Other Turn	Right Turn	Pedestrian	
Failure To Yield	4 <sup>a</sup> / 2 <sup>b</sup>		1/ 1		50/24	4/ 2	1/ 1	4/ 2	64/32
Disregarded Traffic Signal	10/ 4			1/ 1	1/ 1				12/ 6
Improper Turn Signal						1/ 1			1/ 1
Made Improper Turn			1/ 1	1/ 1	4/ 1	1/ 1			7/ 4
Following Too Close		11/ 5							11/ 5
Improper Lane Change			5/ 2						5/ 2
Total	14/ 6	11/ 5	7/ 4	2/ 2	56/27	5/ 3	1/ 1	4/ 2	100/50

a Percentage of older-driver accidents.

b Number of driving-knowledge test questions.



The subjects were told to answer all questions to the best of their ability. There was no time limit, and subjects were allowed to ask the proctor to clarify any questions they did not understand. One of the subjects taking the driving knowledge test is shown in Figure 2-6.



Figure 2-6. Driving knowledge test.

### **On-Road Driving Performance**

The driving performance of the subjects was measured on the road using the driver-performance-measurement (DPM) technique developed at Michigan State University [2,3]. The 12-mile DPM route was located in Omaha, Nebraska. It was designed to measure the performance of the subjects in situations associated with the right-angle and left-turn collisions in which older drivers are over-involved. The engineering countermeasures were incorporated into the route. The subjects drove the route in their own cars before and after the engineering countermeasures were installed. The DPM test route and procedure are described in more detail in Chapter 3.

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## Chapter 3

### **DRIVER PERFORMANCE MEASUREMENT**

The DPM method for evaluating driver performance was the result of a comprehensive research study conducted by the Highway Traffic Safety Center at Michigan State University [1,2]. The method is a systematic approach to driving performance evaluation that enables the reliable rating of driver performance with respect to decreasing or increasing the hazard associated with designated traffic situations. The determination of satisfactory or unsatisfactory driving performance is based on the evaluation of the interrelationship of the expected observable driver behaviors associated with search, speed control, and direction control in response to specific traffic situations. The pattern concept and the technique of rating behavior patterns distinguishing the DPM method from check-list driving performance tests. Pilot studies conducted in Michigan found that the DPM method provides a more reliable and valid measure of safe driving than other road tests. The pilot studies also found a high degree of agreement between the different examiners' evaluations of the same driver. Consequently the DPM method was selected for evaluating driving performance. Its application for the purposes of the research is described in this chapter.

#### **DPM ROUTE**

The DPM route was designed to measure the driving performance of the older drivers associated with maneuvers often involved in elderly-driver accidents at intersections. The route was laid out along in Omaha, Nebraska. It had a total of seven locations at which driving performance was evaluated. Five of the locations involved left turns, one involved a right turn, and the other involved travel on a residential street, which involved approaches to two uncontrolled intersections and one right turn at a stop-sign controlled intersection. Four of the left-turn locations were at signalized four-leg intersections on four-lane divided arterial streets at which the left turns were made from left-turn lanes. Three of the four left turns were controlled by protected/permitted phasing and the fourth by permitted phasing. The fifth left turn was at an unsignalized T-intersection on a four-lane divided arterial street intersecting a four-lane undivided arterial street at which the left turn maneuver was made from a left-turn lane. The right turn was at a signalized intersection of two four-lane divided arterial streets. The total length of the route was 12 miles. The route began and ended at Immanuel Hospital. A map of the route is shown in Figure 3-1. A brief description of the seven test locations follows.

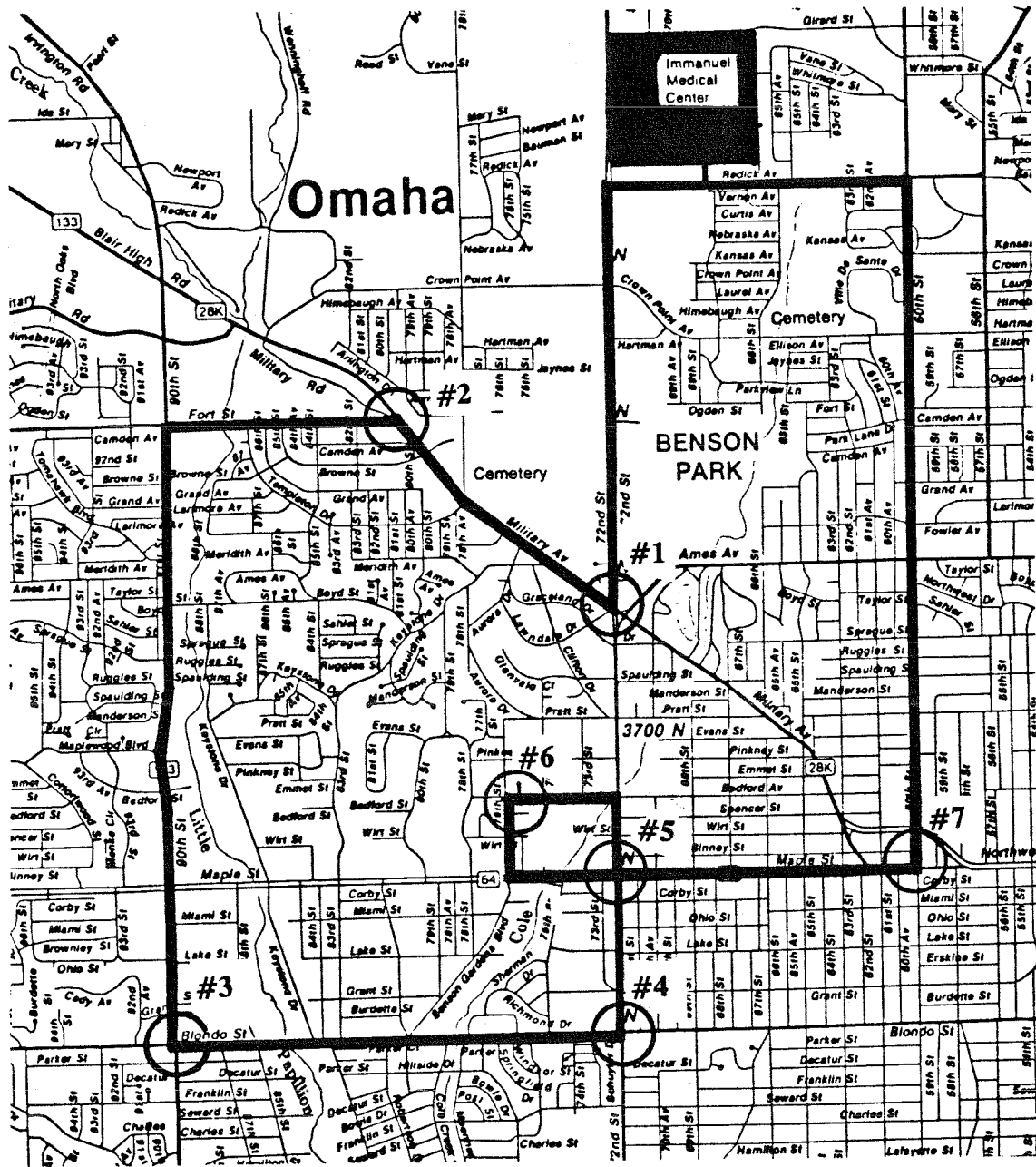


Figure 3-1. DPM route.

### **#1 - 72nd and Military**

The first location where drivers were evaluated was 72nd and Military Streets. The test sequence was a right turn from the southbound approach on 72nd Street. Both roadways were 4-lane divided arterial streets with speed limits of 40 mph. The southbound approach on 72nd Street had a left-turn lane which was controlled by protected/permitted left-turn signal phase, two through lanes, and a channelized right-turn lane.

### **#2 - Military and Fort**

The second test location on the route was at the intersection of Military and Fort Streets. The test sequence was a left turn from the northbound approach on Military Street. Military Street was a 4-lane divided arterial street, and Fort Street was a 4-lane undivided arterial street. Both roadways had a speed limit of 40 mph. The intersection was a T-intersection with Fort Street teeing into Military Street. The intersection was unsignalized with stop-sign control on eastbound approach on Fort Street. The northbound approach on Military Street had a left-turn lane.

### **#3 - 90th and Blondo**

The third test location was at 90th and Blondo Streets. The test sequence was a left turn from the southbound approach on 90th Street to the eastbound direction on Blondo Street. Blondo Street was a 4-lane undivided arterial street with a speed limit of 35-mph, and 90th Street was a 4-lane divided arterial street with a speed limit of 40 mph. All of the intersection approaches had left-turn lanes which were controlled by protected/permitted left-turn signal phasing except on the southbound approach which had a permitted left-turn signal phase.

### **#4 - 72nd and Blondo**

The fourth test location was at the intersection of 72nd and Blondo Streets. At this intersection, a left turn from eastbound on Blondo Street to northbound on 72nd Street was evaluated. Blondo Street was a 4-lane undivided arterial street with a speed limit of 35 mph, and 72nd Street was a 4-lane divided arterial street with speed limit of 40 mph. All of the intersection approaches had left-turn lanes which were controlled by protected/permitted left-turn signal phasing.

### **#5 - 72nd and Maple**

The fifth test location was at 72nd and Maple Streets, where a left turn from the northbound approach on 72nd Street to the westbound direction on Maple Street was evaluated. Both roadways were 4-lane divided arterial streets with 40-mph speed limits. All of the intersection approaches had left-turn lanes, which were controlled by protected/permitted left-turn signal phasing.

### **#6 - 76th and Spencer**

The sixth test location was in a residential area. The three maneuvers were evaluated in this test sequence: (1) the approach on northbound 76th Street to the T-intersection of 76th and Spencer Streets, at which Spencer Street teed into 76th Street from the right, (2) the approach on eastbound Spencer Street to the T-intersection of 75th and Spencer Streets at which 75th Street teed into Spencer Street from the left, and (3) the eastbound approach on Spencer Street and right turn onto southbound 72nd Street at the intersection of 72nd and Spencer Streets. The northbound approach on 76th Street in the first maneuver and the eastbound approach on Spencer Street in the second maneuver were uncontrolled approaches. The eastbound approach to 72nd and Spencer Streets in the third maneuver was stop-sign controlled. Spencer, 75th, and 76th Streets were residential streets with speed limits of 25 mph. However, 72nd Street was a 4-lane divided arterial street with a 40-mph speed limit.

### **#7 - 60th and Maple**

The seventh location was at 60th and Maple Streets located in the outlying business district of Benson. A left turn from eastbound approach on Maple Street to northbound 60th Street was evaluated. Maple Street was a 3-lane arterial street through Benson, and 60th Street was a 2-lane arterial street. The westbound and eastbound approaches on Maple Street had left-turn lanes with permitted left-turn signal phasing. The northbound and southbound approaches on 60th Street did not have left-turn lanes. The speed limit on both streets was 30 mph.

## **EVALUATION PROCEDURE**

The DPM technique was used to evaluate the driving performance of the subjects. The evaluation was done by a certified driver education expert trained in the DPM technique. The evaluator scored the driving performance of the subjects while riding with them in the front

passenger seat of their vehicles. In order to prevent biased evaluations, the evaluator did not know to which study groups the subjects had been assigned.

The seven locations on the DPM route where driving performance of the subjects was evaluated were referred to as sequences. Each sequence was divided into three segments as shown in Table 3-1. For the six sequences involving turning maneuvers, the segments were: (1) the approach, (2) the turn, and (3) the acceleration and tracking after the turn. The residential sequence consisted of three different individual segments within the area. Two of the segments were approaches to uncontrolled intersections and the third segment was a right turn at a stop-sign controlled intersection.

Table 3-1. Sequences and segments on DPM route.

Sequence	Intersection	Maneuver	Segment
1	72nd & Military	Right Turn	1.1 - Approach to Military 1.2 - Right Turn on Military 1.3 - Acceleration & Tracking
2	Military & Fort	Left Turn	2.1 - Approach to Fort 2.2 - Left Turn on Fort 2.3 - Acceleration & Tracking
3	90th & Blondo	Left Turn	3.1 - Approach to Blondo 3.2 - Left Turn on Blondo 3.3 - Acceleration & Tracking
4	90th & Maple	Left Turn	4.1 - Approach to 72nd 4.2 - Left Turn on 72nd 4.3 - Acceleration & Tracking
5	72nd & Maple	Left Turn	5.1 - Approach to Maple 5.2 - Left Turn on Maple 5.3 - Acceleration & Tracking
6	76th & Spencer	Residential Driving	6.1 - Uncontrolled T @ Spencer 6.2 - Uncontrolled T @ 75th 6.3 - Approach & Turn on 72nd
7	60th & Maple	Left Turn	7.1 - Approach to 60th 7.2 - Left Turn on 60th 7.3 - Acceleration & Tracking

Each segment was scored using search, speed control, and direction control criteria. These criteria included a check of the following driver behaviors:

1. Search while approaching an intersection.
2. Search while waiting to make a turn.
3. Search when changing lanes.
4. Use of mirrors when necessary.
5. Head movements to check blind spots.
6. Tracking in the correct lane.
7. Tracking in a left-turn bay.
8. Tracking on a through lane.
9. Speed adjustment when approaching an intersection.
10. Use of vehicle turning signals.
11. Waiting for vehicle/pedestrian clearance when turning.
12. Deceleration when stopping at an intersection.
13. Acceleration to match traffic speed after completing a turn.
14. Keeping vehicle in proper lane while turning.
15. Reaction to traffic signal indications when turning.
16. Speed control between intersections.
17. Stopping position on intersection approach.
18. Braking while stopping.
19. Adjusting to traffic from the rear.
20. Following distances.
21. Gap acceptance.

The forms used to score the DPM are shown in Appendix C.

The search, speed control, and direction control were each scored as either satisfactory or unsatisfactory. One point was given for satisfactory performance and zero points were given for unsatisfactory performance. Therefore, a total of three points (one each for search, speed control, and direction control) was possible for a segment. Since each sequence had three segments, the maximum score for a sequence was nine.

In addition to search, speed control, and direction control scores, the evaluator also gave a score for the overall performance of the subject on each segment. One point was given for satisfactory performance and zero points were given for unsatisfactory performance. A total overall score for the entire DPM route was computed by adding the three overall segment scores for all seven sequences. Therefore, the maximum overall DPM route score was 21.



The DPM tests were conducted during the off-peak hours between 9:00 am and 3:00 pm on Monday through Saturday. The subjects drove their own vehicles so that the DPM scores would not be influenced by the subjects being unfamiliar with the vehicles they drove during the tests. In order to improve the reliability of the test scores, each subject drove around the DPM route twice and the mean of the two DPM scores was used in the data analysis. All of the subjects were familiar with the streets on the DPM route.

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2. F.E. Vandosall and M.D. Rudisill. The New Michigan Driver Performance Test. Proceedings of the American Association for Automotive Medicine. Louisville, Kentucky. October, 1979.

## Chapter 4

### COUNTERMEASURES

During the first year of the research, four basic countermeasures were identified for improving the safety of elderly drivers: (1) physical therapy, (2) perceptual therapy, (3) driver education, and (4) engineering improvements. The countermeasures were designed to address the problems of older drivers that were determined as a result of the accident data analysis and the assessments the driving knowledge and abilities of older drivers conducted during the first year of the research. In addition, the results of the review of the literature and current practice relative to methods of improving the safety of older drivers were also considered in the design of the countermeasures. The specific countermeasures demonstrated and evaluated during the second year of the research are described in this chapter.

#### PHYSICAL THERAPY

The physical therapy was a set of self-administered, home-based exercises designed to improve posture, trunk rotation, neck flexibility, and shoulder flexibility. The therapy consisted of seven exercises designed by Pat Hageman, Director of Physical Therapy Education at the University Medical Center. The exercises were to be done four times per week for 8 weeks. Prior to the start of their exercise program, the subjects were given a one-hour training session by physical therapists at the University of Nebraska Medical Center. During the training session, the subjects practiced all of the exercises. Also, they were given brochures containing instructions for doing the exercises and diaries in which to record the dates on which they did the exercises. The subjects were encouraged to contact the physical therapists whenever they had any questions. After 4 weeks, the physical therapists contacted the subjects to check on their progress and answer any questions. A brief description of the seven exercises follows.

#### Chin Flexion and Extension

This exercise was designed to improve neck flexion and extension. It is illustrated in Figure 4-1. The instructions for doing the exercise were:

1. Keep your head facing forward.
2. Bend head forward, touching chin on chest and hold for 5 seconds.
3. Tilt head backward, until forehead is parallel to the ceiling, or as far back as possible, and hold for 5 seconds.

This exercise was to be repeated five times.



Figure 4-1. Chin flexion and extension exercise.

### Neck Rotation

This exercise was designed to improve neck rotation. It is illustrated in Figure 4-2. The instructions for doing the exercise were:

1. Turn neck as far to the right as possible and hold for 5 to 10 seconds.
2. Turn neck as far to the left as possible and hold for 5 to 10 seconds.

This exercise was to be repeated five times.

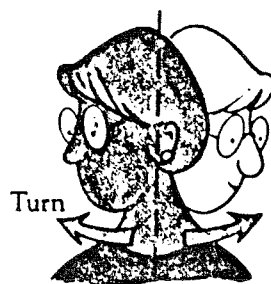


Figure 4-2. Neck rotation exercise.

### **Side Bending**

This exercise was designed to improve the lateral bending of the neck. It is illustrated in Figure 4-3. The instructions for doing the exercise were:

1. Look straight ahead.
2. Tilt head to the left as if trying to touch your ear to your left shoulder and hold for 5 to 10 seconds.
3. Tilt head to the right as if trying to touch your ear to your right shoulder and hold for 5 to 10 seconds.

This exercise was to be repeated five times.



Figure 4-3. Side bending exercise.

### **Chin Tucks**

This exercise was designed to improve the flexion and extension of the neck. It is illustrated in Figure 4-4. The instructions for doing the exercise were:

1. Nod your head slightly forward.
2. Glide your neck backward, aligning your ears perpendicular to your shoulders and hold for 5 to 10 seconds.

This exercise was to be repeated ten times.

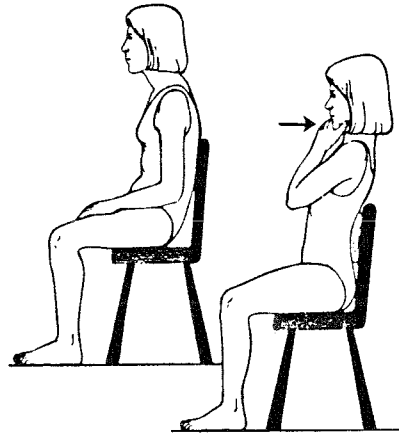


Figure 4-4. Chin tuck exercise.

### **Shoulder Back**

This exercise was designed to improve shoulder flexibility. It is illustrated in Figure 4-5. Instructions for doing the exercise were:

1. Sit up straight in a chair.
2. Move shoulders forward as far as possible.
3. Bring shoulders backward as far as possible.

This exercise was to be repeated ten times.

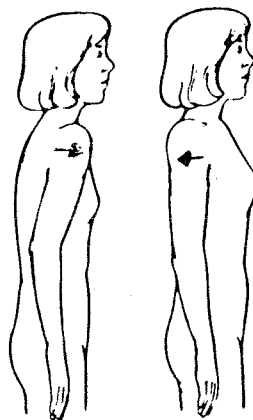


Figure 4-5. Shoulder back exercise.

## **Trunk Rotation**

This exercise was designed to improve trunk rotation. It is illustrated in Figure 4-6. Instructions for doing the exercise were:

1. Rotating from the waist, slowly twist to the left and hold for 5 to 10 seconds.
2. Return to the forward position.
3. Rotating from the waist, slowly twist to the right and hold 5 to 10 seconds.

This exercise was to be repeated five times.

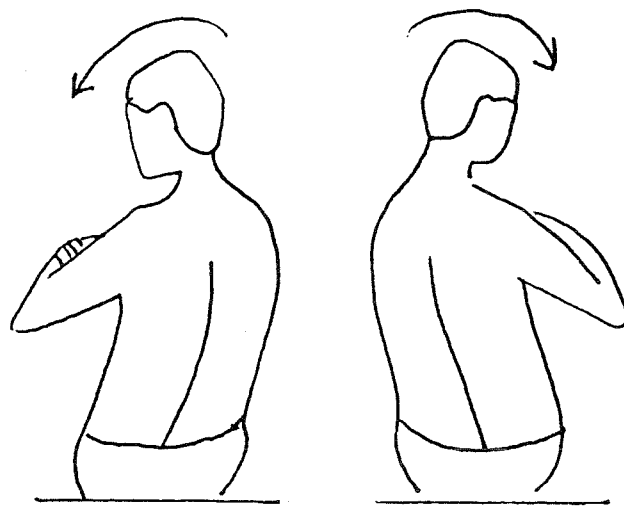


Figure 4-6. Trunk rotation exercise.

## **Standing Arm Lift**

This exercise was designed to improve shoulder flexibility. It is illustrated in Figure 4-7. Instructions for doing the exercise were:

1. Bring your arms out to your side with elbows bent.
2. From this position, slowly slide your arms overhead as you straighten your elbows.
3. Slide your arms down to the starting position.

This exercise was to be repeated ten times.

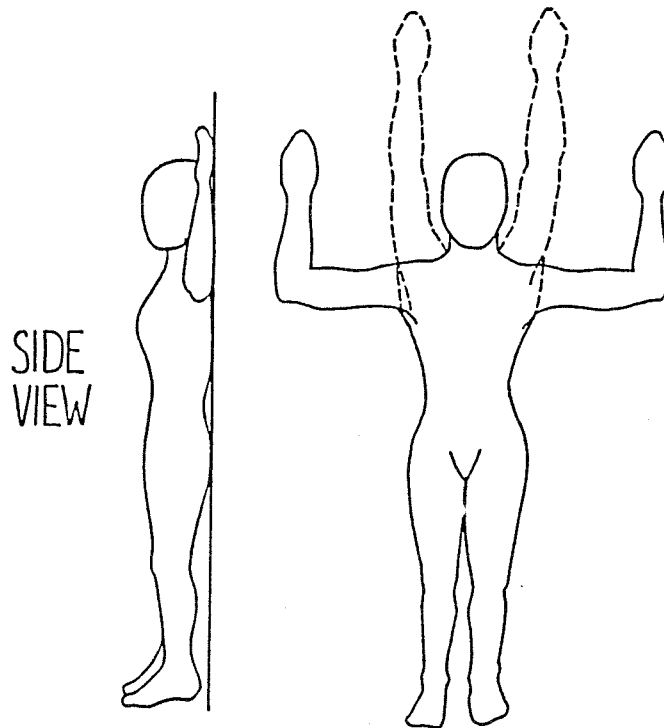


Figure 4-7. Standing arm lift exercise.

## **PERCEPTUAL THERAPY**

The perceptual therapy was a set of self-administered, home-based exercises designed to improve the following five components of visual perception: (1) spatial relationships, (2) visual discrimination, (3) figure-ground, (4) visual closure, and (5) visual memory. The therapy consisted of 568 exercises designed by Jill Moon, Occupational Therapist at the Rehabilitation Center of Immanuel Hospital in Omaha, Nebraska. The exercises were to be done for 20 minutes four times per week for 8 weeks. Prior to the start of their exercise program, the subjects were given a one-hour training session by Jill Moon at the Immanuel Rehabilitation Center. During the training session, the subjects practiced the exercises for each of the five components of visual perception. The subjects were given workbooks which contained the



exercises and instructions for doing them. They were also given diaries in which to record the dates on which they did the exercises. The subjects were encouraged to contact the Immanuel Rehabilitation Center whenever they had any questions. After 4 weeks, the subjects were contacted to check on their progress and answer any questions.

The exercises in the workbook were organized into five sections, one for each component of visual perception. The exercises in each section of the workbook were arranged in order of degree of difficulty progressing from the simplest to the most difficult. The subjects were to do the exercises in order, spending about 4 minutes on each section during a 20-minute session. They were to do as many exercises as possible, working at their own pace, during the 8 weeks. If they completed the exercises in one of the sections before the end of the 8 weeks, they were to start the section over from the beginning. A brief description of the exercises in the five sections of the workbook follows.

### **Spatial Relationships**

Spatial relationships refers to the ability to orient one's self in space and perceive the positions of objects in relation to one's self and to other objects. The workbook contained 165 spatial relationship exercises. In these exercises, four patterns were presented and the subject was to identify the one that was in a different position than the other three. The patterns in the simpler exercises were triangles and rectangles, one of which was disoriented with respect to the other three. The more difficult exercises involved complex patterns such as pictures of animals in which only one part of the pattern was disoriented. One of the spatial relationship exercises is shown in Figure 4-8.

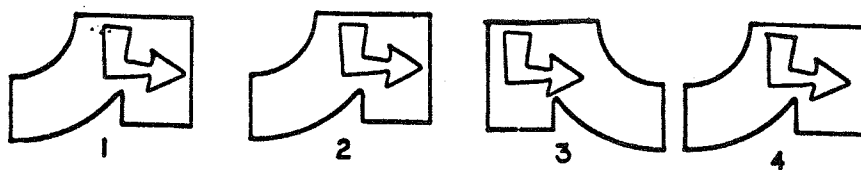


Figure 4-8. Spatial relationship exercise.

## Visual Discrimination

Visual discrimination is the ability to differentiate dominant features among different objects such as differences in position, shapes, form, and colors. The workbook contained 124 visual discrimination exercises. In these exercises, four figures were presented and the subject was to determine which of the three on the right match the one on the left. The figures in the easier exercises were simple geometric shapes such as circles, triangles, and rectangles. The more difficult exercises involved complex shapes such as animals and machines. One of the visual discrimination exercises is shown in Figure 4-9.

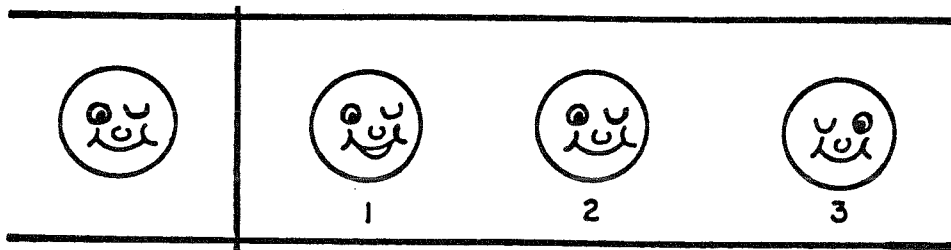


Figure 4-9. Visual discrimination exercise.

## Figure-Ground

Figure-ground is the ability to distinguish an object from its background. The figure-ground section of the workbook contained 56 exercises. In these exercises, a form and four designs are presented. The subject was to determine in which one of the four designs the form is hidden or embodied. The easier exercises involved simple forms and backgrounds. The more difficult exercises involved complex forms and backgrounds. One of the figure-ground exercises is shown in Figure 4-10.

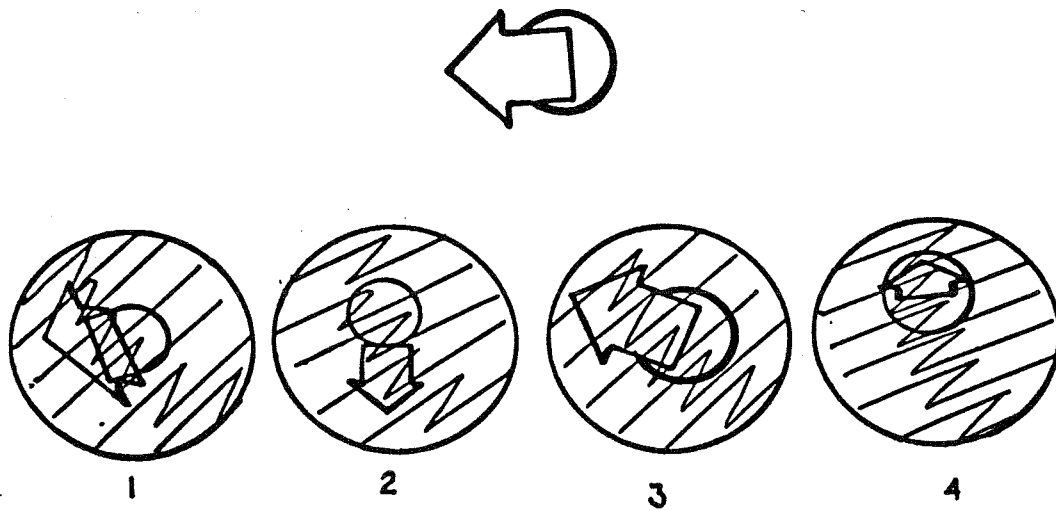


Figure 4-10. Figure-ground exercise.

**Visual Closure**

Visual closure is the ability to identify objects when only portions of them are visible. The visual closure section of the workbook contained 135 exercises. In these exercises, a completed solid-line design and four incomplete broken-line designs were presented. The subject was required to select the incomplete broken-line design that matched the complete solid-line design. The designs in the easier exercises were comprised of simple geometric shapes. Those in the more difficult exercises consisted of complex shapes. One of the visual closure exercises is shown in Figure 4-11.

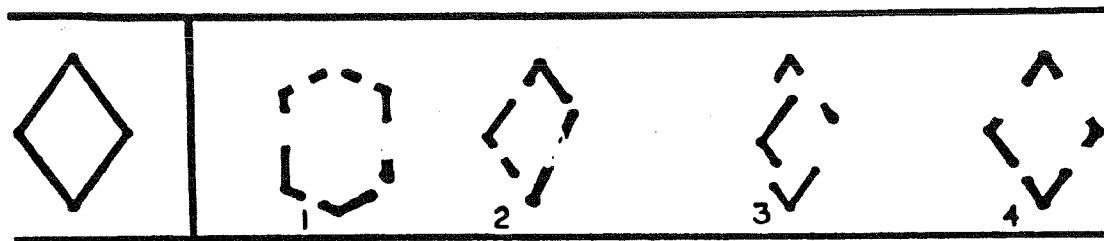


Figure 4-11. Visual closure exercise.

## Visual Memory

Visual memory is the ability to recall dominant features or sequences of objects. The workbook contained 88 visual memory exercises. The first 42 exercises required the subject to recall the dominant features of a single object. The subject was asked to memorize the features of an object presented on one page and then identify which one of the four objects on the next page matched it, without looking back at the object. The last 46 exercises required the subject to recall a sequence of objects. The subject was asked to memorize the sequence of 2, 3, or 4 objects presented on one page and then identify which one of four sequences on the next page match it, without looking back at the sequence. The easier exercises involved simple geometric shapes. The more difficult exercises involved irregular complex shapes. One of the visual memory exercises is shown in Figure 4-12.

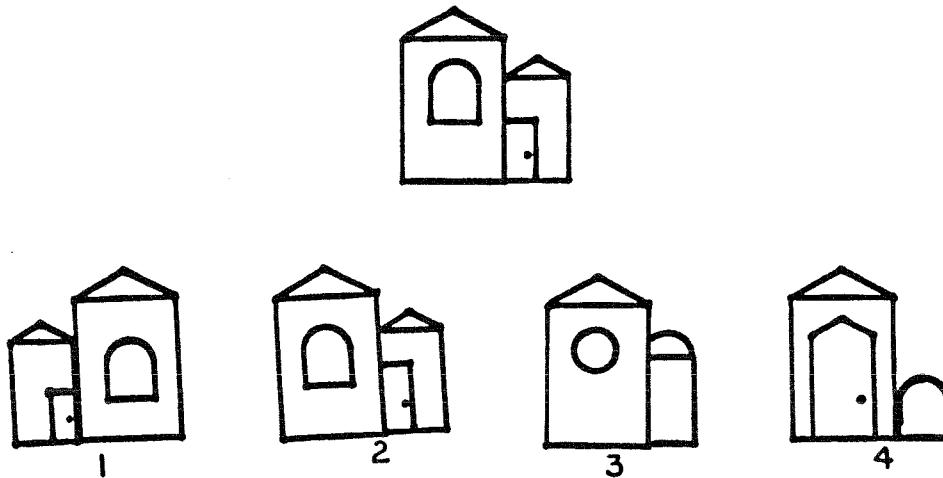


Figure 4-12. Visual memory exercise.

## **DRIVER EDUCATION**

The AAA *Safe Driving for Mature Operators* course was selected during the first year of the research as the driver education countermeasure to be evaluated during the second year of the research. This course was selected because it provided adequate coverage of the information needed to address the driving knowledge deficiencies of older drivers and it was one of the lowest cost older driver programs available. The course was taught by one of the officers of the Nebraska State Highway Patrol who normally teaches the AAA course in Omaha, Nebraska. The class was held in the Holling Center at Immanuel Hospital in Omaha, Nebraska. The course consisted of 8 hours of classroom instruction presented in one day.

Each subject received a course manual [1] which covered the information presented by the course instructor. The manual contained eight chapters. A summary of the driving knowledge presented in each chapter follows.

### **Chapter 1 - Introduction**

Chapter 1 provides an introduction to the course. It discusses the positive and negative effects of aging on the safety and performance of older drivers. The importance of quick reflexes and how they are affected by aging is explained. A do-it-yourself reflex test is presented to enable the subjects to get some idea of the quickness of their own reflexes. Also, the importance of proper adjustment of the driver's seat is discussed and how to adjust it properly is explained. The chapter concludes with 10 questions about safe driving to demonstrate the need for taking the course.

### **Chapter 2 - Seeing**

Chapter 2 covers visual searching techniques and sight distance problems. Methods of scanning the roadway and rules for approaching intersections are presented. The elimination of blind spots and the use of rear view mirrors are explained. Procedures for dealing with vision problems associated with backing, parallel parking, wearing glasses, and night driving are presented. A quick self-test of visual acuity is also included so that subjects can get some idea of their visual acuity. The chapter concludes with 10 review questions about the information presented in the chapter.

### **Chapter 3 - Communicating**

Chapter 3 discusses communication with other drivers and the meaning of some of the most confusing traffic control devices. The proper uses of headlights, horn, emergency signals, and turn signals are explained. The meanings of signs, signals, and pavement markings associated with left-turn lanes, restricted lanes, reversible lanes, and two-way left-turn lanes are presented. Also, the meanings of the standard shapes of traffic signs are explained. The chapter concludes with 10 review questions about the information presented in the chapter.

### **Chapter 4 - Adjusting Speed**

Chapter 4 discusses the subject of selecting a safe speed and dealing with faster moving traffic. The effects of roadway and traffic conditions on safe speeds and the relationship between speed and sight distance are described. The roles of speed limits and warning signs are explained. The proper methods of entering and exiting expressways are also explained. The chapter concludes with 10 review questions about selecting a safe speed.

### **Chapter 5 - Margin of Safety**

Chapter 5 deals with the subject of maintaining margins of safety. The principles of safe following distances, adequate lateral clearances, and adjusting to traffic from behind are presented. Procedures for making proper turns, accepting adequate gaps, and safe passing maneuvers are described. The chapter concludes with 10 review questions about margins of safety.

### **Chapter 6 - Driving Emergencies**

Chapter 6 discusses driving emergencies. The arguments for and against the use of seat belts are presented and the proper use of seat belts is explained. Procedures for stopping, turning, and accelerating quickly to avoid collisions are described. Driving on slippery road surfaces and protecting oneself in a collision are also discussed. The chapter concludes with 10 review questions on emergency driving procedures.

## **Chapter 7 - Your Car**

Chapter 7 covers automobile and preventive maintenance. The chapter describes the primary systems of the automobile and explains why and how they should be checked and maintained. A preventive maintenance checklist is presented. The checklist indicates why, what, and when to check several parts of the automobile including: headlights, brake and signal lights, windows and windshield, tires, brakes, steering, suspension, exhaust, windshield wipers, engine, cooling system, oil, and oil filter. The chapter concludes with 10 questions on the automobile and preventive maintenance.

## **Chapter 8 - You the Driver**

Chapter 8 discusses the physical and mental condition of the driver. It describes the effects of alcohol, drugs, fatigue, and emotional stress on driving performance. The chapter concludes with 10 review questions on the information presented in the chapter.

## **ENGINEERING**

The engineering countermeasures were incorporated into the DPM route at the seven locations at which driving performance was evaluated. Because the DPM route was designed to measure the driving performance of the subjects relative to the maneuvers often involved in elderly-driver accidents at intersections, the engineering countermeasures were designed to improve the performance of older drivers in making these maneuvers. Therefore, engineering countermeasures were installed to facilitate left-turn maneuvers at five of the locations, right-turn maneuvers at one location, and the approach to an uncontrolled intersection at the other location. The countermeasures were limited to signs, pavement markings, and traffic signal displays because of the time and budget constraints of the research. The countermeasures were selected to address the particular operational and safety problems observed at each location. These problems were reviewed with the traffic engineering staff of the City of Omaha to determine the most appropriate countermeasures for each location. The final selection was made in cooperation with the City Traffic Engineer, Michael N. Gorman, who approved the installation of each countermeasure. The following is a description of the engineering countermeasures installed at the seven locations on the DPM route where driving performance was evaluated.

### **#1 - 72nd and Military**

The right turn from southbound 72nd Street to westbound Military Street was the maneuver evaluated at this location on the DPM route. The engineering countermeasure was a painted extension on the right-turn channelization nose for the southbound approach. Observations of traffic operations at this location indicated that some right-turning drivers did not see the right-turn channelization far enough in advance to avoid making erratic maneuvers to complete their right turns. Some of the rearend accidents experienced on this approach may have been caused by these erratic right-turn maneuvers. The improved delineation was designed to eliminate these erratic maneuvers. A before-and-after photograph of the installation is shown in Figure 4-13.

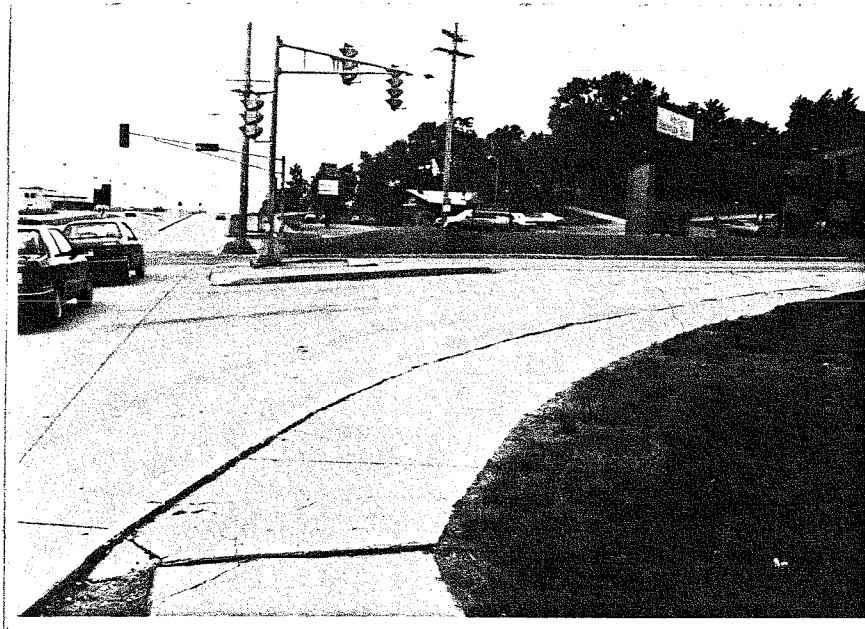
### **#2 - Military and Fort**

The left turn from northbound Military Street to westbound Fort Street was the maneuver evaluated at this location on the DPM route. The engineering countermeasure was a larger street-name sign on the northbound approach to Fort Street. The accident experience at this location indicated a relatively high frequency of left-turn accidents on the northbound approach. The intersection was an uncontrolled T-intersection which made the intersection difficult to see from the northbound approach on Military Street. This problem could have caused the attention of drivers to be diverted so that they may not have seen the opposing traffic through which they were to turn. A before-and-after photograph of this installation is shown in Figure 4-14.

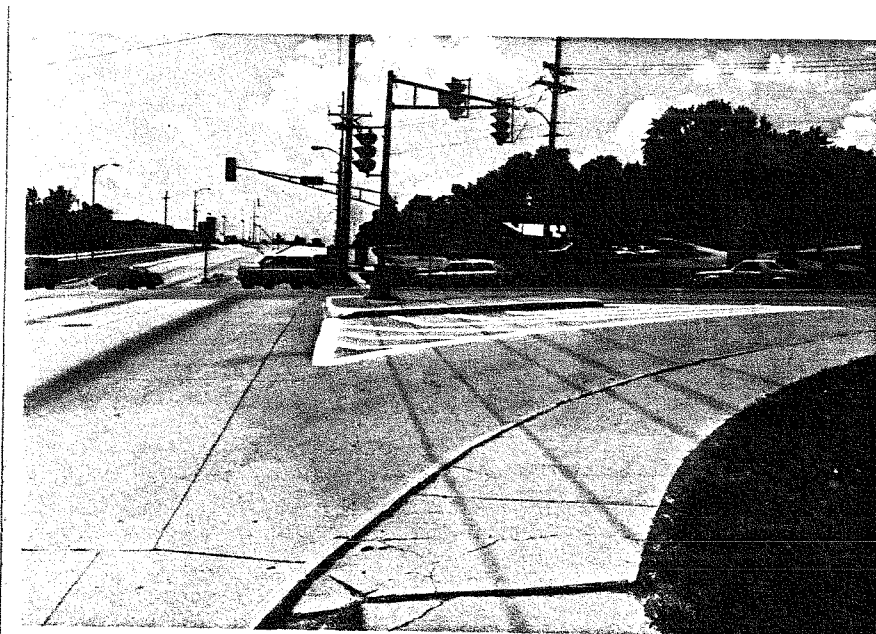
### **#3 - 90th and Blondo**

The left turn from southbound 90th Street to eastbound Blondo was the maneuver evaluated at this location on the DPM route. The accident experience indicated that there was a left-turn accident problem on both the northbound and southbound approaches on 90th Street. Both approaches were on a crest vertical curve which created a sight-distance restriction for left-turning drivers. This problem was compounded when vehicles were present in the opposing left-turn lane. Therefore, to increase the sight distance for the left-turn vehicles, the left-turn lane line was widened from 6 inches to 2 feet on the northbound and southbound approaches, leaving a 9-foot left-turn lane. This countermeasure was intended to improve the lateral positioning of the left-turn vehicles by moving them closer to the median and provide a positive offset between the left-turning vehicles and greater sight distance for the left-turn movement. A before-and-after photograph of the installation is shown in Figure 4-15.



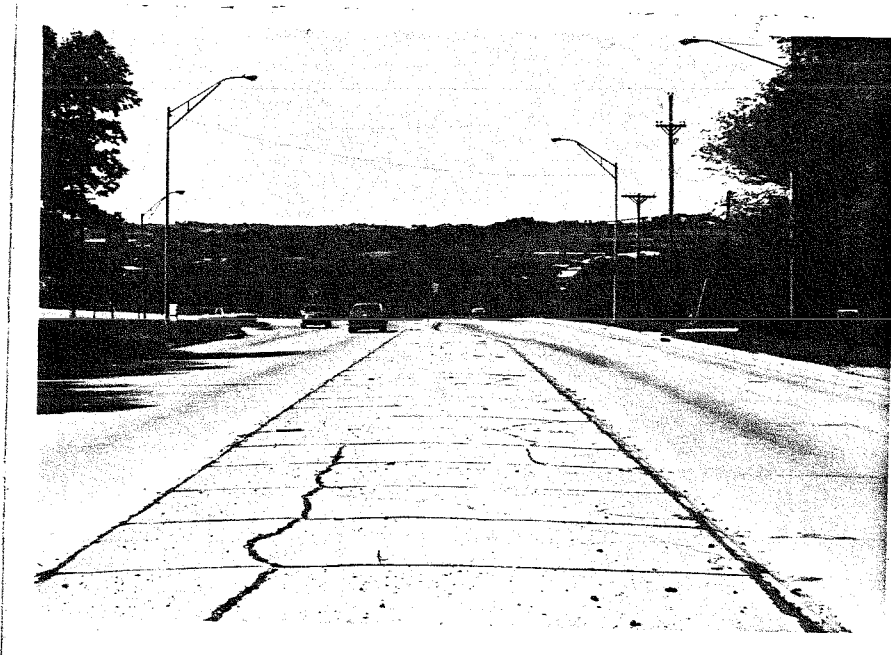


a. Before installation of countermeasure.

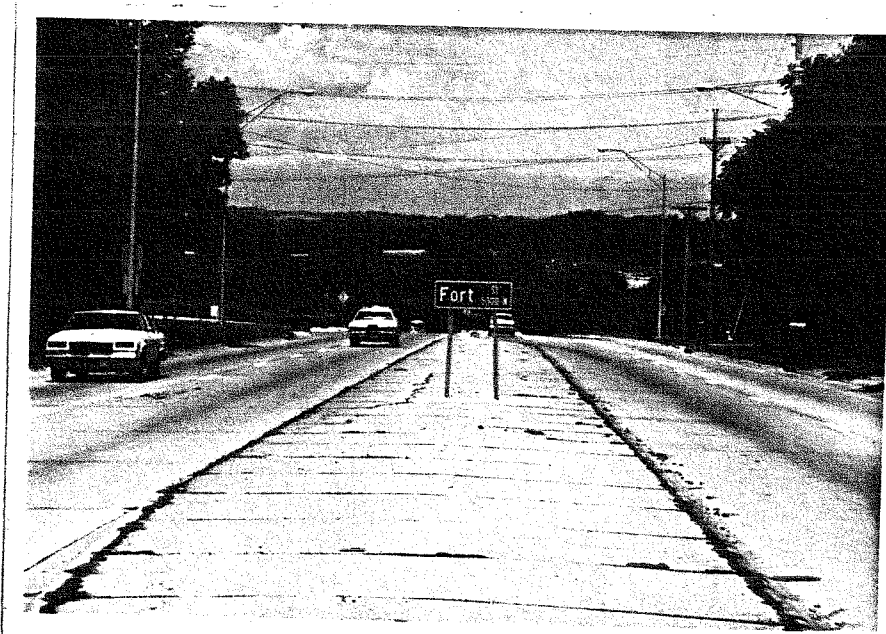


b. After installation of countermeasure.

Figure 4-13. Right-turn channelization at 72nd and Military.

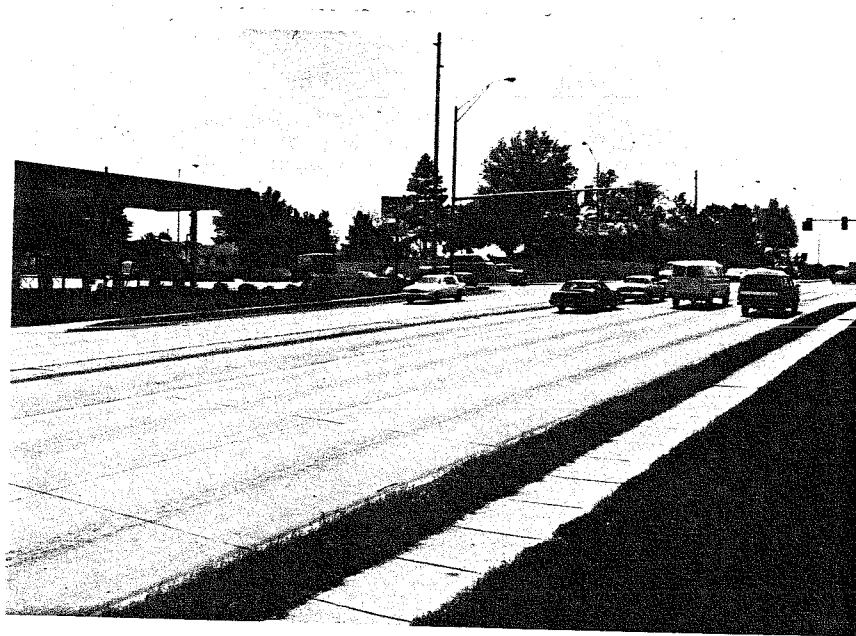


a. Before installation of countermeasure.

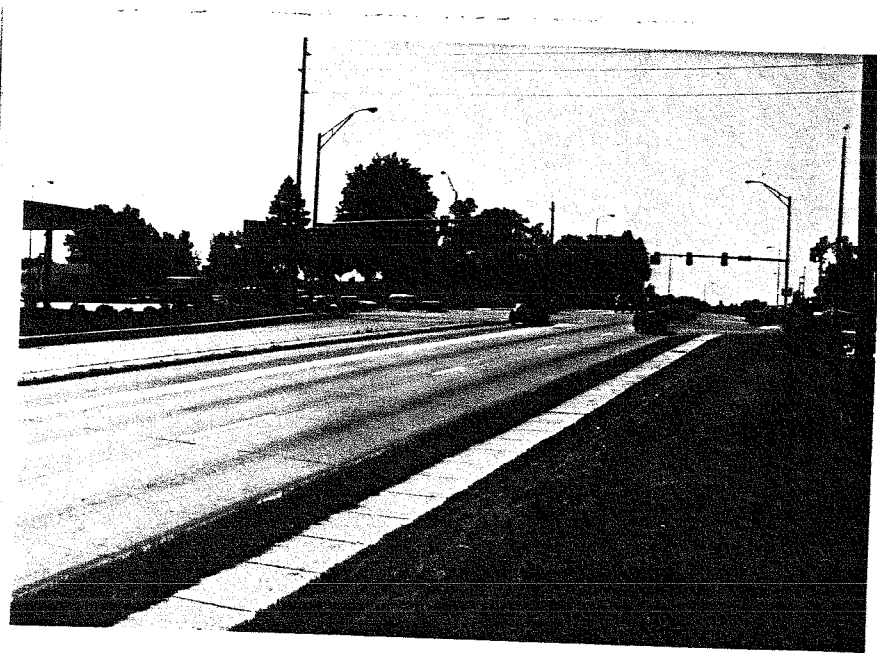


b. After installation of countermeasure.

Figure 4-14. Street name sign at Military and Fort.



a. Before installation of the countermeasure.



b. After installation of the countermeasure.

Figure 4-15. Wider left-turn lane line at 90th and Blondo.

#### **#4 - 72nd and Blondo**

The left turn from eastbound Blondo Street to northbound 72nd Street was the maneuver evaluated at this location on the DPM route. The accident pattern and observations of traffic operations indicated that there were two problems experienced by drivers making this left-turn maneuver. Therefore, two engineering countermeasures were used in combination to help the left-turn drivers on the eastbound approach at 72nd and Blondo Streets.

The first countermeasure was replacing the left-turn signal head with a 5-section left-turn signal head. The existing left-turn signal head was 4-section head which seemed to confuse drivers. Drivers often stopped at the stopline on the red displayed after the protected left-turn phase and did not expect a permitted left-turn phase to follow, which could contribute to rear-end collisions in the left-turn lane. A before-and-after photograph of this installation is shown in Figure 4-16.

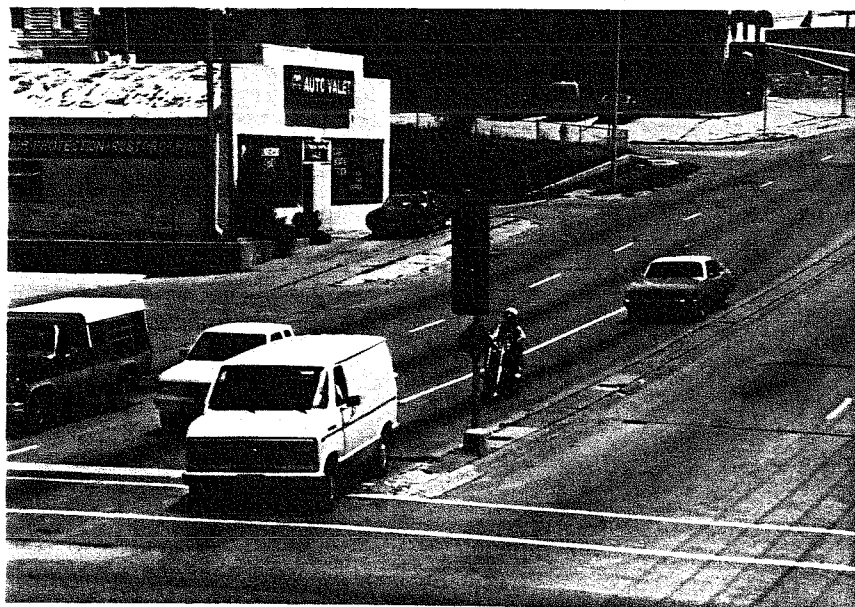
The second countermeasure was painting skip lines through the intersection to indicate the proper path for the left-turn vehicles. In addition, a solid lane line was painted on 72nd Street to separate the left-turn vehicles from the opposing right-turn vehicles. Observations of traffic operations and the accident experience indicated that vehicles turning from Blondo Street to northbound 72nd Street often turned into the wrong lane with a high number of accidents involving collisions between the left-turn and opposing right-turn vehicles. A before-and-after photograph of this countermeasure is shown in Figure 4-17.

#### **#5 - 72nd and Maple**

The left turn from northbound 72nd Street to westbound Maple Street was the maneuver evaluated at this location on the DPM route. The accident pattern indicated that a relatively high number of collisions between vehicles making this left turn and opposing through vehicles. Also, observations of traffic operations found that vehicles making this left turn and opposing right-turn vehicles often turned into the wrong lane. Therefore, two engineering countermeasures were used in combination to help the left-turn drivers on the northbound approach.

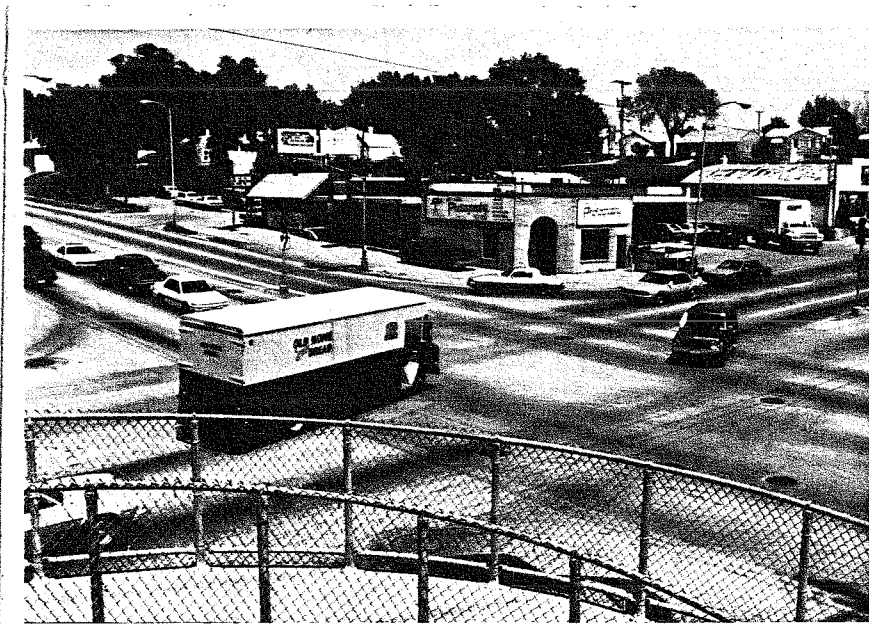


a. Before installation of the countermeasure.

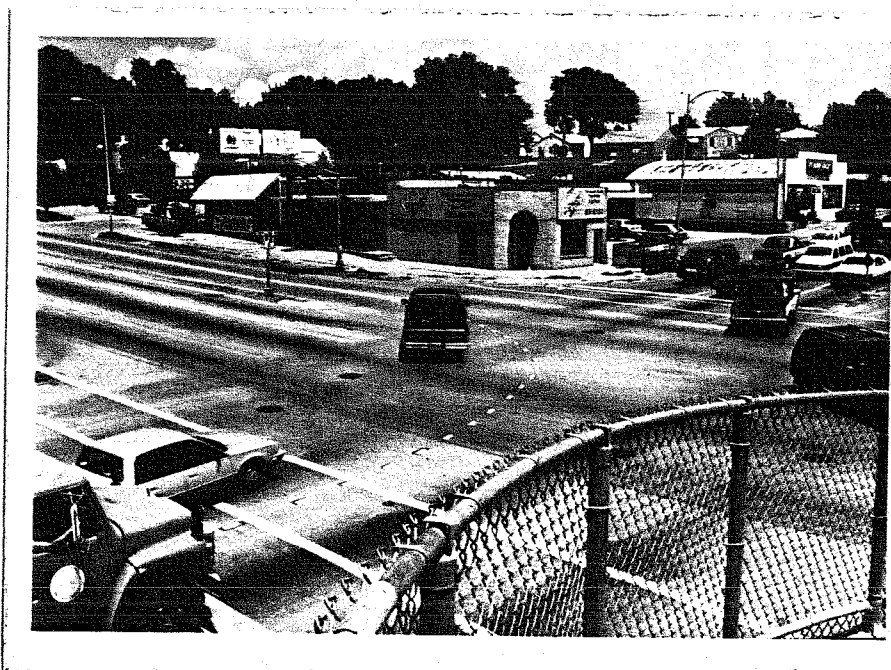


b. After installation of the countermeasure.

Figure 4-16. Left-turn signal at 72nd and Blondo.



a. Before installation of the countermeasure.



b. After installation of the countermeasure.

Figure 4-17. Skip lines and solid lane line at 72nd and Blondo.

The first countermeasure was to replace the far-left 3-section signal head with a 5-section far-left signal head, which put the signal more directly in the left-turn drivers' field of view while searching for acceptable gaps in the opposing through traffic stream. Thus, during the permitted phase, the drivers could simultaneously view the signal and check for acceptable gaps in the opposing traffic without excessive head movement. A before-and-after photograph of the signal head is shown in Figure 4-18.

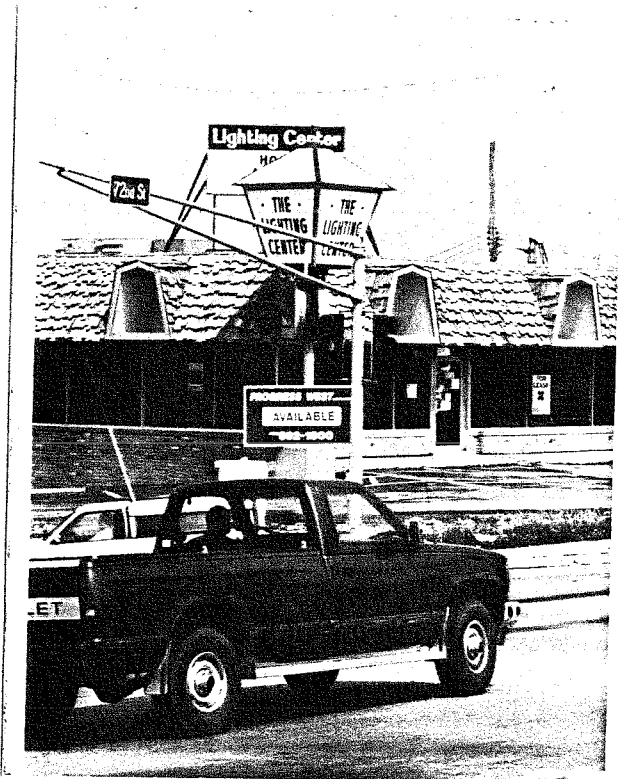
The second countermeasure installed was painting skip lines through the intersection to indicate the proper path for the left-turning vehicles and painting a solid lane line on Maple Street to separate the left-turn vehicles from the opposing right-turn vehicles. A before-and-after photograph of the countermeasure is shown in Figure 4-19.

#### **#6 - 76th and Spencer**

The approach to two uncontrolled "T" intersections and the approach and right turn at a stop-sign controlled intersection were the maneuvers evaluated at this location on the DPM route. Observations of traffic operations indicated that several drivers northbound on 76th Street passed through the uncontrolled "T" intersection at Spencer Street without looking for traffic on the cross street. Since the intersection was an uncontrolled intersection, failing to search for cross-street traffic could result in a right-angle collision. The intersection is difficult to see because of the trees along the roadway. Therefore, a T-intersection ahead sign was placed 250 feet before the intersection to warn drivers of the presence of the intersection. A before-and-after photograph of the installation is shown in Figure 4-20.

#### **#7 - 60th and Maple**

The left turn from eastbound Maple Street to northbound 60th Street was the maneuver evaluated at this location. The accident experience did not reveal a left-turn accident problem. However, observations of traffic operations indicated frequent conflicts between left-turn vehicles and pedestrians. There, a TURNING VEHICLES MUST YIELD TO PEDESTRIANS sign was installed for the left-turning vehicles on the eastbound approach to make the left-turning drivers aware of the possibility of the conflict with pedestrians and remind them of their legal obligation to yield to pedestrians in the crosswalk. A before-and-after photograph of this installation is shown in Figure 4-21.



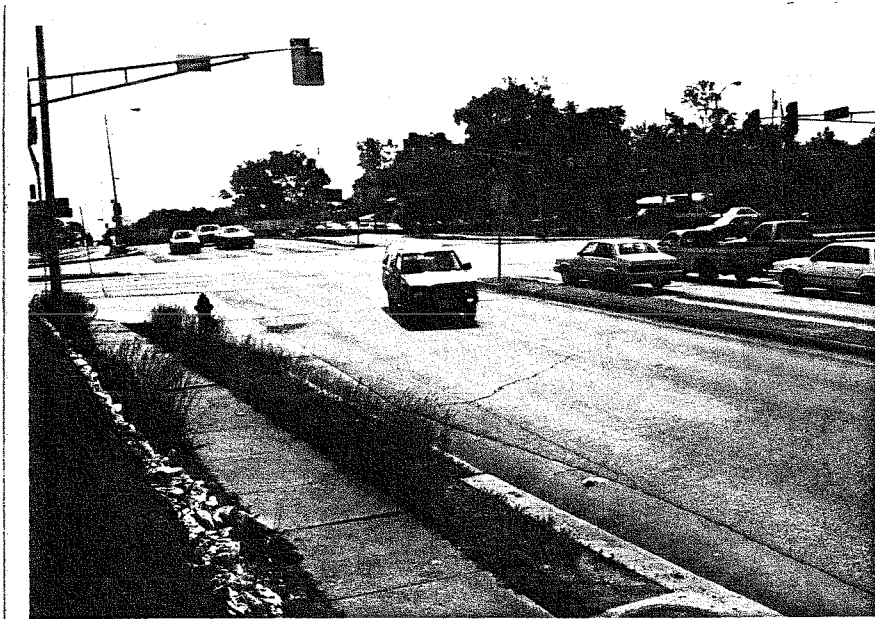
a. Before installation of countermeasure.



b. After installation of countermeasure.

Figure 4-18. Left-turn signal at 72nd and Maple.



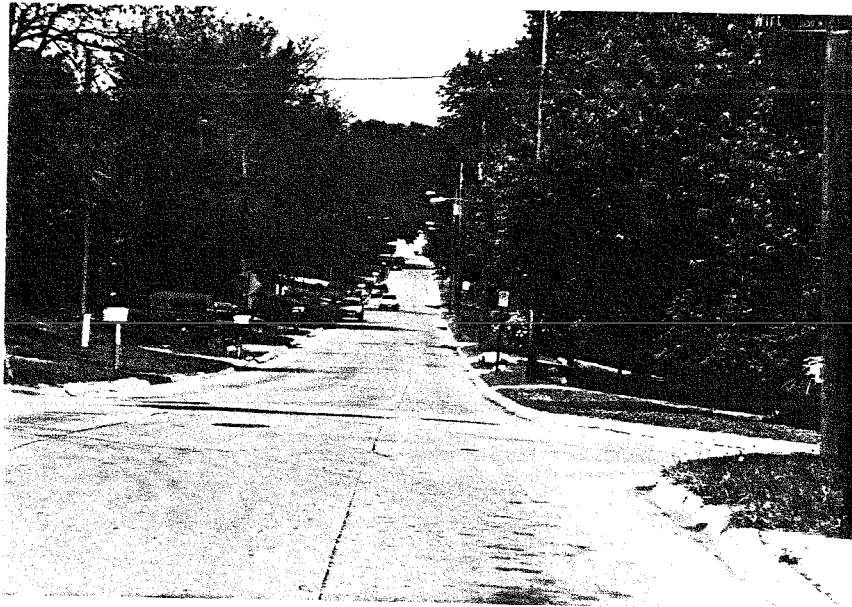


a. Before installation of countermeasure.

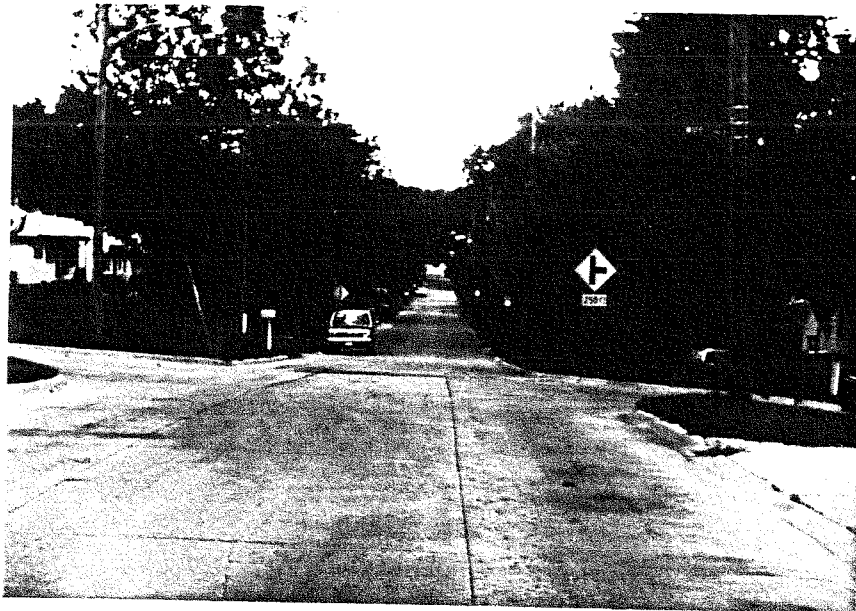


b. After installation of countermeasure.

Figure 4-19. Skip lines and solid lane line at 72nd and Maple.



a. Before installation of countermeasure.



b. After installation of countermeasure.

Figure 4-20. T-intersection ahead warning sign at 76th and Spencer.



a. Before installation of countermeasure.



b. After installation of countermeasure.

Figure 4-21. YIELD TO PEDESTRIANS sign at 60th and Maple.

## REFERENCES

1. Safe Driving for Mature Operators. Course Manual, Driver Improvement Program. American Automobile Association, Washington, D.C. 1989.

## Chapter 5

### EVALUATION

The evaluation involved determination of both the primary and secondary effects of the countermeasures. The primary effects were defined as the changes that resulted directly from the countermeasures. The primary effects of the physical and perceptual therapies were the changes that occurred in the range of motion and visual perception of the subjects, respectively. Likewise, the primary effects of the driver education were the changes in the driving knowledge of the subjects, and the primary effects of the engineering countermeasures were the changes in the driving behavior of the subjects and traffic in general. The secondary effects were defined as the changes in the driving performance of the subjects. The primary and secondary effects of the countermeasures are examined in this chapter. In addition, a cost-effectiveness analysis of the countermeasures is presented.

### REVISED SAMPLE SIZES

A total of 105 subjects volunteered to participate in the study. The 105 subjects were given the before tests and assigned to the 12 study groups as described in Chapter 2. However, 11 of the subjects did not complete their participation in the study for various reasons. Two of the 11 subjects became ill and the others had personal business and/or scheduling conflicts that prevented them from continuing their participation in the study. Thus only 94 subjects completed study. The revised sample sizes are shown in Table 5-1.

Some of the subjects who were initially assigned to group B2, who were to receive perceptual therapy and take their second driving performance test after the engineering countermeasures had been installed on the DPM route, were inadvertently sent information about the schedule for the driver education course that was intended for the subjects in group B5, who were to receive both perceptual therapy and driver education and take their second driving performance test after the engineering countermeasures had been installed on the DPM route. Consequently, there were only four subjects left in group B2 instead of the eight originally assigned to it, and there were 11 subjects instead of nine in group B5.

There was one final change to the original experimental design shown in Table 2-2. The subjects originally assigned to the control groups A6 and B6 were combined into one control group in order to increase the sample size used to evaluate the engineering countermeasures. The driving performance of these subjects was tested three times instead of twice. The first time

their driving performance was tested was at the beginning of the study when all of the other subjects were first tested. The second time was two months later before the engineering countermeasures had been installed on the DPM route. The third time was another two months later after the engineering countermeasures had been installed. The difference between first and second DPM test scores served as the control for the study, and the difference between the second and third DPM test scores served to measure the effects of the engineering countermeasures.

Table 5-1. Revised sample sizes.

Countermeasure	Second On-Road Driving Performance Test Route <sup>a</sup>		Total
	A	B	
1 - Physical Therapy	9	9	18
2 - Perceptual Therapy	6	4	10
3 - Driver Education	8	7	15
4 - Physical Therapy and Driver Education	8	7	15
5 - Perceptual Therapy and Driver Education	8	11	19
6 - None	17		17
Total			94

<sup>a</sup> A - Before engineering countermeasures were installed.  
 B - After engineering countermeasures were installed.

## PRIMARY EFFECTS

### Physical Therapy

The primary effects of the physical therapy were evaluated by comparing the range of motion of the subjects before and after the subjects in groups A1, B1, A4, and B4 received the physical therapy. The subjects were divided into two groups. One of the groups was composed of the subjects in groups A1, B1, A4, and B4 who received physical therapy, and the other group was the rest of the subjects who did not receive physical therapy. An analysis of variance (ANOVA) was conducted to determine if there were any statistically significant differences in the 16 range-of-motion measurements between the two groups across the two testing sessions.

The means and standard deviations of the range-of-motion measurements are shown in Table 5-2. Comparison of the before and after means indicates that the pattern of changes in range of motion was similar for the two groups. The subjects who received physical therapy showed improvement in nine of the 16 range-of-motion measurements whereas those not receiving physical therapy showed improvement in eight of the measurements.

The results of the ANOVA in Table 5-3 show the significance of the effects of the two factors (group and time) and their interaction for each of the 16 range-of-motion measurements. There was only one statistically significant ( $\alpha = 0.05$ ) difference in the mean values between the two groups, which was the in-car, neck-lateral-bend-left measurement. Thus, the higher mean values shown in Table 5-2 for the subjects who did not receive physical therapy were significantly different than those for the subjects who did receive physical therapy, which simply suggests that, as a group, the subjects who did not receive physical therapy had inherently more range of motion with respect to in-car, neck lateral bend to the left. Otherwise, there were no significant differences between the two groups with respect to the range-of-motion variables.

There were seven statistically significant ( $\alpha = 0.05$ ) differences in the mean values between the two times (before and after) the measurements were taken. The higher mean values shown in Table 5-2 for the after measurements for the following five range-of-motion measurements were significantly different than the before measurements: (1) indoor neck rotation right, (2) indoor trunk rotation left, (3) indoor trunk rotation right, (4) in-car neck flexion, and (5) in-car neck extension. Likewise, the lower mean values shown in Table 5-2 for the after measurements for the following two range-of-motion measurements were significantly different than the before measurements: (1) indoor shoulder flexion left and (2) in-car neck rotation left.

Table 5-2. Range-of-motion measurements.

Range-of-Motion Measurement	Subject Receiving Physical Therapy			Subjects Not Receiving Physical Therapy		
	Before		After	Before		After
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
<b>Indoor Measurements</b>						
Neck Flexion	46.0°	11.6°	50.5°	11.5°	48.4°	12.0°
Neck Extension	44.8°	12.1°	45.0°	10.4°	48.4°	9.6°
Neck Rotation Left	60.4°	7.5°	59.9°	8.3°	62.1°	8.8°
Neck Rotation Right	60.9°	8.1°	62.6°	8.0°	59.8°	8.2°
Neck Lateral Bend Left	23.9°	6.4°	23.4°	7.2°	23.8°	8.3°
Neck Lateral Bend Right	26.9°	7.4°	27.4°	7.4°	25.9°	9.2°
Shoulder Flexion Left	163.7°	7.9°	160.8°	6.5°	164.7°	7.7°
Shoulder Flexion Right	158.8°	9.5°	158.5°	8.0°	157.5°	12.2°
Trunk Rotation Left	30.5°	9.4°	49.4°	11.5°	37.1°	11.0°
Trunk Rotation Right	30.4°	12.5°	45.5°	12.8°	34.4°	11.8°
<b>In-Car Measurements</b>						
Neck Flexion	41.1°	8.4°	44.0°	8.9°	44.2°	9.4°
Neck Extension	45.0°	11.4°	45.1°	8.2°	41.3°	9.5°
Neck Rotation Left	64.8°	11.5°	64.5°	12.7°	66.1°	9.1°
Neck Rotation Right	62.4°	12.4°	63.8°	11.7°	63.5°	10.2°
Neck Lateral Bend Left	27.4°	7.7°	25.3°	10.0°	24.3°	7.2°
Neck Lateral Bend Right	25.5°	6.3°	25.0°	7.8°	23.0°	7.4°
Sample Size	35		33		70	
					61	



Table 5-3. ANOVA of range-of-motion data.

Range-of-Motion Measurement	Factor				Interaction of Group and Time	
	Group <sup>a</sup>		Time <sup>b</sup>		F-value	P-value
	F-value	P-value	F-value	P-value		
Indoor Measurements						
Neck Flexion	0.05	0.8231	1.85	0.1773	2.20	0.1420
Neck Extension	1.52	0.2207	0.12	0.7321	2.28	0.2605
Neck Rotation Left	0.11	0.7445	0.42	0.5170	1.68	0.1989
Neck Rotation Right	0.18	0.6705	13.00	0.0005	0.25	0.6142
Neck Lateral Bend Left	0.65	0.4219	1.62	0.2059	1.34	0.2504
Neck Lateral Bend Right	2.51	0.1161	0.50	0.4828	0.08	0.7772
Shoulder Flexion Left	0.01	0.9334	6.31	0.0139	0.59	0.4449
Shoulder Flexion Right	0.00	0.9615	1.23	0.2709	0.86	0.3572
Trunk Rotation Left	0.04	0.8324	43.25	0.0001	15.74	0.0002
Trunk Rotation Right	0.33	0.5649	27.63	0.0001	8.11	0.0055
In-Car Measurements						
Neck Flexion	2.48	0.1184	4.03	0.0481	0.19	0.6612
Neck Extension	0.98	0.3235	5.26	0.0244	2.48	0.1192
Neck Rotation Left	0.61	0.4356	4.05	0.0475	7.28	0.0085
Neck Rotation Right	0.02	0.8963	3.77	0.0555	0.43	0.5145
Neck Lateral Bend Left	5.90	0.0168	3.78	0.0551	0.06	0.8096
Neck Lateral Bend Right	3.85	0.0524	.18	0.6769	0.14	0.7102

<sup>a</sup> Two groups of subjects, one received physical therapy and the other did not.

<sup>b</sup> Two times measurements were taken, one before and the other after physical therapy.

These results merely indicate that the after measurements for these seven range-of-motion variables were consistently higher, or lower, than the corresponding before measurements.

The results of the ANOVA in Table 5-3 indicate that the interaction of group and time was statistically significant ( $\alpha = 0.05$ ) for only three of the range-of-motion measurements: (1) indoor trunk rotation left, (2) indoor trunk rotation right, and (3) in-car neck rotation left. These interaction effects are illustrated in Figures 5-1, 5-2, and 5-3, respectively. Figures 5-1 and 5-2 indicate that the subjects who received physical therapy experienced significantly greater improvements in trunk rotation than the improvements in trunk rotation experienced by the subjects who did not receive physical therapy. Figure 5-3 shows that the reduction in neck rotation to the left experienced by the subjects who received physical therapy was significantly less than that experienced by those who did not receive physical therapy. Therefore, the physical therapy was effective in improving trunk rotation and minimizing the reduction in neck rotation to the left.

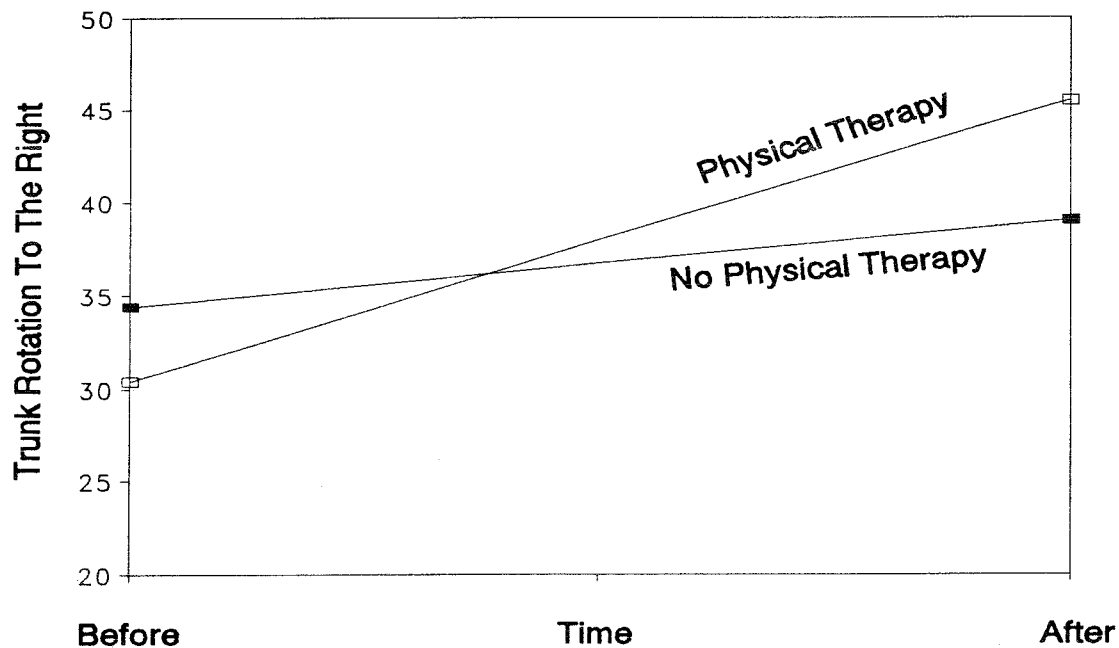


Figure 5-1. Primary effect of physical therapy on trunk rotation to the left.

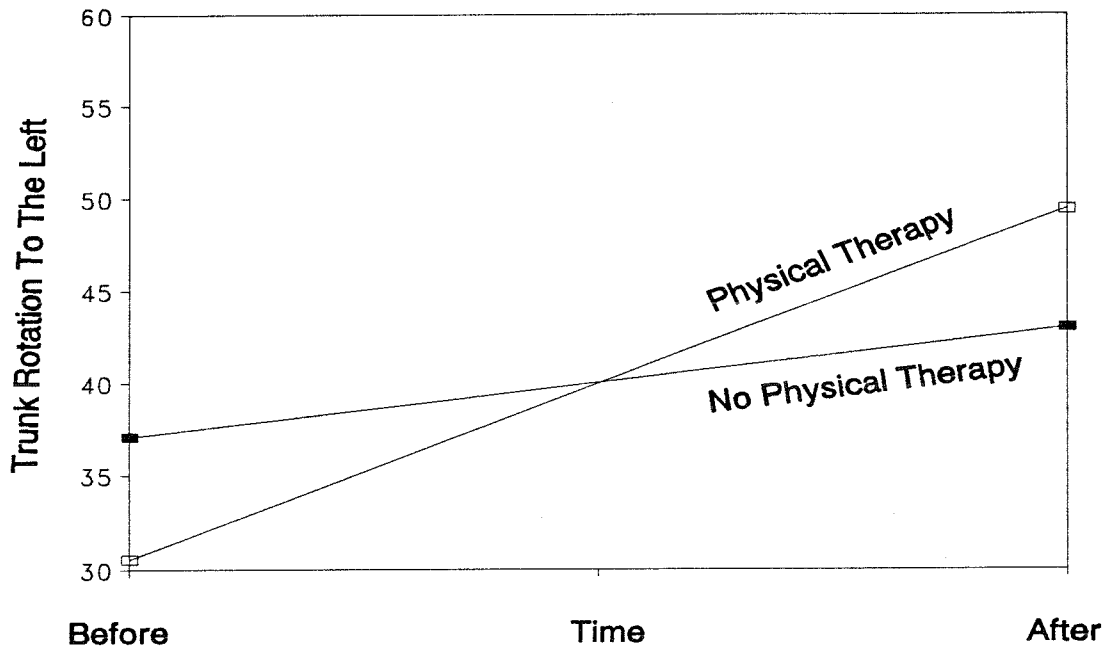


Figure 5-2. Primary effect of physical therapy on trunk rotation to the right.

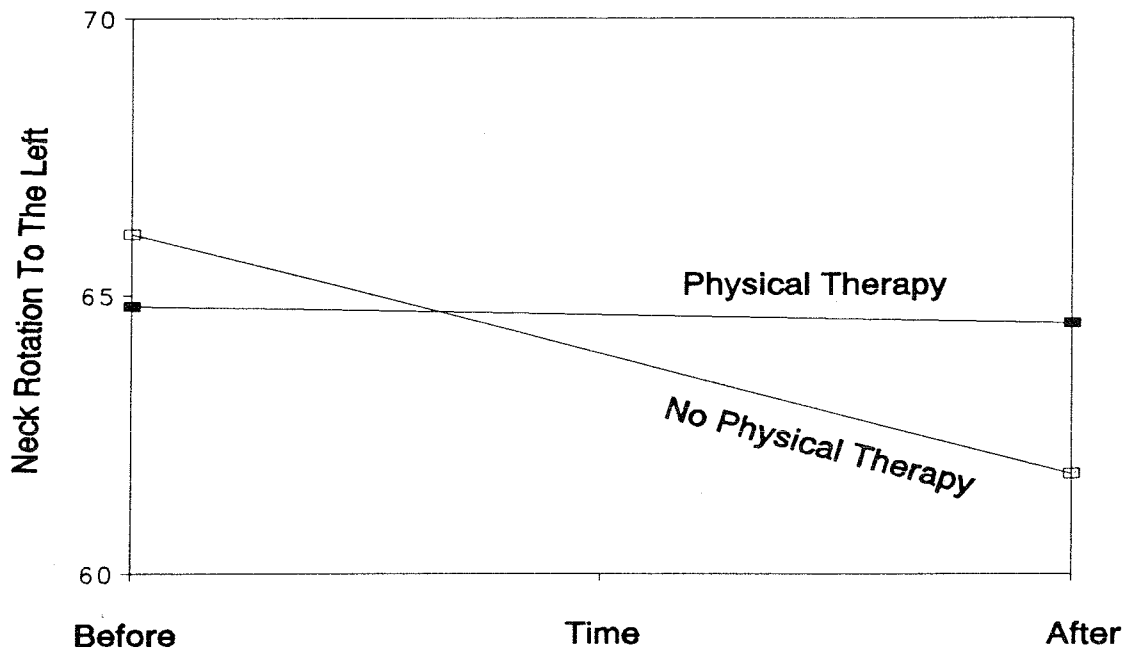


Figure 5-3. Primary effect of physical therapy on neck rotation to the left.

## Perceptual Therapy

The primary effects of the perceptual therapy were evaluated by comparing the visual perception as measured by the MVPT test of the subjects before and after the subjects in groups A2, B2, A5, and B5 received the perceptual therapy. The subjects were divided into two groups. One of the groups was composed of the subjects in groups A2, B2, A5, and B5 who received perceptual therapy, and the other group was the rest of the subjects who did not receive perceptual therapy. An ANOVA was conducted to determine if there were any statistically significant differences in the MVPT scores and response times between the two groups across the two testing sessions.

The means and standard deviations of the MVPT scores and response times are shown in Table 5-4. Comparison of the before and after means indicates that the both groups experienced improvements in MVPT scores and increases in MVPT response times. All of the after mean MVPT scores were higher than the before MVPT scores for both groups; and, all of the after MVPT response times were longer than the before MVPT response times.

The results of the ANOVA in Table 5-5 show the significance of the effects of the two factors (group and time) and their interaction for each of the MVPT scores and response times. There were only three statistically significant ( $\alpha = 0.05$ ) differences in the mean values between the two groups. The higher mean figure-ground scores and the shorter mean overall and figure-ground response times shown in Table 5-4 for the subjects who did received perceptual therapy were significantly different than those for the subjects who did not receive perceptual therapy. These results simply suggest that, as a group, the subjects who did received perceptual therapy were inherently better with respect to these aspects of visual perception. Otherwise, there were no significant differences between the two groups with respect to visual perception.

There were statistically significant ( $\alpha = 0.05$ ) differences in the mean values between the two times (before and after) the measurements were taken for all of the MVPT scores and response times. The higher mean MVPT scores and response times shown in Table 5-4 for the after measurements were significantly different than the before measurements. These results merely indicate that the after MVPT scores and response times consistently higher than the corresponding before measurements.

Table 5-4. MVPT scores and response times.

Component of Visual Perception	Subjects Receiving Perceptual Therapy				Subjects Not Receiving Perceptual Therapy			
	Before		After		Before		After	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
MVPT Score (percent)								
Overall	87.6	8.1	95.3	4.1	87.4	7.7	90.8	7.6
Spatial Relationships	90.0	11.4	95.8	6.8	89.5	10.5	94.5	8.9
Visual Discrimination	88.5	17.3	97.2	8.8	92.5	11.8	95.4	8.9
Figure-Ground	83.5	15.5	95.4	6.8	83.0	15.6	84.9	15.2
Visual Closure	87.2	9.8	93.0	9.7	84.5	13.9	88.4	11.2
Visual Memory	92.4	14.6	99.1	4.6	95.1	10.0	98.1	6.7
MVPT Response Time (seconds)								
Overall	3.5	0.7	3.8	1.0	3.6	1.0	4.6	1.3
Spatial Relationships	3.4	1.1	4.0	1.1	3.7	1.2	4.7	1.6
Visual Discrimination	3.9	1.6	3.9	1.2	3.9	1.2	4.9	1.8
Figure-Ground	2.3	0.5	2.8	0.9	2.5	0.7	3.4	1.2
Visual Closure	4.2	1.1	4.6	1.6	4.4	1.6	5.4	1.9
Visual Memory	3.5	1.4	3.5	0.8	3.6	1.2	4.5	2.2
Sample Size	35		29		70		65	

Table 5-5. ANOVA of MVPT scores and response times.

Component of Visual Perception	Factor						Interaction of Group and Time	
	Group <sup>a</sup>			Time <sup>b</sup>			F-Value	P-Value
	F-Value	P-Value		F-Value	P-Value			
	MVPT Score							
Overall	2.86	0.0940		42.57	0.0001		7.06	0.0093
Spatial Relationships	0.19	0.6602		12.47	0.0006		0.02	0.8741
Visual Discrimination	0.32	0.5703		10.80	0.0014		2.96	0.0890
Figure-Ground	4.65	0.0332		13.38	0.0004		6.73	0.0110
Visual Closure	3.23	0.0751		10.55	0.0016		0.58	0.4479
Visual Memory	0.61	0.4373		9.10	0.0033		1.31	0.2563
	MVPT Response Time							
Overall	5.26	0.0237		37.58	0.0001		6.06	0.0257
Spatial Relationships	3.68	0.0575		27.20	0.0001		1.05	0.3089
Visual Discrimination	2.87	0.0993		6.39	0.0132		6.76	0.0108
Figure-Ground	4.87	0.0292		27.00	0.0001		2.03	0.1575
Visual Closure	3.05	0.0840		15.54	0.0002		1.91	0.1700
Visual Memory	3.11	0.0804		9.33	0.0030		4.02	0.0479

<sup>a</sup> Two groups of subjects, one received perceptual therapy and the other did not.

<sup>b</sup> Two times measurements were taken, one before and the other after perceptual therapy.

The results of the ANOVA in Table 5-5 indicate that the interaction of group and time was statistically significant ( $\alpha = 0.05$ ) for the overall and figure-ground MVPT scores and the overall, visual-discrimination, and visual-memory MVPT response times. These interaction effects are illustrated in Figures 5-4, 5-5, 5-6, 5-7, and 5-8, respectively. Figures 5-4 and 5-5 indicate that the subjects who received perceptual therapy experienced significantly greater improvements in their overall and figure-ground MVPT scores than the subjects who did not receive perceptual therapy. Figures 5-6, 5-7, and 5-8 show that the increases in overall, visual-discrimination, and visual-memory MVPT response times experienced by the subjects who received perceptual therapy were significantly less than those experienced by those who did not receive perceptual therapy. Therefore, the perceptual therapy was effective in improving overall visual perception as well as the figure-ground component and the visual-discrimination and visual-memory response times.

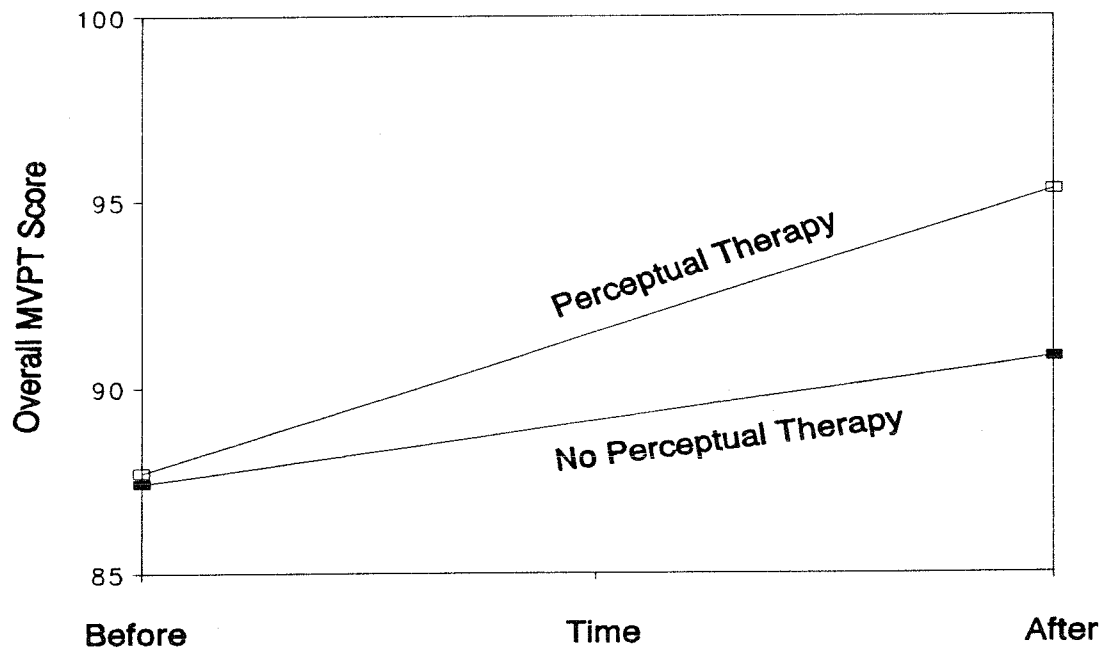


Figure 5-4. Primary effect of perceptual therapy on overall MVPT score.

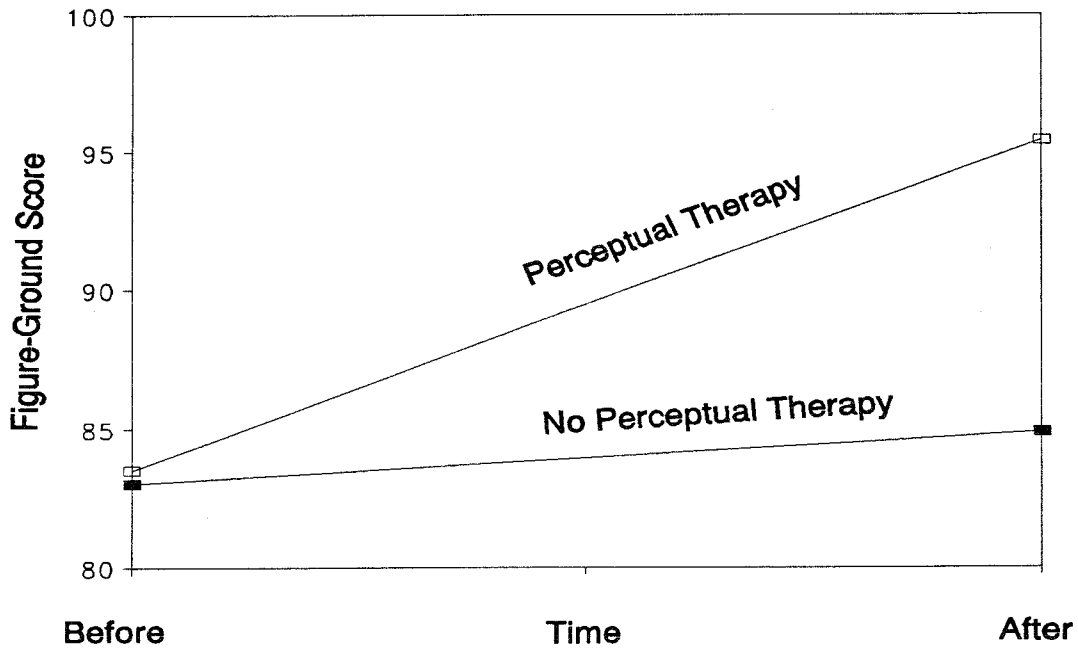


Figure 5-5. Primary effect of perceptual therapy on figure-ground score.

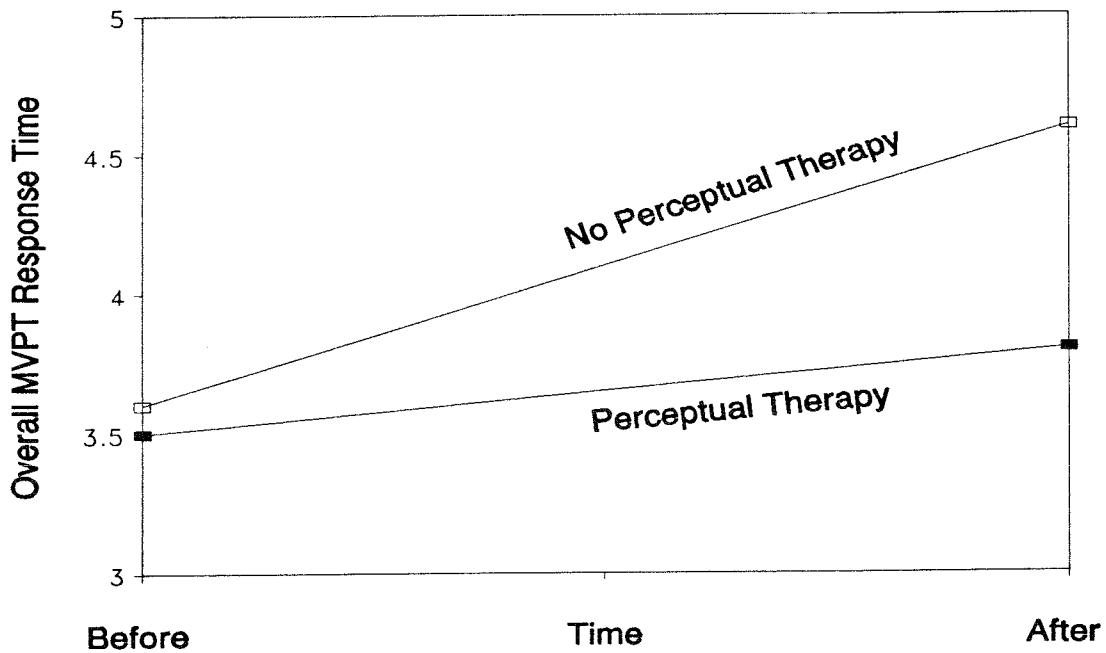


Figure 5-6. Primary effect of perceptual therapy on overall MVPT response time.



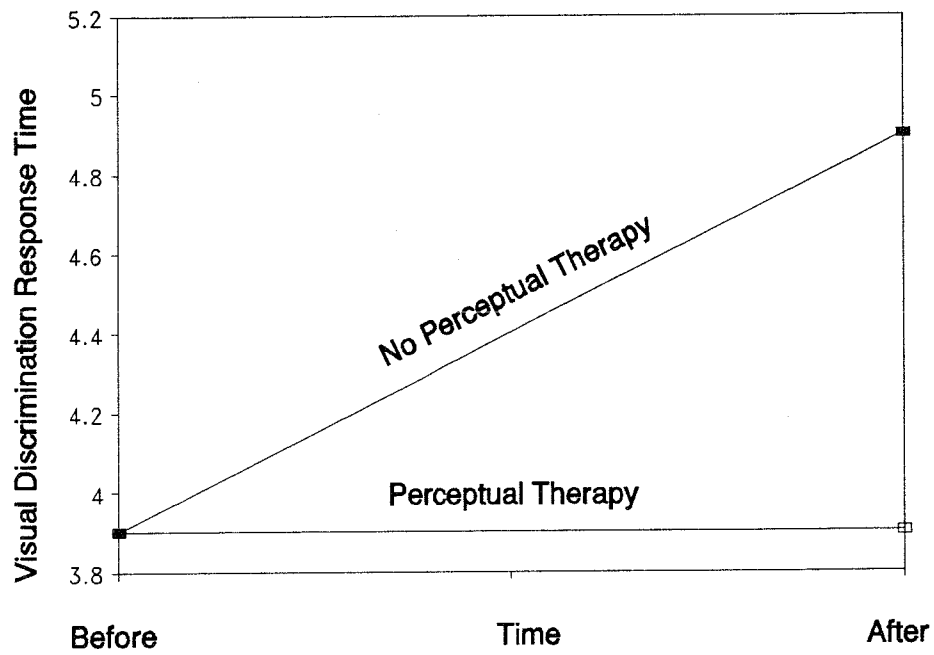


Figure 5-7. Primary effect of perceptual therapy on visual discrimination response time.

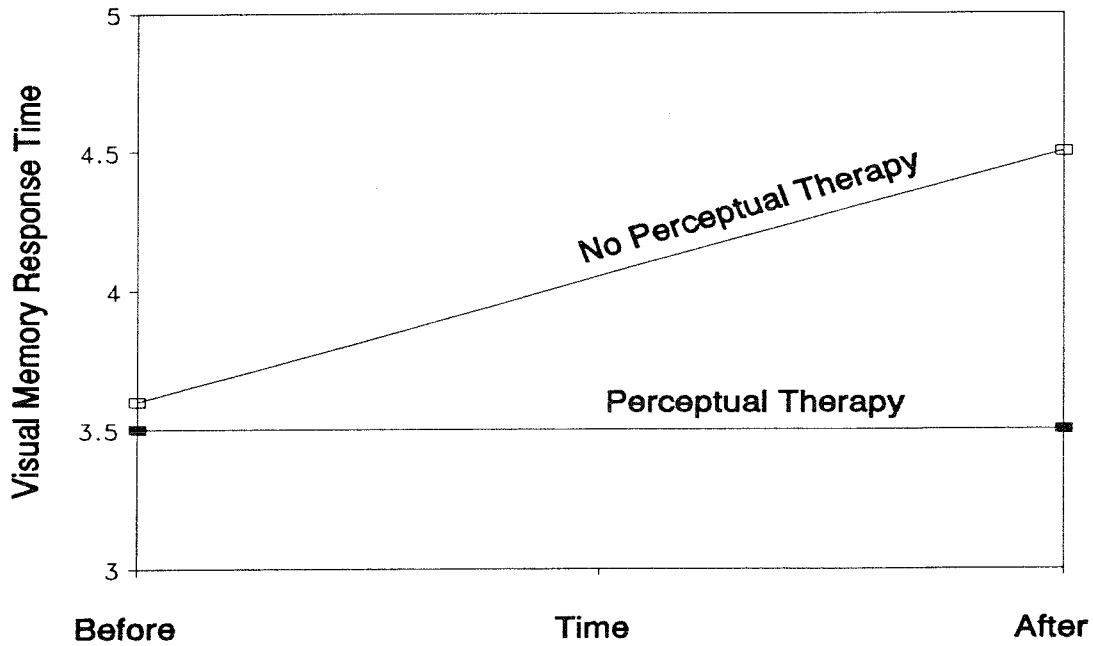


Figure 5-8. Primary effect of perceptual therapy on visual memory response time.

## Driver Education

The primary effects of the older-driver education course was evaluated by comparing the driving knowledge test scores the subjects before and after the subjects in groups A3, B3, A4, B4, A5, and B5 had taken the course. The subjects were divided into two groups. One of the groups was composed of the subjects in groups A3, B3, A4, B4, A5, and B5 who received the driver education, and the other group was the rest of the subjects who did not receive the driver education. An ANOVA was conducted to determine if there were any statistically significant differences in the driving knowledge test scores between the two groups across the two testing sessions.

The means and standard deviations of the driving knowledge test scores are shown in Table 5-6. Comparison of the before and after means indicates that the subjects who received the driver education improved their driving knowledge test scores and the those who did not receive the driver education did not improve their scores. In fact, the mean scores for those who did not receive the driver education was lower on the after test.

Table 5-6. Driving knowledge test scores.

Group	Driving Knowledge Test Score			
	Mean		Standard Deviation	
	Before	After	Before	After
Subjects Receiving Driver Education	61.0	65.4	17.6	18.9
Subjects Not Receiving Driver Education	63.4	57.3	9.4	24.1
Sample Size	52	49	53	45

The results of the ANOVA in Table 5-7 show the significance of the effects of the two factors (group and time) and their interaction on the driving knowledge test scores. There were no statistically significant ( $\alpha = 0.05$ ) differences in the mean scores between the two groups or between the two times (before and after). These results indicate that there were no inherent differences between the two tests or between the two groups with respect to driving knowledge.

However, the interaction of group and time was statistically significant ( $\alpha = 0.05$ ). This interaction effect is shown in Figure 5-9. It indicates that the subjects who received driver education experienced significantly greater improvements in their driving knowledge test scores than the subjects who did not receive driver education. The subjects not receiving driver education showed no improvement, but actually did worse on the after test. Therefore, the driver education was effective in improving the driving knowledge of the subjects.

Table 5-7. ANOVA of driving knowledge test scores.

Factor	F-Value	P-Value
Group	0.25	0.6142
Time	0.61	0.4373
Interaction	9.91	0.0021

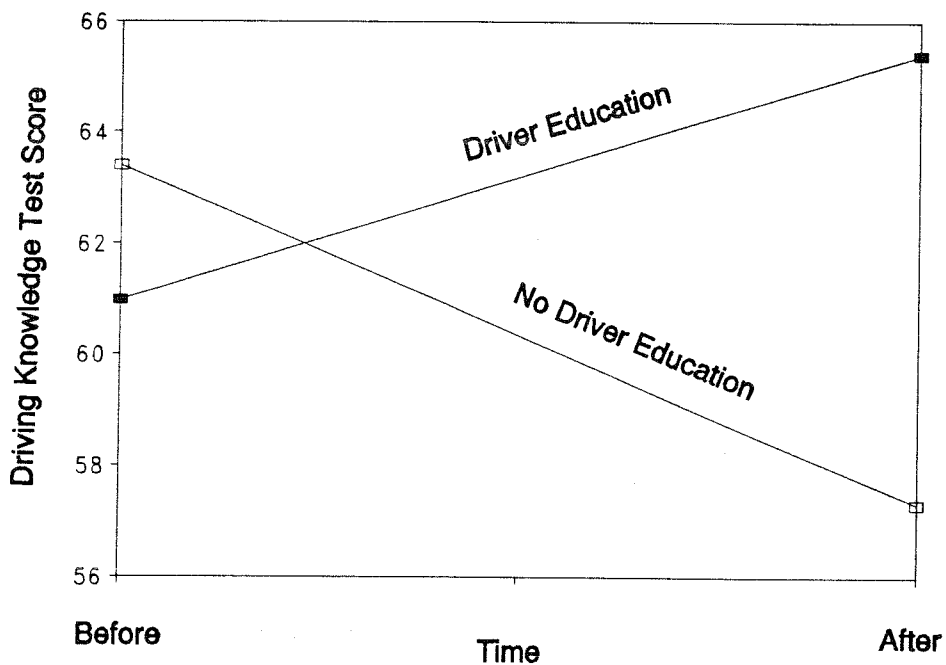


Figure 5-9. Primary effect of driver education on driving knowledge.

## **Engineering Countermeasures**

In order to assess the primary effects of the engineering countermeasures, the driving behaviors of 16 subjects in the control group (A6 and B6) were observed during their second and third DPM test runs (*i.e.* the DPM test runs before and after the countermeasures were installed). The observations were in addition to those made by the DPM evaluator at each of the DPM test locations. This additional information included observations of turning paths, lane placement, head movements, braking and slowing, and erratic maneuvers. The specific observations made at each DPM test location were pertinent to the anticipated effects of the particular countermeasure(s) installed. The information was collected by an observer riding in the back seat of the subject's vehicle. Differences in the driving behaviors between two runs were defined as the primary effects of the engineering countermeasures. A discussion of the primary effects of the engineering countermeasures at each DPM test location follows.

### **#1 - 72nd and Military**

The painted extension to the right-turn channelization, shown in Figure 4-13, had a positive effect on the subjects' driving performance. Before the improvement, two subjects braked suddenly to avoid missing the right-turn lane, and one subject turned into the wrong lane on Military Street from the right-turn lane. After the improvement, none of the subjects made erratic maneuvers or turned into the wrong lane. The improved channelization delineation made the presence of the right-turn lane more visible to the subjects and provide better control of their turning paths on to Military Street.

### **#2 - Military and Fort**

The larger street name sign, shown in Figure 4-14, did not seem to affect the driving behavior of the subjects. No erratic maneuvers were observed before the sign was installed, and none were observed after it was installed. However, without being asked, 10 of the 16 subjects indicated that they noticed the larger sign.

### **#3 - 90th and Blondo**

The wider left-turn lane lines, shown in Figure 4-16, did affect the driving behavior of the subjects. Using reference markings placed at 1-foot intervals at the stop line, the observer recorded the distance each subject's vehicle was from the median when it crossed the stop line. The lane placement of each subject is shown in Table 5-8. Before the left-turn lane line was widened, the average distance of the subjects from the median was 2.8 feet. After the left-turn lane line was widened, the average distance was reduced to 2.0 feet.

A two-tail Wilcoxon test of means indicated that this reduction was statistically significant (p-value < 0.005).

Table 5-8. Lane placement at 90th and Blondo.

Subject	Mean Distance From Median (feet) <sup>a</sup>	
	Before	After
1	3.0	1.5
2	3.0	1.5
3	2.5	2.0
4	3.5	2.0
5	3.5	2.5
6	2.0	2.0
7	2.0	2.5
8	2.5	2.0
9	3.0	2.0
10	2.5	1.5
11	2.0	1.5
12	3.5	2.5
13	1.5	1.0
14	4.0	2.5
15	2.5	2.0
16	4.5	3.0
Average	2.8	2.0

<sup>a</sup> Mean value for two trips around DPM route.

<sup>b</sup> P-value < 0.005 for two-tail Wilcoxon test of means.

Also, the lane placement distributions before and after the widening of the left-turn lane line are shown in Table 5-9. Before the left-turn lane lines were widened, only 16 percent of the subjects' lane placements were a distance of 2 feet or less from the median. After the left-turn lane line was widened, over 50 percent were a distance of 2 feet or less from the median.

The results of a Fisher's Exact 2x2 Contingency Table Test indicated that the lane placement of the subjects was significantly closer to the median after the installation of the wider left-turn lane lines with a p-value of .003.

Thus, the subjects did respond to the wider left-turn lane lines by moving closer to the median. As a result, their left-turn sight distance would have been improved.

Table 5-9. Lane placement distributions at 90th and Blondo.

DPM Test	Number of Lane Placements <sup>a</sup>	
	< 2 feet	> 2 feet
Before	5	27
After	17	15

- <sup>a</sup> Each of the 16 subjects made two trips around the DPM route in each DPM test.
- <sup>b</sup> P-value = 0.003 for Fisher's Exact 2x2 Contingency Table Test.

#### #4 - 72nd and Blondo

The improved left-turn traffic signal display, shown in Figure 4-16, was not observed to have any effect on the driving behavior of the subjects. During the before DPM test runs, none of the subjects was confronted with the change interval between the protected and permitted left-turn phases. Consequently, the subjects did not experience the confusing protected left-turn change-interval signal indications of the existing signal display. Therefore, although no erratic maneuvers were observed after the installation of the improved signal display, it was not possible to determine the anticipated effect of the display because no erratic maneuvers were observed during the before DPM runs.

The left-turn skip lines and the solid lane line, shown in Figure 4-17, were expected to encourage drivers to turn into the correct lane. The lanes into which the subjects turned are shown in Table 5.10. Before the lines were installed, the number of times the subjects turned into the wrong lane was three; whereas afterward, they turned into the wrong lane only two times. The results of a Fisher's Exact 2x2 Contingency Table Test indicated this difference was not statistically significant ( $\alpha = 0.05$ ). But, since over 90 percent of the time the subjects turned into the correct lane in the before run, it would have been difficult to show that a significant improvement had occurred.

Table 5-10. Subjects turning into correct lane at 72nd and Blondo.

DPM Test Run	Turn into correct lane? <sup>a</sup>	
	Yes	No
Before	29 (91%)	3 (9%)
After	30 (94%)	2 (6%)

<sup>a</sup> Each of the 16 subjects made two trips around the DPM route in each DPM test.  
<sup>b</sup> P-value = 1.00 for Fisher's Exact 2x2 Contingency Table Test.

However, observations of traffic operations indicated that the lines were definitely effective in encouraging the traffic to turn into the correct lane. The lanes into which the traffic was observed to turn are shown in Table 5-11. Before the lines were installed, 47 percent of the turns made on the protected left-turn phase and 41 percent of the turns made on the permitted phase were into the correct lane. But, after the lines were installed these percentages increased to 64 and 58 percent, respectively. The results of a Fisher's Exact 2x2 Contingency Table Test indicated these increases were statistically significant ( $\alpha = 0.05$ ).

Table 5-11. Traffic turning into correct lane.

Period	Turn into correct lane?	
	Yes	No
Protected Left-Turn Phase <sup>a</sup>		
Before	86 (47%)	97 (53%)
After	193 (64%)	109 (36%)
Permitted Left-Turn Phase <sup>b</sup>		
Before	69 (41%)	101 (59%)
After	101 (58%)	74 (42%)

<sup>a</sup> P-value < 0.0005 for Fisher's Exact 2x2 Contingency Table Test.

<sup>b</sup> P-value = 0.0050 for Fisher's Exact 2x2 Contingency Table Test.

#### #5 - 72nd and Maple

The installation of the far-left 5-section traffic signal, shown in Figure 4-18, was very effective in reducing the width of the field of view used by the subjects when making a protected left-turn at this location. Before the improved signal display was installed, the subjects had to turn their heads to see the protected left-turn indication on the overhead mast arm while making the left turn. After the new signal display was installed, the subjects could see the protected left-turn indication without turning their heads while making the left turn.

The left-turn skip lines and the solid lane line, shown in Figure 4-19, were also effective in encouraging the subjects to turn into the correct lane. The lanes into which the subjects turned are shown in Table 5-12. Before the lines were installed, the subject turned into the wrong lane five times. But after the lines were installed, none of the subjects turned into the wrong lane. The results of a Fisher's Exact 2x2 Contingency Table Test indicated this difference was statistically significant ( $\alpha = 0.05$ ).



Table 5-12. Turning into correct lane at 72nd and Maple.

DPM Test Run	Turn into correct lane? <sup>a</sup>	
	Yes	No
Before	27 (84%)	5 (16%)
After	32 (100%)	0 (0%)

<sup>a</sup> Each of the 16 subjects made two trips around the DPM route in each DPM test.  
<sup>b</sup> P-value = 0.0215 for Fisher's Exact 2x2 Contingency Table Test.

The lines were also found to be effective in encouraging traffic to turn into the correct lanes. Observations of the lane into which traffic turned are shown in Table 5-13. Before the lines were installed 50 percent of the turns on the protected left-turn phase and 58 percent of the turns on the permitted left-turn phase were made into the correct lane. After the lines were installed, these percentages increased to 68 and 70 percent, respectively. The results of a Fisher's Exact 2x2 Contingency Table Test indicated this difference was statistically significant ( $\alpha = 0.05$ ).

Table 5-13. Traffic turning into correct lane at 72nd and Maple.

Period	Turn into correct lane?	
	Yes	No
Protected Left-Turn Phase <sup>a</sup>		
Before	97 (50%)	96 (50%)
After	101 (68%)	47 (32%)
Permitted Left-Turn Phase <sup>b</sup>		
Before	96 (58%)	70 (42%)
After	141 (70%)	61 (30%)

<sup>a</sup> P-value = 0.0009 for Fisher's Exact 2x2 Contingency Table Test.  
<sup>b</sup> P-value = 0.0163 for Fisher's Exact 2x2 Contingency Table Test.

### #6 - 76th and Spencer

The T-intersection ahead sign, shown in Figure 4-20, was observed to have an effect on the subjects' driving behavior. The number of times subjects braked or slowed down in advance of the intersection is shown in Table 5-14. Before the sign was installed, the subjects were observed to brake or slow down in advance of the intersection only three times. But after the installation of the T-intersection ahead sign, the subjects were observed to brake or slow down 12 times. This change in driving behavior was statistically significant ( $\alpha = 0.05$ ) according to the results of a Fisher's Exact 2x2 Contingency Table Test. Therefore, the sign apparently made the subjects more aware of the presence of the intersection.

5-14. Braking and slowing in advance of 76th and Spencer.

DPM Test Run	Subject braked or slowed?	
	Yes	No
Before	3 (9%)	29 (91%)
After	12 (38%)	20 (62%)

- <sup>a</sup> Each of the 16 subjects made two trips around the DPM route in each DPM test.  
<sup>b</sup> P-value = 0.0083 for Fisher's Exact 2x2 Contingency Table Test.

### #7 - 60th and Maple

The pedestrian warning sign, shown in Figure 4-21, was installed to reduce the conflicts between left-turning vehicles and pedestrians. Therefore, the number of times pedestrians were present at the crosswalk and the number of times the subjects turned into the path of a pedestrian were observed. These data are shown in Table 5-15. During the before DPM test runs, pedestrians were present at the crosswalk 14 times and four conflicts between the subjects and the pedestrians occurred. During the after DPM test runs, pedestrians were present 12 times and only one conflict occurred. Therefore, the sign did seem to make the subjects more aware of the presence of the pedestrians and/or remind them of their legal obligation to yield to pedestrians. However, the results of a Fisher's Exact 2x2 Contingency Table Test indicated that the reduction in conflicts was not statistically significant ( $\alpha = 0.05$ ).

Table 5-15. Subject/pedestrian conflicts at 60th and Maple.

DPM Test Run	Number of Times Pedestrians Present	Number of Conflicts
Before	14	4
After	12	1

<sup>a</sup> Each of the 16 subjects made two trips around the DPM route in each DPM test.

<sup>b</sup> P-value = 0.1374 for Fisher's Exact 2x2 Contingency Table Test.

The conflicts between left-turn traffic and pedestrians were also observed at this location before and after the sign was installed. Observations were made each time a pedestrian was in the crosswalk and a left-turn vehicle was present and able to turn left. If a pedestrian was in the crosswalk and a left-turn vehicle was present but not able to turn left because of opposing traffic, no observation was made. Each time an observation was made, the occurrence of a conflict between the pedestrian and left-turn vehicle was noted. Thus, the percentage of time a conflict occurred when it was possible to have a conflict could be determined. The observations were made for 3 hours per day during a 4-day period before and after the sign was installed.

The conflict data are shown in Table 5-16. Before the sign was installed, 213 observations were made and conflicts occurred 47 percent of the time. After the sign was installed, 157 observations were made and conflicts occurred only 18 percent of the time. The results of a Fisher's Exact 2x2 Contingency Table Test indicate that the reduction in conflicts was statistically significant ( $\alpha = 0.05$ ). Therefore, the sign was effective in reducing conflicts between left-turn vehicles and pedestrians.

Table 5-16. Left-turn traffic/pedestrian conflicts at 60th and Maple.

Period	No Conflict Occurred	Conflict Occurred	Number of Observations
Before	100 (47%)	113 (53%)	213 (100%)
After	128 (82%)	29 (18%)	157 (100%)

<sup>a</sup> P-value < 0.0005 for Fisher's Exact 2x2 Contingency Table Test.

## SECONDARY EFFECTS

### All Countermeasures

The changes in the driving performance of the 94 subjects were considered to be the secondary effects of the countermeasures. These effects were computed by subtracting the subjects' DPM test scores before implementation of the countermeasures from their DPM test scores after implementation of the countermeasures. The differences in the subjects' scores were also ranked with the largest difference given the rank of 94 and the smallest difference given the rank of one. The mean differences in the DPM test scores and the mean ranks were then computed for each study group. The results of these calculations are shown in Table 5-17.

The mean differences for all of the study groups except one were positive indicating an improvement in driving performance. The only group that did not experience an improvement in driving performance was the control group A6. This group did not receive physical therapy, perceptual therapy, or driver education. The mean difference for this group was computed using the first and second DPM test scores which were obtained before the engineering countermeasures were installed on the DPM route.

The lowest mean rank of differences was for the control group A6, indicating that all of the countermeasures were effective in improving the driving performance of the subjects. The highest mean rank of the differences was for group A5, the subjects that received perceptual therapy and driver education. Thus, the combination of perceptual and driver education was most effective. The least effective was the combination of perceptual therapy and engineering countermeasures (group B2); however, there were only four subjects in this group because some of the subjects originally assigned to the group took the driver education course by mistake and therefore were reassigned to group B5.

The combination of the driver education with either physical or perceptual therapy added to the improvement provided by the individual countermeasures. The mean ranks of groups receiving either physical therapy (A1 and B1) or driver education (A3 and B3) were lower than the mean ranks of the corresponding groups receiving both physical therapy and driver education (A4 and B4). Likewise, the mean ranks of the groups receiving perceptual therapy (A2 and B2) or driver education (A3 and B3) were lower than the mean ranks of the groups receiving both perceptual therapy and driver education.

Table 5-17. On-road driving performance test scores.

Countermeasure	DPM Test Score <sup>a</sup> (%)		Mean Differ- ence (%)	Mean Rank of Differ- ences
	Before	After		
A - After DPM Test Score on DPM Route Before Engineering Countermeasures Installed				
1 - Physical Therapy	82.9	89.7	6.8	58.8
2 - Perceptual Therapy	88.1	95.8	7.7	61.6
3 - Driver Education	87.8	91.5	3.7	57.8
4 - Physical Therapy and Driver Education	85.2	93.9	8.7	60.8
5 - Perceptual Therapy and Driver Education	82.9	96.8	13.9	83.5
6 - None	84.1	83.7	-0.4	26.0
B- After DPM Test Score on DPM Route After Engineering Countermeasures Installed				
1 - Physical Therapy	86.7	93.1	6.4	62.1
2 - Perceptual Therapy	89.9	92.2	2.3	44.0
3 - Driver Education	85.4	91.7	6.3	61.4
4 - Physical Therapy and Driver Education	85.9	95.6	9.7	78.3
5 - Perceptual Therapy and Driver Education	85.7	94.8	9.1	71.6
6 - None	83.7	92.1	8.4	54.8

<sup>a</sup> Maximum Possible DPM Test Score = 100.0%.

Comparing the mean ranks of the A groups (*i.e.*, those groups that were not exposed to the engineering countermeasures) with mean ranks of the corresponding B groups (*i.e.*, those groups that were exposed to the engineering countermeasures) indicates that the engineering countermeasures added to the improvement provided by physical therapy, driver education, and the combination of physical therapy and driver education. However, this was not the case for the perceptual therapy (group A2 versus B2) and the combination of perceptual therapy and driver education (group A5 versus B5). Group A2 showed a higher improvement than group

B2 even though the subjects in group B2 received the same treatment as group A2 plus the advantage of driving on the DPM route after the engineering countermeasures had been installed. But, this result may have been a consequence of the small sample size of group B2. Similarly, group A5 showed a higher improvement than group B5 even though the subjects in group B5 received the same treatment as group A5 plus the advantage of driving on the DPM route after the engineering countermeasures had been installed.

Kruskal-Wallis tests were used to test the equality of the group means. These nonparametric tests were used because the data were not well-suited to the sample-size and normal-distribution requirements of the ANOVA. The Kruskal-Wallis test indicated that the group means were not equal ( $\alpha = 0.001$ ). Therefore, a Kruskal-Wallis multiple pairwise comparison test was conducted to determine which means were significantly different from one another. The results of the pairwise comparison test are shown in Table 5-18.

The p-values in Table 5-18 indicate that all of the groups receiving a therapy, driver education, and/or exposed to the engineering countermeasures, except group B2, showed statistically significant ( $\alpha = 0.015$ ) improvements in driving performance relative to the control group A6, which did not receive a therapy or driver education and was not exposed to the engineering countermeasures. Again, the fact that group B2 did not show a significant improvement could probably be attributed to its small sample size. Therefore, all of the countermeasures resulted in a significant improvement in the driving performance of the subjects. However, none of the differences were statistically significant ( $\alpha = 0.015$ ). Therefore, none of the countermeasures provided a significantly greater improvement in driving performance than any of the other countermeasures.

### **Specific Engineering Countermeasures**

The engineering countermeasures provided a significant improvement in the driving performance of the subjects as discussed in the previous section. However, the effects on driving performance of the specific engineering countermeasures installed on the DPM route were also examined. The mean DPM test scores of the subjects in group B6 before and after the installation of the engineering countermeasures at each DPM test location are shown in Table 5-19. All of the after scores were higher than the corresponding before scores indicating that all of the engineering countermeasures were effective in improving the driving performance of the subjects. However, the results of a two-tail Wilcoxon Signed Ranks Test indicated that not all of the improvements in driving performance were statistically significant ( $\alpha = 0.05$ ).

Table 5-18. P-values for Kruskal-Wallis multiple pairwise comparison test.

Group <sup>a</sup>	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6
A1	-											
A2	0.8444	-										
A3	0.9442	0.7972	-									
A4	0.8910	0.9607	0.8432	-								
A5	0.1147	0.1804	0.1083	0.1784	-							
A6	0.0069	0.0065	0.0113	0.0110	0.0001	-						
B1	0.8041	0.9699	0.7556	0.9299	0.1720	0.0031	-					
B2	0.4098	0.3434	0.4482	0.3760	0.0448	0.2831	0.3122	-				
B3	0.8543	0.9899	0.8062	0.9699	0.1768	0.0068	0.9594	0.3483	-			
B4	0.1911	0.2861	0.1798	0.2797	0.7565	0.0002	0.2780	0.0723	0.2806	-		
B5	0.3316	0.4753	0.3102	0.4597	0.4377	0.0001	0.4726	0.1199	0.4670	0.6337	-	
B6	0.7505	0.6109	0.8168	0.6664	0.0515	0.0074	0.5557	0.5243	0.6205	0.0919	0.1641	-

- <sup>a</sup>
- A - Subjects in the "A" groups were not exposed to the engineering countermeasures.
  - B - Subjects in the "B" groups were exposed to the engineering countermeasures.
  - 1 - Subjects in the "1" groups received physical therapy.
  - 2 - Subjects in the "2" groups received perceptual therapy.
  - 3 - Subjects in the "3" groups received driver education.
  - 4 - Subjects in the "4" groups received physical therapy and driver education.
  - 5 - Subjects in the "5" groups received perceptual therapy and driver education.
  - 6 - Subjects in the "6" groups did not receive any countermeasures.

Table 5-19. On-road driving performance scores at DPM test locations.

DPM Location	Mean DPM Test Score <sup>a</sup> (%)		Mean Difference (%)	Wilcoxon Signed Ranks Test P-Value
	Before	After		
#1 - 72nd and Military	93.9	96.7	3.4	0.2626
#2 - Military and Fort	85.6	88.9	3.3	0.1235
#3 - 90th and Blondo	90.0	92.2	2.2	0.4327
#4 - 72nd and Blondo	92.2	94.4	2.2	0.2411
#5 - 72nd and Military	91.1	95.5	4.4	0.0284
#6 - 76th and Spencer	33.3	50.0	16.7	0.0087
#7 - 60th and Maple	88.9	96.7	7.8	0.0414

<sup>a</sup> Maximum Possible DPM Test Score = 100.0%.

Only the engineering countermeasures at the following locations resulted in significant improvements in driving performance: (1) #5 - 72nd and Maple, (2) #6 - 76th and Spencer, and (3) #7 - 60th and Maple.

### COST-EFFECTIVENESS

The cost-effectiveness of the countermeasures was evaluated. The mean improvement in DPM test score used was the measure of effectiveness. The mean improvements for the countermeasures are shown in Table 5-17 as the mean differences between the before and after DPM test scores. However, the results of the Kruskal-Wallis multiple pairwise comparison test in Table 5-18 indicated that there were no statistically significant differences among the mean improvements of the countermeasures. Therefore, the mean improvement for all of the countermeasures was the average improvement experienced by the subjects the study groups that received countermeasures (*i.e.*, groups A1, A2, A3, A4, A5, B1, B2, B3, B4, B5, and B6). The average improvement for the subjects in these groups was 7.9 percent.



The costs of the countermeasures were computed by the professionals who designed and implemented them. The cost of the physical therapy was computed by Pat Hageman, Director of Physical Therapy Education at the University of Nebraska Medical Center. The cost of the perceptual therapy was computed by Jill Moon, Occupational Therapist at the Immanuel Rehabilitation Center. The costs of the therapies included the one-hour training sessions and the instructional brochures and exercise workbooks. The cost per older driver was computed by dividing the total cost of the training and instructional/exercise materials by the number of subjects receiving the therapy. The cost of the physical therapy was \$5.35 per older driver, and the cost of the perceptual therapy was \$11.50 per older driver.

The cost of the driver education was the standard registration fee for the AAA course *Safe Driving for Mature Operators*. The fee for the course was \$7.00 per older driver.

The cost of the engineering countermeasures was computed by Glenn Hansen, Traffic Operations Engineer with the City of Omaha. The total cost of these countermeasures was \$3,066.00, which included the costs of materials, equipment, and labor. The cost per older driver would depend on the traffic volume and the percent of older driver in the traffic stream.

The cost-effectiveness of the countermeasures is shown in Table 5-20. The countermeasures were equally effective with each providing a 7.9 percent improvement in the driving performance of older drivers. Therefore, the most cost-effective countermeasure was the one with the lowest cost, which was the physical therapy. The cost-effectiveness of the engineering countermeasures would depend on the number of older drivers exposed to the countermeasures, which in turn would depend on the traffic volume and percent of older drivers in the traffic stream. In order to compare the engineering countermeasures to the other countermeasures, the average daily traffic volumes (ADT's) at which the engineering countermeasures would be equally cost-effective with the other countermeasures were computed. The calculation of these breakeven ADT's was based on the following assumptions: (1) each countermeasure had a service life of one year and (2) the traffic volume had 10 percent older drivers. The breakeven ADT's for the engineering countermeasures with respect to the other countermeasures are shown in Table 5-21.

Table 5-20. Cost-effectiveness of the countermeasures.

Countermeasure	Mean Improvement in DPM Test Score (%)	Cost (\$/older driver)	Cost-Effectiveness (\$/older driver/%)
1 - Physical Therapy	7.9	5.35	0.68
2 - Perceptual Therapy	7.9	11.50	1.46
3 - Driver Education	7.9	7.00	0.89
4 - Physical Therapy and Driver Education	7.9	12.35	1.56
5 - Perceptual Therapy and Driver Education	7.9	18.50	2.34
6 - Engineering Countermeasures	7.9	N.A. <sup>a</sup>	N.A.

<sup>a</sup> N.A. - Value would depend on traffic volume and percent of older drivers.

Table 5-21. Breakeven ADT's for engineering countermeasures.

Countermeasure	Breakeven ADT <sup>a</sup>
1 - Physical Therapy	5,730
2 - Perceptual Therapy	2,670
3 - Driver Education	4,380
4 - Physical Therapy and Driver Education	2,480
5 - Perceptual Therapy and Driver Education	1,660

<sup>a</sup> Based on 10 percent older drivers and one-year service life of countermeasures.

For the engineering countermeasures to be more cost-effective than the other countermeasures, the sum of the ADT's exposed to the engineering countermeasures would have had to have been greater than the breakeven ADT's. Therefore, if the sum of the ADT's exposed to the engineering countermeasures was above 5,730 vehicles per day, the engineering countermeasures would have been the more cost-effective than the other countermeasures. If the sum of the ADT's was 3,000 vehicles per day, then the engineering countermeasures would have been less cost-effective than the physical therapy and the driver education but more cost-effective than the perceptual therapy and the combinations of driver education and physical and perceptual therapy. However, if the sum of the ADT's was below 1,660 vehicles per day, the engineering countermeasures would have been less cost-effective than any of the other countermeasures. The sum of the ADT's exposed to the engineering countermeasures at the seven locations on DPM test route where the engineering countermeasures were installed was about 70,000 vehicles per day. Therefore, the engineering countermeasures were the most cost-effective countermeasures based on the assumptions listed above.

The relative cost-effectiveness of engineering countermeasures is shown in Figure 5-10. The three lines represent the breakeven ADT's for engineering countermeasures with respect to the other countermeasures for annual costs of engineering countermeasures up to \$150,000 per year. If the point at which the annual cost of an engineering countermeasure and the ADT exposed to it intersect is above the breakeven ADT line, the engineering countermeasure would be cost-effective with respect to the other countermeasure. If the point of intersection is below the breakeven ADT line, the engineering countermeasure would not be cost-effective with respect to the other countermeasure. For example, if an engineering countermeasure that costs \$50,000 per year was installed at a location where 60,000 vehicles per day were exposed to it, the engineering countermeasure would be cost-effective with respect to perceptual therapy but not with respect to physical therapy or driver education. Or, if a program of engineering countermeasures was implemented a several location at a cost of \$50,000 per year and the sum of the traffic volumes exposed to the countermeasures at all locations was 60,000 vehicles per day, the program of engineering countermeasures would be cost-effective with respect to perceptual therapy but not with respect to physical therapy or driver education.

However, direct comparison of the engineering countermeasures with the other countermeasures is difficult. The effects of the engineering countermeasures are limited to specific locations. Improvements in driving performance only occur at the locations where the engineering countermeasures are installed. But the effects of the other countermeasures are not site specific. The improvements in driving performance resulting from the other countermeasures (*i.e.*, physical therapy, perceptual therapy, and driver education) occur wherever the subjects drive. On the other hand, the effects of the other countermeasures are limited to those who

who receive them. Improvements in driving performance resulting from them are not realized by those who do not receive them. But the effects of the engineering countermeasures are applicable to the entire traffic stream, and the improvements in driving performance are realized by all drivers and not just older drivers.

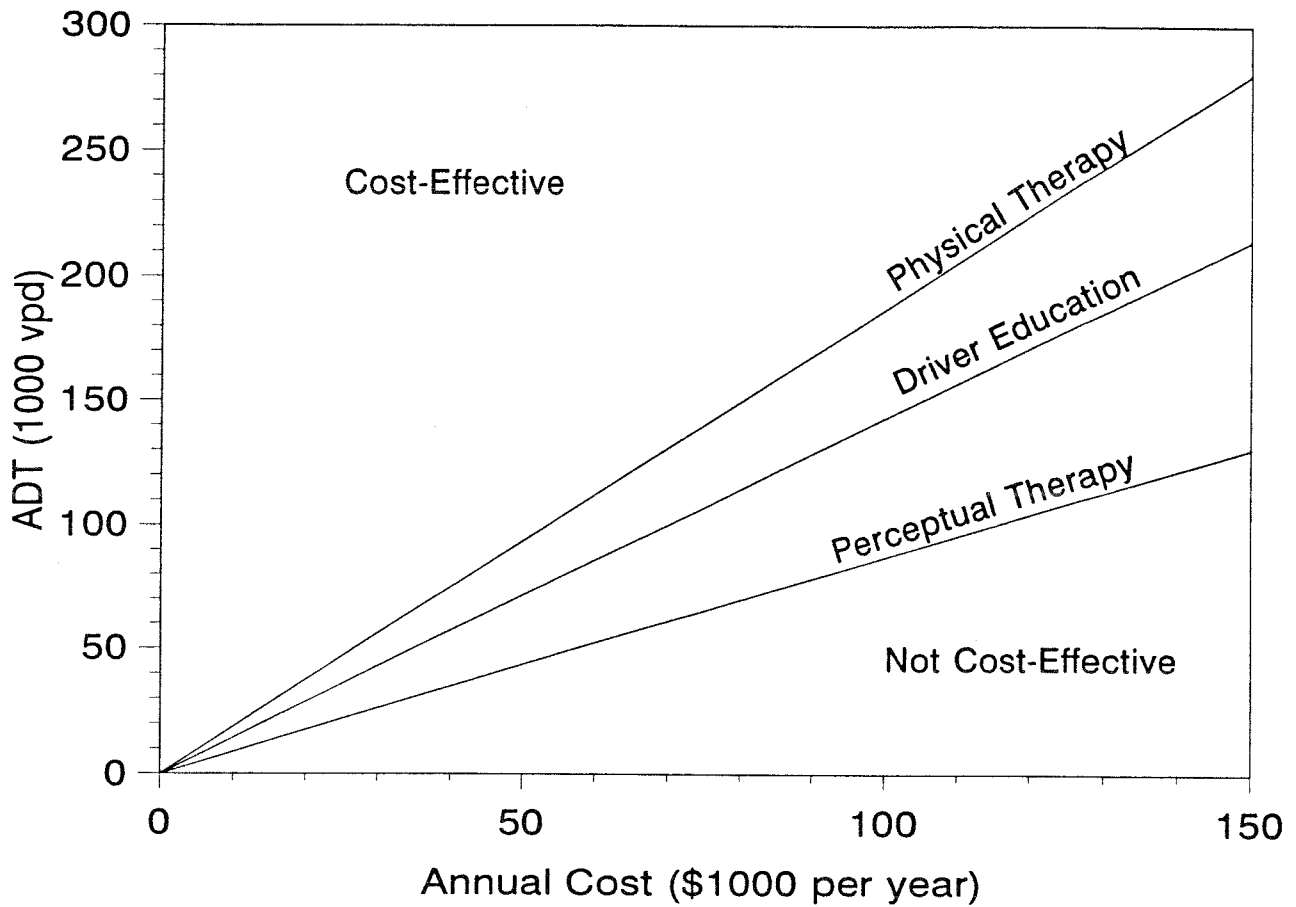


Figure 5-10. Relative cost-effectiveness of engineering countermeasures.

## CONCLUSIONS AND RECOMMENDATIONS

### DRIVING PERFORMANCE

Physical therapy, perceptual therapy, driver education, and engineering countermeasures were all found to significantly improve the driving performance of older drivers. Combining driver education with physical or perceptual therapy tended to increase the improvement in driving performance, but none of the increases were statistically significant. Likewise, although the engineering countermeasures were effective in improving the driving performance of older drivers, they did not add significantly to the improvement that was achieved by the other countermeasures. The combination of perceptual therapy and driver education provided the greatest improvement followed by the combinations of engineering countermeasures with driver education and either physical or perceptual therapy. However, there were no statistically significant differences among the improvements provided by the countermeasures either individually or in combination. The average improvement provided was 7.9 percent. Therefore, it was concluded that the countermeasures and their combinations are equally effective and provide a 7.9 percent improvement in the driving performance of older drivers.

### COST-EFFECTIVENESS

Since the countermeasures were equally effective, the most cost-effective countermeasure was the one with the lowest cost. The costs of the countermeasures evaluated in the research were: (1) \$5.35 per older driver for physical therapy, (2) \$11.50 per older driver for perceptual therapy, (3) \$7.00 per older driver for driver education, and (4) \$3,066 total cost for the engineering countermeasures. Among the first three countermeasures, physical therapy was the most cost-effective because it had the lowest cost per older driver. The combination of these countermeasures provided the same level of effectiveness (*i.e.*, a 7.9 percent improvement in driving performance) at a higher cost and therefore were less cost-effective. The cost of the engineering countermeasures per older driver was a function of the number of older drivers exposed to them, which in turn was dependent on the traffic volumes and percent of older drivers on the roadways where countermeasures were installed. Assuming 10 percent older drivers and a one-year service life for all countermeasures, the ADT's at which the engineering countermeasures were as cost-effective as the other countermeasures were computed. In order to be as cost-effective as physical therapy, the sum of the ADT's exposed to the engineering countermeasures would have had to have been 5,730 vehicles. Since the sum of the ADT's

engineering countermeasures was about 70,000, the engineering countermeasures were the most cost-effective countermeasures for the traffic volumes in this study.

Direct comparison of engineering countermeasures with the other countermeasures is difficult. Engineering countermeasures are different in nature than the other countermeasures. Engineering countermeasures are site-specific whereas the other countermeasures are driver-specific. The effects of engineering countermeasures are limited to the locations where they are installed, but the effects of the other countermeasures are realized wherever the subjects drive. The effects of the other countermeasures are limited to the drivers who receive them, but the effects of the engineering countermeasures are realized by all drivers who travel through the locations where they are installed. Nevertheless, the relative cost-effectiveness of engineering countermeasures with respect to the other countermeasures shown in Figure 5-10 indicates that engineering countermeasures would be most cost-effective on high-volume rural highways and urban streets, and programs of older-driver education and instruction in physical and perceptual exercises would be most cost-effective in rural areas with low-volume streets and highways.

## **OTHER EFFECTS**

The countermeasures not only improved the driving performance of the older driver, but they also provided other effects which no doubt contributed to the improvements in driving performance. The physical therapy was effective in improving some of the range-of-motion dimensions. It provided significant improvements in the trunk and neck rotation of the subjects. The perceptual therapy provided significant improvements in the subjects' visual perception, and the driver education significantly improved the subjects' driving knowledge.

The engineering countermeasures also resulted in some significant improvements in the driving behavior of the subjects and other drivers. The improved delineation of the right-turn channelization increased the visibility of the right-turn lane and provided better control of the subjects' turning paths. The larger street-name sign was noticed by most of the subjects. The wider left-turn lane line caused the subjects' lane placement to be significantly closer to the median, which improved their sight distance. The left-turn skip markings and solid lane lines significantly improved the percentage of subjects and other drivers who turned into the correct lane while making a left turn. The installation of the far left-turn signal head was very effective in reducing the width of the field of view needed to make a left turn, which made it easier for the subjects to safely complete the turn. The T-intersection ahead sign significantly increased the percent of subjects who approached the intersection with caution, and the TURNING TRAFFIC MUST YIELD TO PEDESTRIANS sign significantly reduced the conflicts between left-turn traffic and pedestrians.

These other effects of the countermeasures were positive effects that were consistent with the intent of their design. Therefore, it was concluded that the countermeasures were designed satisfactorily to meet the needs of older drivers. However, it is very likely that these designs are not the optimum. They could probably be enhanced to yield even greater improvements in the driving performance of older drivers.

## **LIMITATIONS OF THE RESEARCH**

The limitations of the research should be noted when considering the application of the results.

### **Subjects**

The subjects who participated in the study may not have been representative of the older driver population. They were not selected at random. Instead they volunteered to participate in the study. Consequently, they may have been more highly motivated than the general older-driver population to improve their driving performance.

The subjects were generally in very good mental and physical condition. Their range of motion, visual perception, mental status, and reaction times were above the norms for their age group. In addition, they were good drivers. The effectiveness of the countermeasures observed in this research may be different for older drivers who are not in good physical and mental condition, and/or who are not good drivers.

### **Driving Conditions**

The driving performance of the older drivers was evaluated at intersections on urban streets during off-peak hours. The driving maneuvers evaluated were left turns and right turns at signalized intersections and approaches to unsignalized intersections. Although these are conditions and maneuvers most often involved in older-driver accidents, the effectiveness of the countermeasures may not be the same for different driving conditions and/or maneuvers.

## **Driving Performance**

The driving performance of the subjects was evaluated using the DPM method developed at Michigan State University [1,2]. Although it has been found to be a reliable indicator of safe driving performance, it may not be a direct measure of accident experience. Therefore, the 7.9-percent improvement in driving performance attributed to the countermeasures is only an indication of the resultant improvement in the safety of older drivers. It is not necessarily the reduction in older-drivers accidents provided by the countermeasures.

## **Engineering Countermeasures**

The engineering countermeasures were comprised of signs, pavement markings, and traffic signal displays that were to improve the safety of the maneuvers at intersections most often involved in elderly-driver accidents. They were designed in compliance with the *Manual on Uniform Traffic Control Devices* [3] to address particular operational and safety problems observed at the intersections where the driving performance of the subjects was evaluated. Their designs involved the application of conventional traffic engineering principles to facilitate the driving task involved in the maneuvers being evaluated. The engineering countermeasures were not intended to be universal solutions to the problems of older drivers. Instead they were intended to be representative of ways to improve traffic control and highway design to account for the limitations of older drivers.

Therefore, the improvements in driving performance provided by the engineering countermeasures should be viewed as indicative of that provided by the application of traffic engineering design principles to the problems of older drivers at particular locations. The specific engineering countermeasures evaluated in this research should not be expected to provide the same level of effectiveness at other locations with different operational and safety problems than those observed at the locations where the engineering countermeasures were installed in this study.

## **Cost-Effectiveness**

The cost-effectiveness analysis was based on a number of assumptions that may limit the general applicability of the results. First, the countermeasures were assumed to have equal service lives of one year. In other words, the effects of physical therapy, perceptual therapy, driver education, and the engineering countermeasures were all assumed to last for one year after which the countermeasure would have to be repeated or replaced at the same cost. However, it is conceivable that the countermeasures actually have different service lives. For example,



costs of the therapies might be one-time costs. Once the exercise instructions and workbooks have been purchased, the exercises could be repeated indifferently without additional cost or loss of effectiveness. Similarly, the driving knowledge acquired in the driver education course could be effectively retained for much longer than one year and some of the traffic control devices used in the engineering countermeasures could be effective for 5 to 10 years without replacement.

The costs of the countermeasures used in the analysis were those paid for the countermeasures during the conduct of the research. Other than the need to comply with the research budget, no special efforts were made to minimize the costs of the countermeasures. The costs of the driver education and engineering countermeasures were representative. The cost of the driver education course was the registration fee charged by AAA for the *Safe Driving for Mature Operators* course, and the costs of the engineering countermeasures were those normally incurred by the City of Omaha for the installation of the traffic control devices. However, the costs of the physical and perceptual therapies may not have been representative. These exercise programs were new programs, and the most efficient methods preparing the materials and providing the instruction had not been developed. Therefore, it is very likely that these countermeasures could be implemented at a lower cost which would improve their cost-effectiveness.

The relative cost-effectiveness of the engineering countermeasures with respect to the other countermeasure was computed assuming that traffic was comprised of 10 percent older drivers. Although about 10 percent of all drivers are 65 years or older [4], this figure may not be appropriate for all communities or all locations on the highway system. Many communities in the rural Midwest region have nearly 15 percent older drivers [5]. Even within larger metropolitan areas some streets and highways have higher percentages of older drivers because they are in the vicinity of older residential neighborhoods, medical facilities, senior centers, and other land uses that attract older people. Therefore, the relative cost-effectiveness of engineering countermeasures may be higher or lower than that found in this study depending on the location where they are to be implemented.

### **Suboptimal Designs**

The countermeasures evaluated in this research were satisfactorily designed to meet the needs of older drivers. However, they were not the optimal designs because of the limited resources available to the research for the design of the countermeasures. Therefore, even greater improvements in the driving performance of older drivers than those observed in this study could probably be provided by the countermeasures if their designs were optimized.

## **FURTHER STUDY**

Further study is needed to overcome the limitations of this research. Similar studies should be conducted using older subjects who are not as physically and mentally fit as the subjects in this study. Also, research should be conducted to determine the long-term effects of the countermeasures on the driving performance and accident experiences of older drivers.

Although the countermeasures were all found to be effective in improving the driving performance of older drivers, further research should be conducted to optimize the design of the countermeasures and maximize their effectiveness. The physical and perceptual therapy should be examined to determine the optimum combination of exercises that would maximize their positive effect on driving performance and facilitate their use by older drivers. Additional research is needed on the design and application of traffic control devices to more effectively meet the needs of older drivers.

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## **APPENDIX A**

### **Cognitive Tests**

**GERIATRIC ASSESSMENT PROGRAM  
MINI MENTAL STATUS EXAM  
VISIT: 1 2 3  
(circle one)**

NAME \_\_\_\_\_  
REG. NO. \_\_\_\_\_  
LOCATION \_\_\_\_\_  
DATE \_\_\_\_\_

year \_\_\_\_\_  
season \_\_\_\_\_  
date \_\_\_\_\_  
day \_\_\_\_\_  
month \_\_\_\_\_  
state \_\_\_\_\_  
county \_\_\_\_\_  
city \_\_\_\_\_  
floor \_\_\_\_\_  
address \_\_\_\_\_  
apple1 \_\_\_\_\_  
table1 \_\_\_\_\_  
penny1 \_\_\_\_\_  
serial1 \_\_\_\_\_  
serial2 \_\_\_\_\_  
serial3 \_\_\_\_\_  
serial4 \_\_\_\_\_  
serial5 \_\_\_\_\_  
~~spell1 \_\_\_\_\_~~  
~~spell2 \_\_\_\_\_~~  
~~spell3 \_\_\_\_\_~~  
~~spell4 \_\_\_\_\_~~  
~~spell5 \_\_\_\_\_~~  
apple2 \_\_\_\_\_  
table2 \_\_\_\_\_  
penny2 \_\_\_\_\_  
watch \_\_\_\_\_  
pencil \_\_\_\_\_  
repeats \_\_\_\_\_  
reads \_\_\_\_\_  
takes \_\_\_\_\_  
folds \_\_\_\_\_  
puts \_\_\_\_\_  
writes \_\_\_\_\_  
draws \_\_\_\_\_

Patient Maximum  
Score Score

**Orientation**

- \_\_\_\_\_ 5 What is the (year) (season) (date) (day) (month)?
- \_\_\_\_\_ 5 Where are we (state) (county) (city) (floor) (address)?

**Registration**

- \_\_\_\_\_ 3 Name three objects, allotting one second to say each one. Then ask the patient to name all three objects after you have said them. Give one point for each correct answer. Repeat them until the patient repeats all 3 or it is apparent they can't.

Apple....Table....Penny

**Attention and Calculation**

- \_\_\_\_\_ 5 Begin with 100 and count backward by 7 (stop after fifth answer): 93, 86, 79, 72, 65. Score one point for each correct answer. If the patient will not perform this task, ask the patient to spell "WORLD" backward (DLROW). Record the patient's spelling: \_\_\_\_\_ Score one point for each correctly placed letter.

**Recall**

- \_\_\_\_\_ 3 Ask the patient to repeat the objects above (see Registration). Give one point for each correct answer.

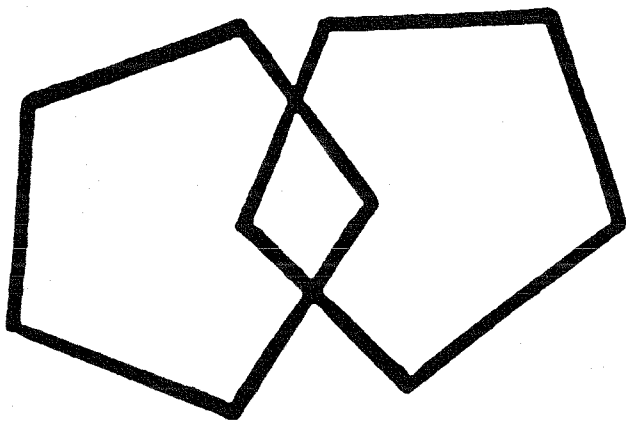
**Language**

- \_\_\_\_\_ 2 Naming: Show a watch and a pencil, and ask the patient to name them.
- \_\_\_\_\_ 1 Repetition: Repeat the following: "No ifs, ands, or buts."
- \_\_\_\_\_ 1 Reading: Read and obey the following: "Close your eyes" (show the patient the item written on reverse side).
- \_\_\_\_\_ 3 Three-Stage Command: Follow the three-stage command, "Take a paper in your right hand; fold it in half; and put it on the table."
- \_\_\_\_\_ 1 Writing: Write a sentence (on reverse side).
- \_\_\_\_\_ 1 Copying: Copy the design of the intersecting pentagons (on reverse side).

\_\_\_\_\_ 30 **TOTAL SCORE POSSIBLE**

Adapted from Folstein MF, Folstein S, McHugh PR. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975; 12:189-98.

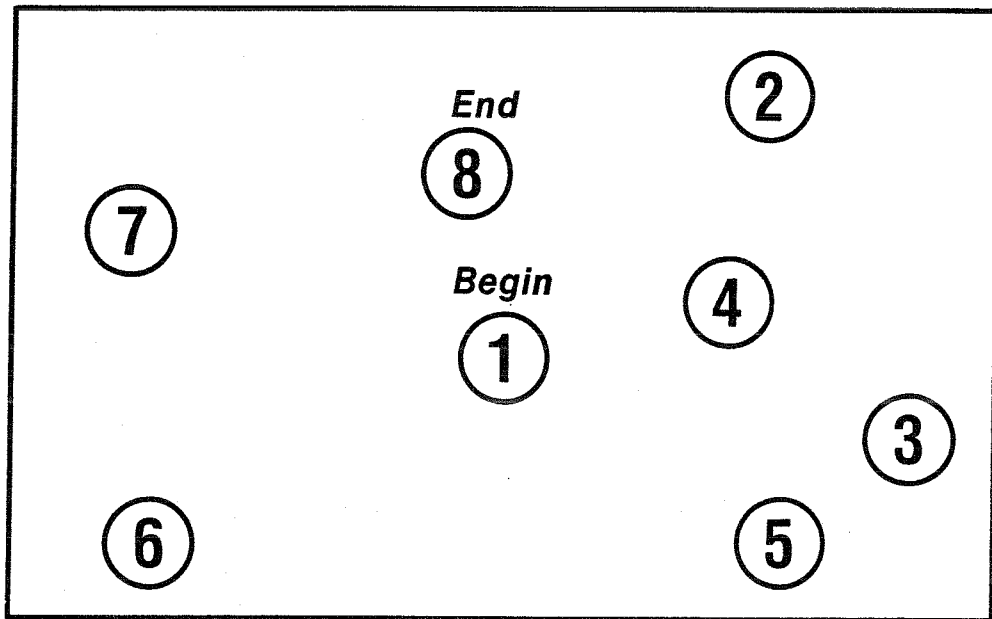
**“CLOSE YOUR EYES.”**



# TRAIL MAKING

## Part A

### SAMPLE



15

17

21

20

19

16

18

4

22

5

13

6

*Begin*

24

7

1

14

2

8

10

3

9

*End*

25

11

12

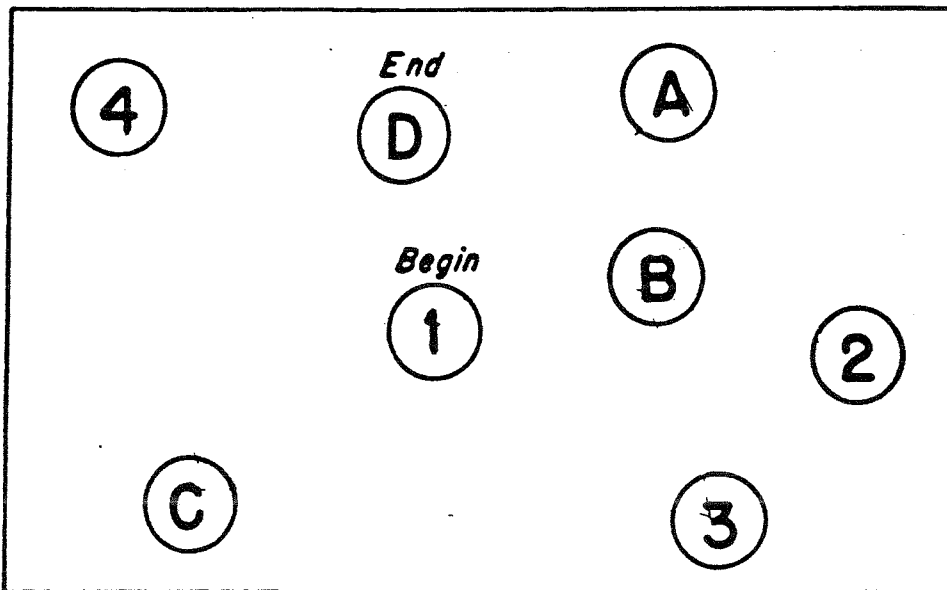
23



# TRAIL MAKING

## Part B

SAMPLE



End

13

10

8

9

I

D

B

4

3

Begin

1

7

5

H

C

12

G

A

J

2

6

L

E

F

K

11

## **APPENDIX B**

### **Driving Knowledge Tests**

## Elderly Driver Pre- Knowledge Measurement

On the answer sheet: put an X on the best answer.

1. A center lane marked on each side by SOLID AND BROKEN yellow lines is for
  - A. Passing.
  - B. Left turns in mid-block. =====
  - C. Center lane parking. =====
  - D. No crossing.
  
2. You are stopped in the right lane at an intersection controlled by a red traffic signal. Deciding that you want to make a left turn as the light turns green you should
  - A. Back up and pull into the left turn lane.
  - B. Wait until the intersection is cleared.
  - C. Go to the next intersection.
  - D. Go ahead with your left turn.
  
3. A driver cannot make a 'protected left turn' without having which of the following?
  - A. A green light.
  - B. A 'left turn only' lane.
  - C. A left green arrow.
  - D. No oncoming traffic.
  
4. Who must yield the right-of-way if the traffic light facing you turns red while you are waiting in the intersection before turning left?
  - A. The driver with the green light must yield the right-of-way.
  - B. The driver who moves forward first may proceed.
  - C. The driver on your right may proceed.
  - D. You must yield the right-of-way.
  
5. Which of these would be the most serious left-turn ERROR?
  - A. Fail to check blind spot early.
  - B. Not allow enough gap in oncoming traffic.
  - C. Fail to show left turn signal on turning.
  - D. Not pull into intersection to wait.
  
6. Which is the best position to take when waiting to make an unprotected left turn in heavy traffic?
  - A. Remain standing behind the crosswalk.
  - B. Car wheels straight while halfway into intersection.
  - C. Wheels pointed left while halfway into intersection.
  - D. Position depends on traffic conditions.

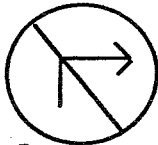
7. You plan to make a left turn at the green light with oncoming traffic within 1/2 block. You should decide to
  - A. Stop behind the crosswalk and wait for a bigger gap.
  - B. Drive to the center of the intersection and wait for a gap.
  - C. Start turning before first car reaches intersection.
  - D. Wait until the signal changes and then turn on red.
  
8. You want to make a left turn in heavy downtown traffic oncoming traffic forces you to stop and wait for a gap. Which of these driver actions would be a MISTAKE?
  - A. Turn when a car one block away is approaching at normal speed.
  - B. Point your front wheels to the left.
  - C. Still be in the intersection when the light turns yellow.
  - D. Check for cars from the right just before you turn.
  
9. A left turn on red can be made from a one-way street if
  - A. You turn into the inside lane.
  - B. You turn into the far lane.
  - C. The cross street is a one-way street to the left.
  - D. The caution light is on.
  
10. What are the first steps you should take when preparing to make a left turn at the next intersection?
  - A. Signal when you reach the intersection.
  - B. Be in or get into the correct lane.
  - C. Speed up but proceed with caution.
  - D. Follow the car ahead to the intersection.
  
11. You wish to turn left but there is oncoming traffic and cars in the intersection. The yellow light comes on. What may you safely do in this situation?
  - A. Wait for red.
  - B. Turn as soon as all oncoming traffic stops.
  - C. Avoid completing your left turn.
  - D. Turn the instant the yellow comes on.
  
12. In what situation can a turn be made from other than the far left legal lane?
  - A. When there is no traffic in the other lanes.
  - B. When the intersection has a left turn signal light.
  - C. When there is no oncoming traffic.
  - D. When traffic signs and pavement markings indicate so.

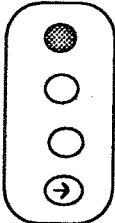
13. You are driving in the right lane of a multilane street in heavy traffic. You wish to turn left at an intersection several blocks ahead. Where should you make your lane change?
- A. Near the corner you wish to turn.
  - B. 1/2 block from that intersection.
  - C. 1 block from that intersection.
  - D. Several blocks from that intersection.
14. When making a left turn in heavy traffic you must yield to which cars?
- A. The first oncoming car.
  - B. Only cars within the intersection.
  - C. All oncoming cars regardless of distance.
  - D. Any vehicle in or close to intersection.
15. If you are traveling in the business district of a city and want to turn. what do you need to identify first from the following?
- A. Other cars turning.
  - B. Pedestrians in the crosswalk.
  - C. If there is a traffic light.
  - D. If it is a one-way or two-way street.
16. The driver who is turning left at an intersection shall
- A. Stop before entering the cross street.
  - B. Yield the right-of-way to pedestrians crossing the street he/she is entering.
  - C. Approach in the inside lane.
  - D. Blow horn to signify his/her intentions.
17. The best way to approach a light that has been green for some time is to
- A. Expect it to stay green.
  - B. Expect it to change.
  - C. Speed up and hurry through.
  - D. Slow way down.
18. Which of the following is the best example of what you should know regarding lane of travel?
- A. Change lanes quickly.
  - B. Change lanes often.
  - C. Staying to right edge of lane.
  - D. Select best lane.

19. A traffic signal turns green just as you reach an intersection. You should
- A. Be alert for cars running the red light on the cross street.
  - B. Stop just to be safe.
  - C. Feel good because you have judged the traffic signals correctly.
  - D. Increase speed to clear the intersection quickly.
20. Right-of-way laws provide us:
- A. our basic rights as drivers.
  - B. rules for turning right.
  - C. rules for when to yield to others.
  - D. principles for land usage.
21. Which scanning habit will help you most in judging the speed and anticipating possible changes in direction of other cars?
- A. checking mirrors regularly.
  - B. moving your eyes regularly.
  - C. ground viewing.
  - D. making head checks.
22. When turning left into a ONE WAY STREET it is usually best to:
- A. turn into for left legal lane.
  - B. keep to the right.
  - C. turn into the lane that has the least traffic.
  - D. turn into the lane just right of the center line.
23. The last thing you should do before leaving a parking space and turning left into the traffic lane is
- A. Signal your intention.
  - B. Recheck for traffic.
  - C. Begin turning the steering wheel.
  - D. Shift to drive.
24. Which is the most important thing for a driver to do before turning left onto a new street.
- A. Release the brake.
  - B. Check for traffic.
  - C. Signal his/her intentions.
  - D. Yield to traffic on the street.
25. Which is the correct lane change procedure to follow?
- A. Mirror- Headcheck- Signal.
  - B. Signal- Headcheck- Mirror.
  - C. Headcheck- Mirror- Signal.
  - D. Mirror- Signal- Headcheck.

- 26) When making a lane change what else should you do besides use turn signals?
- A. Slow down a little.
  - B. Make a blind spot check.
  - C. Show a hand signal.
  - D. Flash your brake lights.
27. Under normal highway traffic conditions, a driver should look ahead of his or her car a distance equal to at least:
- A. 1-2 seconds.
  - B. 4-6 seconds.
  - C. 7-11 seconds.
  - D. 12-15 seconds.
28. At 50 mph and under normal conditions with good tires, brakes and dry pavement, what is the minimum distance you need to see ahead in your path?
- A. five seconds.
  - B. one second.
  - C. three seconds.
  - D. two seconds.
29. When another car is following your car too closely (tailgating), it is best to allow a greater space margin:
- A. to the right side.
  - B. to the left side.
  - C. to both sides.
  - D. to the front.
30. The best way to provide yourself an escape path in case of an emergency is with
- A. distance to the front.
  - B. distance to the sides.
  - C. distance to the rear.
  - D. all of the above.
31. A driver has the most control over the space margin to the:
- A. front.
  - B. rear.
  - C. right side.
  - D. left side.

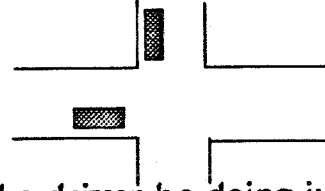


32. A right turn from a one-way street should be made from
- A. Either of the two lanes on the right side of the street.
  - B. Any lane unless prohibited by a sign or pavement marking.
  - C. A position to the right of the center of the street.
  - D. The right lane.
33. When driving around a curve to the left your vehicle will tend to
- A. Speed up.
  - B. Move to the outside of the curve.
  - C. Stay in the center of the lane.
  - D. Move to the inside of the curve.
34. Signs like this mean that a driver
- A. Must stop before turning.
  - B. Cannot turn right.
  - C. Cannot turn left.
  - D. Is coming to a sharp right turn.
- 
35. From which lane should you leave a one-way street?
- A. An outside lane unless marked otherwise.
  - B. A center lane.
  - C. Any lane that is open.
  - D. Always the left lane.
36. You intend to turn into a driveway just after an intersection. When should you signal?
- A. Before you enter the intersection.
  - B. As you enter the intersection.
  - C. When you are actually in the intersection.
  - D. At the driveway.
37. When a signal light with a red 'X' is located above a traffic lane, it means:
- A. Stop and yield.
  - B. Stop and wait for green arrow.
  - C. Do not drive in that lane.
  - D. Dangerous crossing ahead.
38. What does a broken white center line on a city street indicate?
- A. A 1-way street.
  - B. A 4-lane and 2-way street.
  - C. A 3-lane street.
  - D. Pedestrian zone.

39. A car is traveling 20 mph reaches the crosswalk just as the green signal light changes to yellow. The driver should:
- stop and then back out of the intersection.
  - stop and stay in the intersection.
  - continue through intersection with caution.
  - speed up to get through the intersection.
40. When you are approaching a traffic signal and see a green arrow pointing to the right and you want to turn right - you should
- Stop and then you may turn right.
  - Slow down and then turn right when signal is solid green.
  - Yield to cross traffic and then turn right.
  - Continue on and make your right turn.
41. To turn right with a red light and a green arrow to the right you should react just as you would to a
- Stop sign.
  - Flashing red light.
  - Yield sign.
  - Green light and don't walk.
- 
42. You are approaching an intersection on a red light and want to turn right. Before turning you must
- Slow down as you would at a yellow light.
  - Maintain the some speed to keep up with traffic.
  - Come to a full stop as you would at a stop sign.
  - Stop only if someone is in your way.
43. Which is the best way to give yourself more time for stopping in case you need to?
- Look far ahead so you can react sooner.
  - Speed up your thinking and deciding.
  - Practice moving your foot faster.
  - Practice to develop faster reaction time.
44. You approach an uncontrolled intersection and are not sure whether to go in front of a car approaching from your left. What should you do?
- Rely on the right-of-way rule.
  - Delay entering the intersection.
  - Depend on the other driver to stop.
  - Sound your horn to alert the other driver.

46) When two cars are approaching a four-way stop which driver must Yield?

- A. The driver who arrives first.
- B. The driver who arrives second.
- C. The driver on the left yields.
- D. The driver on the right yields.



47) At an uncontrolled intersection what should a driver be doing just before he/she enters the intersection?

- A. Check to see if intersection is controlled or uncontrolled.
- B. Check to determine sight distance each way.
- C. Take a first look for cars.
- D. Take a second look to right and left.

48) How is a correct right turn made?

- A. Center lane to right lane.
- B. Left lane to the right lane.
- C. Right lane to the right lane.
- D. Right lane to any open lane.

49) In which situation should the brake be covered?

- A. The driver ahead accelerates sharply.
- B. A child is running on the side of the road.
- C. The driver behind you brakes suddenly.
- D. You are accelerating to join the traffic.

50) You must yield the right-of way to a blind person...

- A. Only in marked crosswalks.
- B. Regardless of the situation.
- C. When the traffic light is red.
- D. Only at intersections.

## Elderly Driver Post- Knowledge Measurement

On the answer sheet: put an X on the best answer.

- 1) A center lane marked on each side by SOLID AND BROKEN yellow lines is for \_\_\_\_\_
- A. Passing. =====
- B. Left turns in mid-block. =====
- C. Center lane parking. =====
- D. No crossing. =====
- 2) You are stopped in the right lane at an intersection controlled by a red traffic signal. Deciding that you want to make a left turn as the light turns green you should
- A. Back up and pull into the left turn lane.
- B. Wait until the intersection is cleared.
- C. Go to the next intersection.
- D. Go ahead with your left turn.
- 3) Which of the following is required in order to make a protected left turn?
- A. A left green arrow.
- B. No oncoming traffic.
- C. A left turn only lane.
- D. A green light.
- 4) Who must yield the right-of-way if the traffic light facing you turns red while you are waiting in the intersection before turning left?
- A. The driver with the green light must yield the right-of-way.
- B. The driver who moves forward first may proceed.
- C. The driver on your right may proceed.
- D. You must yield the right-of-way.
- 5) Which of these would be the most serious left-turn ERROR?
- A. Fail to check blind spot early.
- B. Not allow enough gap in oncoming traffic.
- C. Fail to show left turn signal on turning.
- D. Not pull into intersection to wait.
- 6) Which is the best position to take when waiting to make an unprotected left turn in heavy traffic?
- A. Remain behind the crosswalk.
- B. Car straight part of way into intersection.
- C. Wheels pointed left part way into intersection.
- D. Position depends on your vehicle.

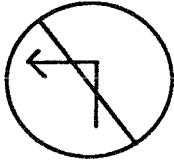
- 7) You plan to make a left turn at the green light with oncoming traffic within 1/2 block. You should decide to
- A. Stop behind the crosswalk and wait for a gap in traffic.
  - B. Drive part way into the intersection and wait for a gap.
  - C. Begin the turn before the first car enters the intersection.
  - D. Wait until the signal has changed then turn left on red.
- 8) You want to make a left turn in heavy downtown traffic oncoming traffic forces you to stop and wait for a gap. Which of these driver actions would be a MISTAKE?
- A. Turn when a car one block away is approaching at normal speed.
  - B. Point your front wheels to the left.
  - C. Still be in the intersection when the light turns yellow.
  - D. Check for cars from the right just before you turn.
- 9) A left turn on red can be made from a one-way street if
- A. You turn into the inside lane.
  - B. You turn into the far lane.
  - C. The cross street is a one-way street to the left.
  - D. The cross street is a two-way street.
- 10) What are the first steps you should take when preparing to make a right or left turn at the next intersection?
- A. Signal when you reach the intersection.
  - B. Be in or get into the correct lane.
  - C. Speed up but proceed with caution.
  - D. Follow the car ahead to the intersection.
- 11) You wish to turn left but there is oncoming traffic and cars in the intersection. The yellow light comes on. What may you safely do in this situation?
- A. Wait for red.
  - B. Turn as soon as all oncoming traffic stops.
  - C. Avoid completing your left turn.
  - D. Turn the instant the yellow comes on.
- 12) In what situation can a turn be made from other than the far left or far right legal lane?
- A. When there is no traffic in the other lanes.
  - B. When the intersection has a left turn signal light.
  - C. When there is no oncoming traffic.
  - D. When traffic signs and pavement markings indicate so.

- 13) You are driving in the right lane of a multilane street in heavy traffic. You wish to turn left at an intersection several blocks ahead. Where should you make your lane change?
- A. Near the corner you wish to turn.
  - B. 1/2 block from that intersection.
  - C. 1 block from that intersection.
  - D. Several blocks from that intersection.
- 14) When making a left turn in heavy traffic you must yield to which cars?
- A. The first oncoming car.
  - B. Only cars within the intersection.
  - C. All oncoming cars regardless of distance.
  - D. Any vehicle in or close to intersection.
- 15) If you are traveling in the business district of a city and want to turn what do you need to identify first from the following?
- A. Other cars turning.
  - B. Pedestrians in the crosswalk.
  - C. If there is a traffic light.
  - D. If it is a one-way or two-way street.
- 16) The driver who is turning left at an intersection shall
- A. Stop before entering the cross street.
  - B. Yield the right-of-way to pedestrians crossing the street he/she is entering.
  - C. Approach in the inside lane.
  - D. Blow horn to signify his/her intentions.
- 17) The best way to approach a light that has been green for some time is to
- A. Expect it to stay green.
  - B. Maintain speed but be ready to stop.
  - C. Speed up and hurry through.
  - D. Slow way down.
- 18) Which of the following is the best example of what you should know regarding lane of travel?
- A. Change lanes quickly.
  - B. Change lanes often.
  - C. Staying to right edge of lane.
  - D. Select best lane.

- 19) A traffic signal turns green just as you reach an intersection. You should
- A. Be alert for cars running the red light on the cross street.
  - B. Stop just to be safe.
  - C. Feel good because you have judged the traffic signals correctly.
  - D. Increase speed to clear the intersection quickly.
- 20) Right-of-way laws provide us:
- A. our basic rights as drivers.
  - B. rules for turning right.
  - C. rules for when to yield to others.
  - D. principles for land usage.
- 21) Which scanning habit will help you most in judging the speed and anticipating possible changes in direction of other cars?
- A. checking mirrors regularly.
  - B. moving your eyes regularly.
  - C. ground viewing.
  - D. making head checks.
- 22) When turning left into a ONE WAY STREET it is usually best to:
- A. turn into far left legal traffic lane.
  - B. keep to the right.
  - C. turn into the lane that has the least traffic.
  - D. turn into the lane just right of the center line.
- 23) What should you do just before leaving a parking space and turning left into the traffic lane?
- A. Signal your intention.
  - B. Recheck for traffic.
  - C. Begin turning the steering wheel.
  - D. Shift to drive.
- 24) Which is the most important thing for a driver to do before turning left onto a new street?
- A. Release the brake.
  - B. Check for traffic.
  - C. Signal his/her intentions.
  - D. Yield to traffic on the street.
- 25) Which is the correct lane change procedure to follow?
- A. Mirror- Headcheck- Signal.
  - B. Signal- Headcheck- Mirror.
  - C. Headcheck- Mirror- Signal.
  - D. Mirror- Signal- Headcheck.

- 26) You should check blind spots to the rear by:
- A. using the inside mirror.
  - B. using the outside mirror.
  - C. using both the inside and outside mirrors.
  - D. looking over your shoulder.
- 27) A driver should always try to maintain a visual lead time of
- A. 2 seconds.
  - B. 4-6 seconds.
  - C. 8 seconds.
  - D. 12-15 seconds.
- 28) As you travel at faster speeds on a highway you should
- A. Increase the distance between your car and the one in front of you.
  - B. Grip the steering wheel more tightly.
  - C. Move to the emptiest lane on the road.
  - D. Keep in the left or center lane rather than the right.
- 29) Your following distance should be longer than two seconds when
- A. Your engine needs a tune-up.
  - B. The driver in front is driving slowly.
  - C. You are on a one-way street.
  - D. The driver behind you is tailgating.
- 30) What part of the space cushion around a car can a driver control most easily without disturbing other drivers?
- A. Ahead of the car.
  - B. Behind the car.
  - C. In the next lane to the right.
  - D. In the next lane to the left.
- 31) The closer you follow the car ahead the
- A. Easier it will be to see around the car ahead.
  - B. Quicker you will reach your destination.
  - C. Harder it will be to stop safely.
  - D. Easier it will be to change lanes.
- 32) A right turn from a one-way street should be made from
- A. Either of the two lanes on the right side of the street.
  - B. Any lane unless prohibited by a sign or pavement marking.
  - C. A position to the right of the center of the street.
  - D. The right lane.

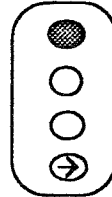


- 33) When driving around a curve to the left your vehicle will tend to
- Speed up.
  - Move to the outside of the curve.
  - Stay in the center of the lane.
  - Move to the inside of the curve.
- 34) Signs like this mean that a driver
- Must stop before turning.
  - Cannot turn right.
  - Cannot turn left.
  - Is coming to a sharp right turn.
- 
- 35) From which lane should you leave a one-way street?
- An outside lane.
  - A center lane.
  - Any lane that is open.
  - Always the left lane.
- 36) You intend to turn into a driveway just after an intersection. When should you signal?
- Before you enter the intersection.
  - As you enter the intersection.
  - When you are actually in the intersection.
  - At the driveway.
- 37) When a signal light with a red "X" is located above a traffic lane, it means:
- This lane is closed to traffic in your direction.
  - Pedestrians must not walk.
  - A stop sign is ahead.
  - A school crossing is ahead.
- 38) What does a broken white line between two lanes on a city street indicate?
- A 1-way street.
  - A 4-lane and 2-way street.
  - A 3-lane street.
  - Pedestrian zone.
- 39) A car is traveling 20 mph reaches the crosswalk just as the green signal light changes to yellow. The driver should:
- stop and then back out of the intersection.
  - stop and stay in the intersection.
  - continue through intersection with caution.
  - speed up to get through the intersection.

- 40) When you are approaching a light and see a green arrow pointing to the right you want to turn right - you should
- A. Stop and then you may turn right.
  - B. Slow down and then turn right when signal is solid green.
  - C. Yield to cross traffic and then turn right.
  - D. Continue on and make your right turn.

- 41) To turn right with a red light and a green arrow you should react just as you would to a

- A. Stop sign.
- B. Flashing red light.
- C. Yield sign.
- D. Green light and don't walk.



- 42) You are approaching an intersection on a red light and want to turn right. Before turning you must
- A. Slow down as you would at a yellow light.
  - B. Maintain the some speed to keep up with traffic.
  - C. Come to a full stop as you would at a stop sign.
  - D. Stop only if someone is in your way.

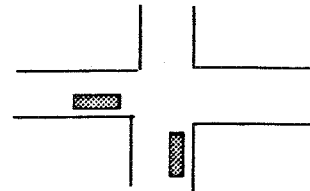
- 43) Which is the best way to give yourself more time for stopping in case you need to?
- A. Look far ahead so you can react sooner.
  - B. Speed up your thinking and deciding.
  - C. Practice moving your foot faster.
  - D. Practice to develop faster reaction time.

- 44) When two vehicles arrive at an uncontrolled intersection from different streets.
- A. Driver on the right shall yield to the vehicle on the left.
  - B. Driver on the left shall yield to the vehicle on the right.
  - C. Both vehicles must stop.
  - D. Neither vehicle must stop.

- 45) You are driving in an urban area, and approaching a car that has just parked at the curb. The driver is about to open the door to get out. An oncoming car is approaching in the center of its lane. You should:
- A. tap horn and maintain center of lane position and reduce speed.
  - B. tap horn and maintain center of lane position and increase speed.
  - c. tap horn and more to left close to center line and increase speed.
  - D. tap horn and move to left close to center line and reduce speed.

45. You are driving in an urban area, and approaching a car that has just parked at the curb. The driver is about to open the door to get out. An oncoming car is approaching in the center of its lane. You should:
- A. tap horn and maintain center of lane position and reduce speed.
  - B. Tap horn and maintain center of lane position and increase speed.
  - c. tap horn and move to left close to center line and increase speed.
  - D. tap horn and move to left close to center line and reduce speed.

46. When two cars are approaching a four-way stop which driver must Yield?
- A. The driver who arrives first.
  - B. The driver who arrives second.
  - C. The driver on the left yields.
  - D. The driver on the right yields.



47. Just before entering an intersection you should
- A. Check to see if the intersection is controlled or uncontrolled.
  - B. Determine your sight distance in each direction.
  - C. Take your first look for pedestrians and other vehicles.
  - D. Take your final check to the left and to the right.

48. How is a correct right turn made?
- A. Center lane to right lane.
  - B. Left lane to the right lane.
  - C. Right lane to the right lane.
  - D. Right lane to any open lane.

49. To help overcome the problem of the unexpected behavior of young children, you should make a special effort to
- A. obey right-of-way laws.
  - B. understand how young children act.
  - C. use the ground viewing habit.
  - D. learn the amount of time required to cross streets.

50. You must yield the right-of way to a blind person...
- A. Only in marked crosswalks.
  - B. Regardless of the situation.
  - C. When the traffic light is red.
  - D. Only at intersections.



## **APPENDIX C**

### **DPM Evaluation Forms**

SUBJECT \_\_\_\_\_ Immanuel Medical Center  
 NUMBER: \_\_\_\_\_ Road Test  
 Examiner \_\_\_\_\_ Rating Form  
 DRIVER LICENSE NUMBER \_\_\_\_\_

Performance on:

Trial #1 \_\_\_\_\_  
 Trial #2 \_\_\_\_\_  
 Search \_\_\_\_\_  
 Speed \_\_\_\_\_  
 Direction \_\_\_\_\_

Sat. \_\_\_\_\_

Date \_\_\_\_\_

TEST SEQUENCE	1	TEST SEGMENT PERFORMACE	SEARCH	SPEED CONTROL	DIRECTION CONTROL
1.1		APPROACH TO MILITARY AV.			
		U-----S	U — S	U — S	U — S
		Searches only forward			
		Doesn't use turn signal			
		Doesn't adjust speed soon enough			
		On lane lines of roadway			
		Searches all directions			
		Signals correctly			
		Reduces speed gradually and stops			
		Tracks vehicle in center of lane			
1.2		RIGHT TURN ON MILITARY AV.			
		U-----S	U — S	U — S	U — S
		Searches Only forward			
		Doesn't wait for traffic clearance			
		Accelerates too slow			
		Doesn't adjust speed to rear traffic			
		Doesn't track vehicle in center of lane			
		Searches all direactions, especially left			
		Waits for vehicle/pedestrian clearance			
		Accelerates correctly			
		Coordinates speed correctly			
		Centers vehicle in correct lane			
1.3		ACCELERATING AND TRACKING ON MILITARY AV.			
		U-----S	U — S	U — S	U — S
		Searches only forward			
		Poor acceleration control			
		Doesn't track properly			
		Doesn't adjust speed correctly			
		Searches all directions, especially left rear			
		Accelerates out of turn			
		Centers vehicle in right lane			
		Adjust speed to traffic and roadway conditions			

**TEST SEQUENCE 2**

**2.1 APPROACH TO FORT STREET**

U-----S

SEARCH	SPEED CONTROL	DIRECTION CONTROL
U — S	U — S	U — S

Doesn't signal	Signals lane change
Searches only front	Searches all directions especially rear
Doesn't check blind spot	Checks blind spot, head check left
Doesn't track vehicle in correct lane	Tracks vehicle in correct lane
Doesn't move into turn lane	Moves left into turn lane
On lane line	Tracking in center of turn bay
Doesn't adjust speed	Reduces speed gradually and stops if necessary

**2.2 LEFT TURN ONTO FORT STREET**

U-----S

U — S	U — S	U — S
-------	-------	-------

Searches only front	Searches all directions, especially front
Doesn't signal	Signals correctly
Doesn't wait for traffic clearance	Waits for vehicle/pedestrian clearance
Accelerate too slow	Accelerates smoothly to traffic speed
Doesn't track vehicle in correct lane	Tracks vehicle into corresponding lane

**2.3 ACCELERATION AND TRACKING ON FORT STREET**

U-----S

U — S	U — S	U — S
-------	-------	-------

Doesn't accelerate out of turn	Accelerates out of turn
Doesn't track vehicle into center of lane	Tracks vehicle in center of lane
Searches only ahead	Searches all directions, especially rear and right
Poor acceleration control	Adjust speed to traffic and conditions

Test Sequence 3

		SEARCH	SPEED CONTROL	DIRECTION CONTROL
3.1 APPROACH TO BLONDO STREET				
U-----S		U — S	U — S	U — S
Doesn't signal	Signals lane change			
Searches only front	Searches all directions, especially rear			
Doesn't check blind spot	Checks blind spot, head check left			
Doesn't track vehicle in correct lane	Tracks vehicle in correct lane			
Doesn't move into turn lane	Moves left into turn lane			
On lane line	Tracking in center of turn bay			
Doesn't adjust speed	Reduces speed gradually and stops if necessary			
3.2 LEFT TURN ONTO BLONDO STREET				
U-----S		U — S	U — S	U — S
Searches only front	Searches all directions, especially left and front			
Doesn't signal	Signals correctly			
Doesn't follow signal	Waits for green signal or arrow			
Doesn't wait for traffic clearance	Waits for vehicle/pedestrian clearance			
Doesn't track correctly	Tracks vehicle in correct lane			
3.3 ACCELERATION AND TRACKING ON BLONDO STREET				
U-----S		U — S	U — S	U — S
Doesn't accelerate out of turn	Accelerates out of turn			
Doesn't track vehicle in center of lane	Tracks vehicle in center of lane			
Searches only ahead	Searches all directions, especially rear and right			
Poor speed control	Adjust speed to traffic and roadway conditions			



Test Sequence 4

		<u>SEARCH</u>	<u>SPEED CONTROL</u>	<u>DIRECTION CONTROL</u>
4.1	APPROACH TO 72ND STREET			
	U-----S	U — S	U — S	U — S
	Doesn't signal			
	Searches only front			
	Doesn't check blind spot			
	Doesn't track vehicle in correct lane			
	Doesn't move into turn lane			
	On lane line			
	Doesn't adjust speed			
	Signals lane change			
	Searches all directions, especially rear			
	Checks blind spot, head check left			
	Tracks vehicle in correct lane			
	Moves left into turn lane			
	Tracking in center of turn bay			
	Reduces speed gradually and stops if necessary			
4.2	LEFT TURN ONTO 72ND STREET			
	U-----S	U — S	U — S	U — S
	Searches only front			
	Doesn't signal			
	Doesn't follow signal			
	Doesn't wait for traffic clearance			
	Doesn't track correctly			
	Searches all directions, especially front and right			
	Signals correctly			
	Waits for green arrow or signal			
	Waits for vehicle/pedestrian clearance			
	Tracks vehicle in correct lane			
4.3	ACCELERATION AND TRACKING ON 72ND STREET			
	U-----S	U — S	U — S	U — S
	Doesn't accelerate out of turn			
	Doesn't track vehicle in center of correct lane			
	Searches only front			
	Poor speed control			
	Accelerates out of turn			
	Tracks vehicle in center of correct lane			
	Searches all directions, especially rear and right			
	Adjust speed to traffic and conditions			

Sequence 5

<u>SEARCH</u>	<u>SPEED CONTROL</u>	<u>DIRECTION CONTROL</u>
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5.1 APPROACH TO MAPLE STREET

U-----S	U — S	U — S	U — S
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Doesn't signal  
 Searches only front  
 Doesn't track vehicle in correct lane  
 Doesn't move into turn lane  
 On lane line  
 Doesn't adjust speed

Signals correctly  
 Searches all directions, especially left  
 Tracks vehicle in correct lane  
 Moves left into turn lane  
 Tracking in center of turn bay  
 Reduces speed gradually and stops if necessary

5.2 LEFT TURN ONTO MAPLE STREET

U-----S	U — S	U — S	U — S
---------	-------	-------	-------

Searches only front  
 Doesn't signal  
 Doesn't follow signal  
 Doesn't wait for traffic clearance  
 Doesn't track correctly

Searches all directions, especially left  
 Signals correctly  
 Waits for green arrow and signal  
 Waits for vehicle/pedestrian clearance  
 Tracks vehicle in correct lane

5.3 ACCELERATION AND TRACKING ON MAPLE STREET

U-----S	U — S	U — S	U — S
---------	-------	-------	-------

Doesn't accelerate out of turn  
 Doesn't track vehicle in center of correct lane  
 Searches only front  
 Poor speed control

Accelerates out of turn  
 Tracks vehicle in center of correct lane  
 Searches all directions, especially rear and right  
 Adjust speed to traffic and conditions

Sequence 6

		<u>SEARCH</u>	<u>SPEED CONTROL</u>	<u>DIRECTION CONTROL</u>
6.1 UNCONTROLLED "T" INTERSECTION AT SPENCER STREET				
U-----S		U — S	U — S	U — S
Searches only front	Searches all directions, especially right			
Doesn't decelerate correctly	Adjust speed to traffic conditions			
Doesn't cover brake	Covers brake			
Doesn't track vehicle correctly	Tracks vehicle on left/center of roadway			
Improper position at intersection	Stops in appropriate location if necessary			
6.2 UNCONTROLLED "T" INTERSECTION AT 75TH STREET				
U-----S		U — S	U — S	U — S
Searches only front	Searches all directions, especially left			
Doesn't decelerate correctly	Adjust speed to vehicle/pedestrian conditions			
Doesn't cover brake	Covers brake			
Doesn't track vehicle correctly	Tracks vehicle on right part of roadway			
Improper position at intersection	Stops in appropriate location if necessary			
6.3 APPROACH AND TURN ONTO 72ND STREET				
U-----S		U — S	U — S	U — S
Search only front	Search all directions, especially rear and left			
Doesn't decelerate correctly	Adjust speed to traffic and roadway conditions			
Doesn't come to a complete stop	Comes to a complete stop at proper position			
Doesn't signal	Signals correctly			
Doesn't wait for traffic clearance	Waits for vehicle/pedestrian clearance			
Doesn't track correctly	Tracks vehicle in correct lane			
Poor speed control	Adjust speed to traffic conditions			

Sequence 7

		SEARCH	SPEED CONTROL	DIRECTION CONTROL
7.1	APPROACH TO 60TH STREET			
	U-----S	U — S	U — S	U — S
	Searches only front Doesn't signal Doesn't track vehicle in correct lane On left lane line Doesn't adjust speed	Searches all directions, especially left Signals correctly Tracks vehicle in correct lane Moves in center of turn lane Reduces speed gradually and stops if necessary		
7.2	LEFT TURN ONTO 60TH STREET			
	U-----S	U — S	U — S	U — S
	Searches only front Doesn't signal Doesn't follow signal Doesn't wait for traffic clearance Doesn't track correctly	Searches all directions, especially left Signals correctly waits for green signal waits for vehicle/pedestrian clearance Tracks vehicle in correct lane position		
7.3	ACCELERATION AND TRACKING ON 60TH STREET			
	U-----S	U — S	U — S	U — S
	Doesn't accelerate out of turn Doesn't track vehicle in center of lane Searches only ahead Poor speed control	Accelerates out of turn Tracks vehicle in center of lane Searches all directions, especially front Adjust speed to traffic and conditions		