AN INVENTORY OF CRITICAL DRIVER KNOWLEDGE FOR MOTOR VEHICLE OPERATORS AGE 65 AND OLDER IN INGHAM COUNTY, MICHIGAN

By

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ABSTRACT

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Statement of the Problem

Since the level of critical driver knowledge among senior drivers is not known, it was the purpose of the study to test and report the level of critical driver knowledge for four groups of Ingham County senior drivers: males with no accidents; females with no accidents; males with one or more accidents in the past two years; and females with one or more accidents in the past two years. An analysis of the data was made to determine (1) the level of critical driver knowledge in the senior driver population, (2) whether the mean critical driver knowledge scores of males and females were equal, (3) whether the mean critical driver knowledge scores for senior drivers with accidents were equal to the mean critical driver knowledge scores of senior drivers with no accidents in the past two years, and (4) whether the mean critical driver knowledge scores were equal for males with accidents, males with no accidents, females with accidents, and females with no accidents.

Methods of Procedure

The University of Michigan's Special Test Set was selected as the measure of critical driver knowledge for the study. The special test set items were written from the very and most cricical tasks identified in the HumRRo driving task analysis. The 246-item special test set was too large to be easily given to one person; therefore, it was divided into three equivalent 82-item forms, Forms A, B, and C.

A random sample of 156 Ingham County senior drivers was stratified into four study cells of equal size. Each person in the 39-subject study cells was randomly assigned to one of three equal size sub-cells. One form of the knowledge inventory, either Form A, B, or C, was randomly assigned to be administered to all thirteen subjects in each sub-cell. These knowledge inventories were administered during a two hour interview in the subjects' homes. Individuals' scores were transferred to mark-sense sheets for use in computer analysis.

The Major Findings

1. Senior drivers were significantly deficient in critical driver knowledge. The mean score for senior drivers was 63 percent correct and the pre-set cutting score for non-deficient critical driver knowledge was 80 percent correct. The difference between the means was significant at the .05 level.

2. Twenty-five senior drivers or 16 percent of the sample were not deficient in critical driver knowledge as they attained or surpassed a score of 80 percent correct on the knowledge inventory.

3. The twenty-four most missed questions dealt with vehicle control, traffic control signs and signals, license and vehicle registration, freeway driving, right and left turns, dimming headlights, and drugs and alcohol.

4. The five topical divisions of the knowledge inventory with the highest mean item difficulty scores were railroad crossings, bridges and tunnels, emergency situations and manuvers, skid control, driver licensing, and night driving.

5. The six topical divisions of the knowledge inventory with the lowest mean item difficulty scores were vehicle equipment, vehicle care and service, general highway driving, anti-theft laws, vehicle inspection, and accidents and accident reports.

6. Eighteen items in the special test set were found to have an item discrimination value of 0 or less.

7. There was no significant difference between mean scores of male and female senior drivers.

8. There was no significant difference between the mean scores of senior drivers who had been in one or more accidents in the past two years and senior drivers who had not been in an accident in the past two years.

9. The mean scores of male or female senior drivers did not depend on their level of accident experience.

This study would not have been attempted without the encouragement and support of a dedicated professional in the field of traffic safety. This study is dedicated to Professor Robert F. Shrader of Miami University, Oxford, Ohio.

"Doc" brought me into the field, and fired me with the dreams and desires necessary to attempt and complete a Ph.D. program in traffic safety.

Thomas L. Miller

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CHAPTER I

THE PROBLEM

Past research has identified the senior driver population as a high accident risk, problem driver group.[1,2,3] Senior drivers are involved in more accidents for their exposure than any other group, except youth, under age 25.[4] They are also more likely to die or suffer serious injury when involved in a crash.[5] In response to high accident experience, the senior driver either stops driving prematurely or ignores the obvious and continues to drive, a hazard to himself and others. Both arbitrary limitations of senior citizen mobility in this highly automobile-dependent society and suffering caused by crashes involve great social costs.

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[1]U.S. Department of Transportation, The Driver Education Evaluation Program (DEEP) Study (Washington, D.C.: Government Printing Office, 1975), p. 19.

[2]E. Allgaier, "Accident Involvement of Senior Drivers," Traffic Digest and Review (March 1965), p. 18.

[3]E. Klebel, "Age and Driver Fitness," Proceedings National Conference on the Aging Driver, American Medical Association and American Association of Motor Vehicle Administrators (Morton Grove: Health and Safety Associates, 1974), p. 39.

[4]T. W. Planek and R. B. Overand, "Profile of the Aging Driver," Traffic Safety (January 1973), p. 2.

[5]S. P. Baker and W. U. Spitz, "Age, Disease and the Driver," Proceedings Third Triennial Congress on Medical and Related Aspects of Motor Vehicle Accidents: International Association for Accident and Traffic Medicine (Ann Arbor: Highway Safety Research Institute, 1971), p. 40.

More recent research in Florida,[6] Michigan[7] and Virginia[8] provided driver refresher classes and materials for a specific senior driver population. Their efforts to identify the level of senior driver knowledge did not go beyond the needs of their specific target population. Therefore, it appears that their results could not be applied to the general senior driver population. In short, no one was sure of what senior drivers did and did not know.

The inventory developed for use in this study was designed to collect information on the amount and scope of critical driver knowledge and its correlation to specified demographic data in the senior driver population. This information was seen as being useful to educators and researchers in developing curriculum and study programs dealing with senior drivers. It should provide the necessary information for development of senior driver refresher courses with wide scale applicability.

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[6]J. L. Crosier, "The Development of Guidelines for a Driver Improvement Program for Residents of a Retirement Community" (Ph. D. dissertation, New York University, 1972).

[7]L. A. Pastalan, et al., Street and Highway Environments and the Older Driver (Ann Arbor: Institute of Gerontology, 1975).

[8]A. J. McKnight and M. Green, Safe Driver Knowledge Dissemination and Testing Techniques, Final Report, Volume 2 (Springfield, Virginia: National Technical Information Service, 1977).

The Problem

Statement of the Problem

Deficient driver knowledge in motor vehicle operators age 65 and older has not been clearly defined. More specifically, to date there has not been a randomly selected group of motor vehicle operators age 65 and older tested for level of driving knowledge with an instrument based on critical driving tasks.

Purpose of Study

The purpose of this study was to identify areas of deficient critical driver knowledge in the Ingham County, Michigan driving population age 65 and older. A second purpose of this study was to compare the mean critical driver knowledge level for the following four groups of Ingham County drivers age 65 and older: males with one or more accidents in the last two years; males with no accidents in the last two years; females with one or more accidents in the last two years; and females with no accidents in the last two years.

The problem was investigated by answering the following research questions:

1. What is the level of critical driver knowledge in the senior driver population?
2. Are the mean critical driver knowledge scores of males equal to the mean critical driver knowledge scores of females?
3. Are the mean critical driver knowledge scores of senior drivers with accidents equal to the mean critical driver knowledge scores of senior drivers with no accidents?

4. Will the mean critical driver knowledge scores be equal for: males with accidents; males with no accidents; females with accidents; and females with no accidents?

Hypotheses

The four hypotheses investigated in the study were:

1. Senior drivers would not show a critical driver knowledge level of 80 percent correct.

$$H_0: \text{ S. D. } \mu = 80$$

$$H_1: \text{ S. D. } \mu \neq 80$$

2. The mean scores for male and female senior drivers would not be equal.

$$H_0: \mu M = \mu F$$

$$H_1: \mu M \neq \mu F$$

3. The mean scores for senior drivers with no accidents in the past two years would not be equal to the mean scores for senior drivers with one or more accidents in the past two years.

$$H_0: \mu \text{ ACC} = \mu \text{ No ACC}$$

$$H_1: \mu \text{ ACC} \neq \mu \text{ No ACC}$$

4. The mean scores for: females with no accidents; females with one or more accidents in the past two years; males with no accidents; and males with one or more accidents in the past two years would not be equal.

$$H_0: \mu F_n = \mu F_y = \mu M_n = \mu M_y$$

$$H_1: \mu F_n \neq \mu F_y \neq \mu M_n \neq \mu M_y$$

Importance of the Study

Groups of senior drivers have shown a fairly consistent range of problem driving behaviors. However, no studies have been made using

random sampling of subjects and a comprehensive list of critical driving knowledge to discover the level of critical driver knowledge in the senior driver population.

It was felt this study could make the following significant contributions to the field of traffic safety:

1. The level of deficient critical driving knowledge will be identified, assisting educators and curriculum planners in "establishment of special driving clinics for elderly drivers," as recommended by the 1975 (DEEP) study.[9]
2. Future researchers into psychomotor and attitudinal aspects of senior driver problems will be provided with the areas of critical driver knowledge as a reference point from which to begin their projects.
3. The results of this study will indicate the main and interaction effects of sex and recorded accident experience on senior driver mean scores of critical driver knowledge.

Limitations of the Study

The data from this study were limited in their direct application to the senior driver population of Ingham County, Michigan, the source of subjects for this study.

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[9]U.S. Department of Transportation, The Driver Education Evaluation Program (DEEP) Study (Washington, D.C.: Government Printing Office, 1975), p. 49.

The results of this study were limited to being only as good as the research documents that preceeded it. One might question how well the Item Bank was constructed. However, the Item Bank is the only definitive source authority of its kind. Great effort was made to make the document a complete, yet workable tool.

Accident records, were, for many reasons, found not to be complete. The data from this research was limited to the unknown level of completeness of the Michigan accident reporting system.

Non-English speaking persons, age 65 and older, with a valid Michigan operator's license were rare and, as they were dropped from the study, remain a limitation of this study.

If the non-participants had been included in the sample they would not have been expected to bias the sample in any systematic manner. Demographic data were collected and compared for all persons contacted in this study.

Definition of Terms

Accident

For the purpose of this study an accident was defined as any notation of accident on an individual's Michigan driver record.

Critical Driver Knowledge

Those items rated as very and most critical by the HumRRo driving task analysis, for which items were written and tested by the Special Test Set of the National Item Bank for Tests of Driving Knowledge, were classed as critical driver knowledge.

Deficient Critical Driver Knowledge

For the purpose of this study deficient critical driver knowledge was defined as an individual score below 80 percent correct on the knowledge inventory.

HSRI Item Bank

The National Item Bank for Tests of Driving Knowledge is a document containing a group of 1,313 test items--hereafter referred to as the HSRI Item Pool. These items were developed from the HumRRo driving task analysis, a review of the literature and current driving knowledge tests. The items reflect the very and most critical tasks identified by the HumRRo task analysis. The items were tested with Iowa driver education students, and U.S. Coast Guard recruits to collect psychometric, normative and validation data for each question.

HumRRo Driving Task Analysis

The HumRRo study used in this project was Driver Education Task Analysis, Volumes I-IV, by A. James McKnight, et al., of Human Resources Research Organization, (HumRRo), Alexandria, Virginia, published in March, 1971.

Senior Driver

For the purpose of this study a senior driver was defined as any licensed driver residing in Ingham County, Michigan, born on or before January 1, 1913.

Special Test Set

The Special Test Set was a representative group of 246 items from the National Item Bank for Tests of Driving Knowledge on which validity and reliability data were collected from four classes of Michigan driver license applicants.

Organization of Remaining Chapters

Chapter II will contain a review of the literature on the senior driver and his driving problems, a description of the HumRRo study and a description of the Item Bank. The sample collection methods, design and methodology of the study will be found in Chapter III. Deficiencies in critical driver knowledge and the mean level of critical driver knowledge found in four groups of senior drivers will be presented in Chapter IV. Chapter V will contain the summary, conclusions, recommendations, recommendations for further research and a discussion.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter presents a review of the literature related to this study of senior drivers. The review of the literature was divided into three related areas dealing with the identification of the senior driver and his problems, the HumRRo study and a discussion of the HSRI item pool and its special test set.

Identification of Senior Drivers and Their Problems

The literature on the senior driver reviewed here covers his identification, increasing population statistics, and driving-related problems. The senior driver is found to be increasing in number, with many driving related problems for which no reliable test data have been collected.

Identification of the Senior Driver

The senior driver is generally accepted as that person over age 65 who holds a valid driver license and drives a motor vehicle. Studies by Bloomfield[1] and McDonald[2] both used age 65 to identify

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[1]G. J. Bloomfield, "A Descriptive Study of Senior Driver Accident Records in the State of Michigan by Age Group, Sex, Urban and Rural Residency" (Ph.D. dissertation, Michigan State University, 1971), p. 18.

[2]H. L. McDonald, "Problems of a Select Group of Older Drivers" (Ph.D. dissertation, Michigan State University, 1970), p. 34.

senior drivers. Historically age 65 has been used in Germany, England and the United States for retirement purposes as early as the 1870s.[3] Planek further supported the use of age 65 as the dividing line for senior drivers when he said:

> While 65 is strictly an arbitrary point in terms of the human organism's aging process, it is used so widely to produce changes in the organism's environment that it is a good choice. At the age of 65 retirement begins, income usually decreases, social security benefits become available, and affiliations begin to change. These external factors cause, in turn, internal changes in the organism. It may be that some of the external changes forced upon an individual reaching 65 are instrumental in producing some of the characteristic differences that are attributed to those "over 65". It also may be that these external changes contribute to some of the accident producing situations in which people over 65 find themselves.[4]

Volumes such as Accident Facts[5] and Michigan Driver Statistics[6] displayed their data into five year groupings, making drivers age 65 and older easily identified. Drivers over age 65 will show a change in driving exposure, which indicates they are involved in a different type of driving from those under age 65.[7]

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[3]T. W. Planek and R. B. Overend, "Profile of the Aging Driver," Traffic Safety (January 1978), p. 1.

[4]T. W. Planek, M. C. Condon, and R. C. Fowler, An Investigation of the Problems and Opinions of Aged Drivers (Chicago: National Safety Council Research Department, Report No. 5/68, 1968), p. 3.

[5]National Safety Council, Accident Facts, 1975 (Chicago: The Council, 1975).

[6]State of Michigan, Michigan Driver Statistics Report 6 (Lansing: Secretary of State, 1973).

[7]Planek, An Investigation of the Problems and Opinions of Aged Drivers, p. 73-74.

Birren pointed out:

> Human chronological age represents different points on a young-old continuum where biological, psychological, or sociological viewpoints must be considered somewhat independent. In each of these areas the individual "ages" at a different rate and according to a characteristic pattern. All these must be considered when discussing performance of a task such as driving.[8]

Age 65 was a convenient point to begin data collection on senior citizens. However, while age 65 was convenient, it remained an arbitrary measure which didn't give an accurate picture of an individual's physical and mental capabilities. When considering groups of subjects the traditional beginning of "senior" status was age 65.

Senior Driver Population

Today 10 percent of the population,[9] or about 20 million people, are over age 65. Senior citizens, as a group, are expected to increase in numbers until the end of the century. Some estimates put the senior citizen population as high as 25 percent by 1999. An article by Brotman indicated:

> A large aged population is a rather new phenomenon, new to this century. Since 1900, the 65+ population has grown much faster than the rest of the population and the 75+ segment has grown even faster. At the turn of the century, there were 3 million older persons, every 25th American; today, there are 20 million, every 10th American. The 65+ group is 6½ times as large as in 1900: the under

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[8] J. E. Birren, "Research on the Psychological Aspects of Aging," Geriatrics (1963), p. 18.

[9] Administration on Aging, The Aging Person: Needs and Services (Washington, D.C.: U.S. Department of Health, Education and Welfare, 1970), p. 1.

> 65 group is only 2½ times as large. If present very low birth rates continue, by the year 2000, we will have almost 29 million older Americans, every 9th American. This dramatic increase does not mean that older people are living very much longer, just that more people are reaching old age. The real increase in life expectancy has occurred in infancy and childhood.[10]

In an article by Fowles the aging population was explained as follows:

> Because of increases in longevity in the past several decades and generally low fertility since the 1920s (except for the post World War II "baby-boom" era), the elderly are becoming an increasing proportion of our nation's population. The demographic characteristics of the elderly such as age, sex, and race, have been undergoing marked shifts for many years and current projects indicate that these trends will most likely continue to the end of this century.[11]

In hearings before the 93rd Congress it was emphasized that:

> . . . during the next 27 years the elderly population is expected to increase markedly. By the turn of the century it is estimated that anywhere from 40 million to 45 million Americans will have had their 65th birthday.[12]

This increase in senior citizen population is expected to bring with it an increase in the number and proportion of senior drivers. For as Wiener stated:

> The scientific and medical community must be encouraged to apply its talents and techniques to this problem which will become more severe as the absolute number and

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[10] H. B. Brotman, "The Fastest Growing Minority: The Aging," American Journal of Public Health (March 1971), p. 250.

[11] D. G. Fowles, "U.S. 60+ Population May Rise 31% to 41 Million by Year 2000," Aging (June-July 1975), p. 14.

[12] U.S. Congress, Senate, The Special Committee on Aging, The Needs of Elderly People, Hearing, 93rd Congress, 1st Session, June 19, 1973 (Washington, D.C.: Government Printing Office, 1973), p. 7.

> percentage of over-60 persons in the U.S. continue to grow, and the percentage of over-60 drivers grows even faster. The last generation of non-driving elderly is dying off now.[13]

The senior citizen is relatively mobile in that only 3 to 5 percent of the elderly were permanently institutionalized.[14]

The proportion of senior citizens in the population is expected to more than double in the next 22 years. This new population of elderly will be accustomed to maintaining their existing level of mobility. This increase in numbers will burden our already limited mass transportation facilities and place an even greater need for the individual to provide his own means of mobility. This will, in turn, increase the proportion of active drivers in the senior citizen population. This increase, coupled with the increased proportion of senior citizens in the general population, will show up as a large increase in the senior driver population.

Driving-Related Problems

Three major areas were identified in the literature as causing problems for the senior driver. These areas were: medical and physical factors associated with aging, temporary personality disorders, and lack of traffic knowledge. Medical, physical,

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[13] E. L. Wiener, "Loss of Mobility in an Automotive Society," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 53.

[14] L. S. Libow, "Older People's Medical and Physiological Characteristics: Some Implications for Transportation," Transportation and Aging: Selected Issues, Proceedings of the Interdisciplinary Workshop on Transportation and Aging (Washington, D.C.: Government Printing Office, May 1970), p. 14.

personality and psychomotor disorders were beyond the scope of this study. This study dealt specifically with the identification of critical driver knowledge. This review describes attitudinal and psychomotor problems to indicate their connection as part of the overall problem.

Medical and physical problems. It was beyond the scope of this review to identify each specific medical and physical problem of senior drivers in detail. This review considered the problems most often cited in the literature as being directly related to driving performance.

There existed basic health problems which occurred with increased frequency among the aged. Ignorance of the effects of these health problems, when associated with the driving task, caused poor performance by senior drivers. These conditions were listed by Sears as being poor vision, coronary artery and related heart problems, and mental and neuromuscular degeneration.[15]

Aging was inevitably accompanied by progressive impairment of vision. Rodstein stated:

> With age, the pupils become smaller, the transparency of the media is reduced, the refracting mechanism is less powerful, and the retina and central nervous system are less efficient. As these capabilities change, presbyopia with a loss of the near field vision, difficulties in descending steps and curbs when bifocal lenses are used for correction, a steady need for increased illumination, a progressive loss of visual acuity, and a decrease in

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[15] K. A. Sears, "Specific Medical Considerations," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 27.

> night vision develop. Taking the optimum visual acuity, contrast, and speed of vision in the normal 20 year old eye as optimal, at age 45 brightness must be increased by 50%, by 100% in the late 50's and by 333% at 80 to achieve the same optimal levels.[16]

Planek, Condon and Fowler[17] found increasingly limited vision as an age-related problem. Poor glare recovery and limited night and peripheral vision were found to be age-related problems, causing misleading visual information and side-on collisions.[18] Forbes, Vandosdall, Pain and Bloomquist found age-related decreases in visual acuity.[19]

Coronary artery disease and related heart problems were found to be age-related. Baker and Spitz found severe narrowing of the coronary arteries in about half of the white males over 50.[20] DiMaio found that 87.2 percent of drivers studied died of occlusive

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[16]M. Rodstein, "Pathological and Physiological Changes in Older Adults: Effects on Drivers and Pedestrians," International Association for Accident and Traffic Medicine, Proceedings Third Triennial Congress on Medical and Related Aspects of Motor Vehicle Accidents (Ann Arbor: Highway Safety Research Institute, 1971), p. 57.

[17]Planek, An Investigation of the Problems and Opinions of Aged Drivers, p. 25.

[18]Rodstein, op. cit., p. 56.

[19]T. W. Forbes and others, Low Contrast and Standard Visual Acuity Under Mesopic and Photopic Illumination (East Lansing: Continuing Education Service, June 1968), p. 18.

[20]S. B. Baker and W. U. Spitz, "Age, Disease and the Driver," Proceedings of the Third Triennial Congress on Medical and Related Aspects of Motor Vehicle Accidents: International Association for Accident and Traffic Medicine (Ann Arbor: Highway Safety Research Institute, 1971), p. 38.

coronary arteriosclerosis.[21] Planek stated that conditions such as cardiovascular disease were associated with increased accidents and violations.[22] Brown found arrhythmias the most serious problem for senior drivers, as they caused light-headedness and blackouts.[23] The widespread incidence of heart and circulatory problems among the senior driver population led the researcher to suspect that cardiovascular problems occurred in combination with less dramatic conditions causing serious deficiencies in driver performance.

Mental and neuromuscular degeneration were also age-related.[24] Mental degeneration or senility included such areas as: irritability; impatience; forgetfulness; short attention span; and emotional liability. These conditions in their gross form were easy to identify and prevented a person from obtaining a driver's license.[25] "Aging brings on loss of muscular skill, strength and coordination."[26]

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[21]D. J. DiMaio, "A Survey of Sudden, Unexpected Deaths in Automobile Drivers," Proceedings of the Third Triennial Congress on Medical and Related Aspects of Motor Vehicle Accidents: International Association for Accident and Traffic Medicine (Ann Arbor: Highway Safety Research Institute, 1971), p. 75.

[22]Planek, An Investigation of the Problems and Opinions of Aged Drivers, p. 46.

[23]A. J. Brown, "Cardiovascular Problems," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 30.

[24]Rodstein, op. cit., p. 58.

[25]W. K. Keller, "Mental and Emotional Aspects," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 31.

[26]Rodstein, loc. cit.

Rodstein also found:

> Movement of the head backward and upwards and rotation of the neck compresses the vertebral arteries and causes dizziness, faintness and syncope. One can well imagine the effects on the aged motorist of looking into the rear and side view mirrors.[27]

Senior drivers are having a harder time adapting to traffic situations as they age. Planek stated that behavioral deficiencies occurred primarily when the environment placed extra demands on the individual.[28] The senior driver exhibited slowed reaction time, loss of muscle skill and a slow response to sudden change of plan which increased the risk of accidents.[29]

Medical problems influenced a senior driver's ability to control a vehicle in varying degrees. Medical problems were readily observable in some people while for others they were hidden. Medical conditions represented one aspect of senior driver problems. The presence of these often unseen medical conditions had to be considered as part of the overall problem being experienced by senior drivers.

Personality factors. Senior drivers, like any other drivers, are sometimes subject to temporary personality disorders, but senior drivers have many more opportunities to become frustrated with the quality of their lives. This increased frustration is translated

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[27]Rodstein, loc. cit.

[28]Planek, An Investigation of the Problems and Opinions of Aged Drivers, p. 36.

[29]Rodstein, loc. cit.

to irrational and unsafe driving behavior. As Lawton remarked:

> Older persons are often surrounded by the frank hostility of youth for elderly authority. They respond in kind with hostility, fear, hate or aggressiveness, so that often the emotional state of the elderly is a seething ferment of disturbance. These may dominate their consciousness to the exclusion of reason and to the obliteration of training and experience, thus removing them from the category of safe drivers.[30]

These personality disorders often take concentration away from the driving task, making the aging driver probably more frequently affected by lack of alertness.[31] Weygandt observed that the senior driver suffered from an attitudinal rigidity. This is a condition which manifests itself in almost total concentration on the destination to the exclusion of highway conditions.[32] This narrowing mental view of the highway in combination with the physical problem of tunnel vision was suggested as the source of failure to yield right of way violations by senior drivers.

All drivers have temporary personality disorders which affect their driving. Senior drivers have more opportunities to be frustrated and to display frustration-linked driving responses. Attitudinal difficulties must be considered as part of the overall problem being experienced by senior drivers.

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[30] A. Lawton, "The Doctor Looks at the Older Driver," Traffic Safety (October, 1974), p. 44.

[31] W. A. Mann, "Problems of the Aging Driver," The Proceedings of the North Carolina Symposium on Highway Safety (Chapel Hill: University of North Carolina Press, 1973), p. 44.

[32] J. L. Weygandt, "Role of the Family Physician," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 58.

Lack of traffic knowledge. All the literature that mentioned senior drivers and traffic knowledge placed them at the low end of the scale. Reasons suggested for this low level of traffic knowledge were lack of formal traffic education and the reduced ability to recall information. These reports used different populations for their data collection; and the reported information on specific driver knowledge deficiencies did not agree from report to report.

Senior drivers in this study would have been born in 1913 or before. They would have begun to drive by age 14 to 20--or by 1927 to 1932. This time pre-dates driver education efforts. It was reasonable to assume, then, that senior drivers might show a lack of knowledge of traffic laws and safe driving practices. These results would be the same expected for any untrained drivers. Mann stated:

> We tested a considerable number of older drivers and found that for some questions over 50% did not know the the correct answer.[33]

Waller suggested that:

> because all of the organic and psychological changes in the elderly in fact place them on a new learning curve for driving, just as the young driver is on a learning curve. The young driver, however, is likely to stabilize after about two or three years, while the older driver remains on a learning curve from about age 55 until he ceases driving.[34]

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[33]Mann, op. cit., p. 45.

[34]J. A. Waller, "Medical Limitations and the Elderly Driver," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 75.

Senior drivers are also subject to forgetting things and becoming less able to recall information rapidly. Reader stated that senior drivers:

> need additional time to solve problems under fast-moving circumstances that traffic produces to make the elderly person unsafe.[35]

And Klebel found that ". . . older persons need more time to organize and process incoming information."[36] Planek stated that ". . . recognization memory does not decline with age while recall memory does."[37] A 1973 document from the Michigan Secretary of State's office gave Older Michigan Driver's Renewal Results. This document showed overall renewal scores in five year age groupings for drivers: age 50-54, 55-59, 60-64, 65-69, and 70 and up. The data reflected an age related decrease in driver knowledge. In other words, the older the driver, the more answers they missed. The pattern of deficient driver knowledge did seem to vary but concluded that male senior drivers had an overall higher mean score than female senior drivers.[38]

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[35]G. C. Reader, "Keynote Address," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 10.

[36]E. Klebel, "Age and Driver Fitness," Proceedings of the National Conference on the Aging Driver (Morton Grove: Health and Safety Associates, 1974), p. 42.

[37]Planek, An Investigation of the Problems and Opinions of Aged Drivers, p. 33.

[38]Michigan Secretary of State, "Older Driver's Renewal Results," Lansing: Michigan Secretary of State, 1973, (mimeographed), p. 1.

In a Florida retirement center study, Crosier found senior drivers lacking in traffic knowledge.[39] His use of the McGlade Road Test found senior drivers with below average knowledge in the areas of emergency driving situations, stopping distance and alcohol. The area of automobile control was also reported at the inadequate knowledge level.[40] The data for this study was drawn from one retirement center in Sun City, Florida. These results cannot be generalized to the senior driver population of Ingham County, Michigan. However, these findings will indicate possible outcomes for this research and should not be ignored.

Senior driver knowledge deficiencies were found by Pastalan in a 1975 Ann Arbor study of Street and Highway Environments and the Older Driver. The knowledge areas pertaining to failure to yield right of way, improper procedures for lane change, turning, passing and backing, and stop and yield signs were identified as problem areas for senior drivers.[41] This study was done with the voluntary cooperation of six senior drivers from a retirement center in Ann Arbor, Michigan.[42] The sample size and selection method did not allow these these results to be generalized beyond the six persons

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[39]J. L. Crosier, "The Development of Guidelines for a Driver Improvement Program for Residents of a Retirement Community," Ph.D. dissertation, New York University, 1972), p. 69.

[40]Ibid., p. 9.

[41]L. A. Pastalan, et al., Street Highway Environments and the Older Driver (Ann Arbor: Institute of Gerontology, 1975), p. 11.

[42]Ibid., p. 10.

in the study. This was one of the few studies where specific areas of deficient driver knowledge were reported for senior drivers.

In an unpublished study at Michigan State University, Nolan, et al., found deficient driver knowledge in senior drivers. A "Senior Driver Project" was developed and presented to 25 volunteer members of a retirement center in East Lansing, Michigan. The Mann "Adult Driver Test" was used to find deficiencies in the following knowledge areas: hydroplaning, new signs, search patterns for lane change and turns, freeway entrance and exit procedures, stopping and passing distance, one way street procedure and stop and yield signs. The pretests were used to construct course curriculum for that specific group.[43] The data in this study represented knowledge deficiencies of the 25 volunteers at Burcham Hills Retirement Center which is populated by senior citizens who have a high level of education and economic resources. This population did not represent a random selection of the drivers in Ingham County, Michigan. However, the results of this study were of use in determining possible outcomes for this research project.

An unpublished 1971 study by Hayes at the Michigan Secretary of State's office listed the five most occurring violations for senior drivers as: failure to yield, failure to drive minimum speed, failure to stop for school bus, improper turns and unsafe backing.[44]

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[43]R. O. Nolan, et al., "Senior Driver Project" (unpublished research report, Data Tally Sheet #1), East Lansing: Michigan State University, 1975.

[44]J. Hayes, "Senior Citizen Aid Program," Lansing: Michigan Secretary of State, 1973 (mimeographed), p. 1

Being ticketed for a violation is at best a random occurrence, but these five most occurring improper actions can be considered as some indication of the direction of deficient knowledge, skill or attitude in the senior driver population. Lack of driver knowledge was to some degree a component of these violations. Therefore, these knowledge areas were indicated as possible problems for senior drivers and were not ignored as possible outcomes for this study.

A 1973 document from the Michigan Secretary of State's office reported an Analysis of Older Driver Answers on Renewal Test Questions.[45] These 29 items were ranked by question difficulty up to 99 percent correct. They were then compared with the results of a 1970 study of the same items. The 1973 items were the results of an audio/visual test-taking device, and the 1970 items were presented in pencil and paper format. Questions missed by 20 percent or more of the 1970 and 1973 renewal drivers were reported as: freeway entry, flashing green arrows, when to dim lights, maximum speed limits and when to use turn signals. These results were suspect because it was later found that older drivers were having a difficult time understanding and using the audio/visual test machines. The results were confounded with the test instrument. These results could not be considered a definitive answer to deficient driver knowledge in senior drivers, unless one assumed that all driving knowledge could be inventoried by 29 questions; but the results gave an indication of where problems

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[45]Michigan Secretary of State, "Analysis of Older Driver Answers on Renewal Test Questions," Lansing: Michigan Secretary of State, 1973, (mimeographed), p. 1.

might occur. The question still remained, however, if errors were due to a lack of understanding of the testing instrument, a lack of driving knowledge, or insufficient knowledge of items being tested.[46]

In a 1977 study to develop Virginia driver manuals for drivers age 55 and older, a 20 item driver license examination was administered to 8,000 drivers.[47] The results indicated lack of driver knowledge in these areas: identification and interpretation of signs; defensive driving; textbook information; and not looking to the rear when backing.[48] The 20 item instrument, while based on the HumRRo task analysis, did not represent a comprehensive examination of driver deficiencies. Only items rated as being critical to senior drivers were tested.[49] The population used in the Virginia Study, age 55 and older, was not the same as the target population of this research. The results of the Virginia study were helpful in indicating the direction of knowledge deficiencies for this research, but could not be considered an outline of the problems of drivers age 65 and older in Ingham County, Michigan because two different age populations were sampled and tested. Also the use of a 20 item examination limited finding deficiencies to only the 20 areas tested. The two severe limitations of the Virginia study prevented the results from being generalized to the senior driver population of Ingham County, Michigan.

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[46]Ibid.

[47]A. J. McKnight and M. Green, Safe Driver Knowledge Dissemination and Testing Techniques. Final Report. Volume 2 (Springfield, Virginia: National Technical Information Service, 1977), p. 10.

[48]Ibid., p. 27.

[49]Ibid., p. iii.

It is clear that the senior driver lacks driver knowledge. However, while all sources agreed the senior driver suffers from a lack of traffic knowledge, no two sources agreed on what areas they defined as lacking. Each report reviewed presented serious problems with inadequate or inappropriate sampling, confounded results, or insufficient test questions to yield a comprehensive inventory of driver knowledge deficiencies. Four general areas of driver knowledge deficiencies were reported as: lack of automobile control in many forms, poor emergency driving, failure to yield, and poor judgment of stopping and passing distances. These general areas provided an indication of where knowledge deficiencies might occur. They did not, however, provide identification of specific critical driver knowledge deficiencies. In each case the reported results could not be generalized to drivers age 65 and older in Ingham County, Michigan.

Summary

This section identified the senior driver as being age 65 or older, and part of a group that is and will continue to experience growing driving problems as this age group expands. The problems they experienced were caused by an undefined combination of medical, psychological and cognitive debility with no two reports agreeing on what knowledge was lacking. Design and sample problems of prior research limited the usefulness of their results.

The task analysis and item pool were documents central to this research. The remaining two parts of this chapter will describe the HumRRo task analysis and the Highway Safety Research Institute item pool with its special test set.

HumRRo Task Analysis

This section defines the Human Resources Research Organization (HumRRo) task analysis. It also describes the organization, construction and reliability findings for the HumRRo study. The last part of this section identifies other users and the relevance of the HumRRo study for this project.

Defined

The HumRRo task analysis was developed by the Human Resources Research Organization of Alexandria, Virginia. It is a document in four parts, describing a systematic analysis of driving tasks and their criticality, instructional objectives derived from that task analysis and the methods used to derive the task analysis and instructional objectives.[50]

Organization

The HumRRo task analysis was designed to provide driver educators, researchers and other professionals with a set of technical data. These data were designed to: "provide a detailed description of the behaviors required of drivers of four-wheeled passenger cars together with the rated criticalities of these behaviors."[51] They were developed to help provide a description of good driving to further the development of sound driver education programs. The specific purpose

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[50] A. J. McKnight, Driver Education Task Analysis, Volume I: Task Descriptions (Springfield, Virginia: National Technical Information Service, 1970), p. vii.

[51] A. J. McKnight, Driver Education Task Analysis, Volume II: Task Analysis Methods (Springfield, Virginia: National Technical Information Service, 1970), p. v.

for this task analysis was stated as: "to identify a set of driver performances that might be employed as terminal objectives in the development of driver education courses."[52] It was also felt that they would "provide a broad foundation for further inquiry into the nature of driver's responsibility."[53] This document, then, was seen as being of use to driver license, law enforcement, and other professionals involved in traffic safety.

The task analysis was prepared in four volumes. Volume I included the driving tasks, divided into the categories of road behaviors, off-road behaviors, tasks related to the environment and a bibliography. Volume II described the method used to analyze the driving tasks and evaluate the criticality of driver behaviors. Preparation of the task descriptors, behaviorally relevant system characteristics, directions to evaluators of criticality, task criticality, means and standard deviations, and a list of evaluators were presented. Part I of Volume III listed the instructional and enabling objectives, grouped into 74 learning units, as developed from the task analysis. Evaluation instruments for driving fundamentals, driving skills and driving knowledge were found in the second part of Volume III. Volume IV described the manner in which the instructional objectives, enabling objectives, driving fundamentals test, driving skills test and knowledge test were formulated.[54]

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[52]McKnight, Volume I, p. vii.

[53]Ibid.

[54]McKnight, Volume IV, p. iii.

Construction of Task Analysis

The HumRRo Task Analysis was to provide a definition of what was good driving. In order to provide a definition of good driving an analysis of the System's goals was required. The system goals were defined as: "Assuring the movement of passengers and material from one place to another with safety, efficiency, comfort and responsibility."[55] Each of these system goals then provided its own set of behavioral requirements to achieve good driving.

A literature review was undertaken to obtain behavioral characteristics to include in a task analysis. The review included 600 items from "textbooks, research reports, technical reports, accident statistics, legislative documents and films."[56]

A systematic task analysis was then conducted on the information gathered by the literature review to find information that would be relevant to meeting the driving goals as defined by the system goal. A list of 1,000 characteristics of the transportation system were generated originally in this manner.[57]

The list of 1,000 characteristics was combined into a list of interacting characteristics which had relevance to the system goals. This became a list of 1,700 tasks, divided into 45 areas required in good driving.[58]

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[55] McKnight, Volume II, p. 7.

[56] Ibid., p. 6.

[57] Ibid., p. 9.

[58] McKnight, Volume IV, p. 4.

The list was organized into two areas: on- and off-road tasks. Tasks were listed once with cross references for those appearing in more than one behavior required for good driving.

The tasks were then ranked for criticality in five categories from high criticality to low criticality. This ranking was performed by 100 authorities in all areas of traffic safety.[59]

Reliability

There were two forms of reliability obtained for the HumRRo task analysis: Inter-judge reliability for use between groups of tasks; and inter-judge reliability for use within groups of tasks. Both measures showed a high level of agreement on an analysis of variance technique, .82 and .99+ respectively.[60] Objectives were written for tasks at each level of criticality. The objectives were grouped into 74 learning units with a statement of purpose, list of performance objectives, description of enabling skills, and knowledge objectives.[61]

Other Users of HumRRo

It would be impractical to report all of the studies which have used the HumRRo task analysis since its completion in 1971. This section will, therefore, specify five major studies which used the HumRRo task analysis. This will serve to illustrate its acceptance as a comprehensive source authority for driving tasks. It will also make the case for the use of the HumRRo task analysis in this study.

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[59] Ibid.

[60] McKnight, Volume II, p. 19.

[61] McKnight, Volume IV, p. 19.

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[59] Ibid.

[60] McKnight, Volume II, p. 19.

[61] McKnight, Volume IV, p. 19.

performance curriculum from instructional objectives developed in a previous part of the project.[66]

The National Public Services Research Institute (NPSRI), used the HumRRo task analysis to develop Driver Manuals for drivers age 55 and older for the state of Virginia. From it they developed a 20-item, 3-frame test which identified most critical tasks. With this they tested 8,000 drivers aged 60 and older to gain information for inclusion in their driver manual.[67]

The fifth user of the HumRRo study was the Highway Safety Research Institute at the University of Michigan. They developed the National Item Bank for Tests of Driving Knowledge based upon the tasks identified in the HumRRo study. They saw the HumRRo task analysis as a complete, well supported document. The degree of criticality to the driving task made it an excellent taxonomy of behaviors and knowledges from which to draw their items for test construction.[68] They used the very and most critical behaviors to construct their item pool.[69]

Five major driver and traffic safety education studies have recognized the HumRRo task analysis as a good product. Their research

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[66]U.S. Department of Transportation, op. cit., p. 57.

[67]A. J. McKnight and M. Green, Safe Driver Knowledge Dissemination and Testing Techniques. Final Report, Volume 2 (Springfield, Virginia: National Technical Information Service, 1977), p. 20.

[68]W. T. Pollock and T. L. McDole, Development of a National Item Bank for Tests of Driving Knowledge: Final Technical Report (Ann Arbor: Highway Safety Research Institute, 1973), p. 12.

[69]Ibid., p. 20.

efforts have been based on the HumRRo task analysis. They have accepted the HumRRo task analysis as "the most inclusive description to date of the cognitive and behavioral elements of passenger car driving."[70]

Relevance of the HumRRo Study

The HumRRo task analysis was related to this study in three important ways.

The first was that the HumRRo task analysis represented the first comprehensive approach to defining the driving task. These task descriptions served as a comprehensive source of authority of driver knowledge. The task descriptors were the "framework on which to build the passenger car driver license item pool."[71] The special test set (STS), based on this comprehensive task analysis, could inventory a given population for driver knowledge deficiencies.

The HumRRo study provided a criticality rating for each task description in the study. This was valuable to this research because "only the items with a 4+ or higher criticality were used to construct the item pool."[72] The task descriptors gave "detailed descriptions of the behaviors required of all drivers of 4 wheeled passenger cars, together with the rated criticalities of these behaviors."[73] In this

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[70]Pollock and McDole, Item Bank, p. 12.

[71]McKnight, Volume II, p. 3.

[72]Ibid., p. 20.

[73]McKnight, Volume I, p. vii.

manner the STS derived from these critical tasks descriptors was a test of critical driver knowledge.

The third reason for the importance of the HumRRo study was that each question in the STS could be tied directly to the critical objective in the HumRRo study. A report of deficient critical driver knowledge could be tied directly to the critical HumRRo objective the STS question was designed to represent. The ability to identify objectives for each deficient knowledge area made this study a valuable tool to educators and curriculum personnel. The HumRRo task analysis allowed this organized approach to defining what critical driver knowledge was lacking in the senior driver population, and relating that information to well-defined instructional objectives.

Summary

The HumRRo task analysis has served as the base for many major traffic safety related research projects. It provided a comprehensive task description of the total driving task with rated criticalities from which the test instrument for this study was drawn, the Special Test Set. The HumRRo task analysis provided a framework of instructional objectives tied directly to the Special Test Set items with which to analyze the results of testing. The HumRRo task analysis allowed for this inventory of critical driver knowledge and provided instructional objectives to help analyze the data from the knowledge inventory. The next section will report on the Highway Safety Research Institute (HSRI) item pool and special test set.

HSRI Item Pool

This section defines the Highway Safety Research Institute (HSRI) Item Pool (IP), and the Special Test Set (STS). It describes the construction and item evaluation activities for the IP and STS. It lists other users and indicates how the IP and STS were central to the completion of this research.

Defined

Two documents were considered in this section of the review of the literature. They were the STS and IP, two parts of the Handbook for Driving Knowledge Testing.

Item pool. The IP is a collection of 1,313 multiple-choice driving knowledge test development materials.[74] The IP questions were written for those tasks with a very or most critical rating in the HumRRo task analysis.[75]

Special test set. Due to practical considerations it was necessary to collect validation and normative data on something less than all 1,313 questions in the item pool.[76] A representative group of 246 multiple-choice items that "reflect items with high criticality to safe, efficient driving"[77] were selected from the item pool to be the STS.

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[74]Pollock and McDole, Item Bank, p. 1.

[75]Ibid., p. 20.

[76]Ibid., p. 49.

[77]Ibid., p. 51.

Construction of the Item Pool and Special Test Set

The IP was constructed as a primary document consisting of 1,313 test items. The STS was developed from the IP as a more manageable test item document from which to gather psychometric and normative data. This section describes the construction of the class "C--passenger cars and light trucks" item pool and the subsequent construction of the STS.[78]

Item pool construction. The class "C" items were reported in the Handbook for Driving Knowledge Testing. The IP was designed to be a massive collection of facts, written as questions, about safe, efficient, legal driving.[79]

Three categories of driving facts were established. They were: driving principles, driving laws and traffic control procedures.[80] A comprehensive source of facts was found for each of the above categories. The HumRRo task analysis was selected as the driving domain for the driving principles category.[81] The large size (1,500 items) of the HumRRo task analysis caused items to be written for only the very and most critical tasks.[82]

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[78] Ibid., p. 4.

[79] W. T. Pollock and T. L. McDole, Handbook for Driving Knowledge Testing (Ann Arbor: Highway Safety Research Institute, 1974), p. 1.

[80] Ibid.

[81] Ibid., p. 5.

[82] Ibid.

Information from the task analysis was supplemented by facts taken from state licensing tests and an extensive review of the literature.[83]

The Uniform Vehicle Code, 1968 Edition, served as the reference for the driving laws section.[84]

The Manual on Uniform Traffic Control Devices, 1970 Edition, was the source document for facts in the traffic control procedures category.[85]

A uniform format was followed to write items for the item pool.[86] The rules for easy readability in item construction were as follows:

1. Keep the item's stem less than seventeen words.
2. Keep the answer choices, also called "foils", to a minimum, uniform number of words in a given item.
3. Use one-syllable, rather than poly-syllable words, when possible.
4. Use common expressions when possible rather than technical terms, e.g., "speed up" rather than "accelerate". Avoid technical jargon and regional terms.[87]

A multiple choice format was selected for the item pool questions for the following reasons:

1. Most of our source document statements were restatable as multiple-choice items.
2. Most state licensing tests presently use a multiple-choice item format.
3. This format is compatible with most automatic testing procedures.

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[83] Ibid.

[84] Ibid.

[85] Ibid.

[86] Ibid., p. 6.

[87] Pollock and McDole, Item Bank, p. 26.

4. Items so prepared are easily convertible to fewer-choice or true-false formats.

5. By judicious selection of answer alternatives, a considerable amount of information can be presented and tested in a single multiple-choice item.

6. A standardized item format permits use of any set of items in a test battery without test-taker confusion over several sets of instructions.

7. Multiple-choice items are easily scored, with the results suitable for a variety of statistical treatments.[88]

None of the 12,000 test items reviewed could meet the uniform format requirement.[89] A total of 1,313 unique test items were written. The major headings were broken down as follows:

Driving Principles	
Pre-Operative Procedures	25 items
Basic Knowledge	427 items
Driving Situations	202 items
Vehicle Situations	62 items
Driver Reponsibilities	7 items
=	723 items
Vehicle Code: Laws and Regulations	339 items
Traffic Control Signs, Signals and Markings	251 items
	1,313 items[90]

The item pool consisted of 1,313 items that covered the critical tasks of driving principles, traffic laws and traffic control devices.

Special Test Set construction. This section describes construction of the 246-item Special Test Set.

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[88]Pollock and McDole, Handbook, p. 6.

[89]Ibid., p. 7.

[90]Ibid.

The full item pool of 1,313 items was too large to be practical for use in the "real world."[91] A sample of the full pool of items was developed to allow for easier collection of normative and validation data.[92] This sample set of items was called the Special Test Set of items (STS).[93] Full pool Iowa data allowed an item cluster analysis to be used to find sets of four or more items that showed high inter-correlation.[94] Item cluster data were used in combination with an item difficulty index to select individual items for STS.[95] Reliability data, also from the Iowa pilot study, were then used to "maximize the inclusion of reliable items in the STS."[96] A final check on the STS consisted of a comparison to the taxonomy to:

> determine respresentativeness of the full pool knowledge domain, and to determine that items reflect high criticality to safe, efficient driving were included in the STS.[97]

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[91] Ibid., p. 12.

[92] Pollock and McDole, Item Bank, p. 50.

[93] Pollock and McDole, Handbook, p. 12.

[94] Pollock and McDole, Item Bank, p. 51.

[95] Ibid.

[96] Ibid.

[97] Ibid.

The STS broke into major headings as follows:

Driving Principles	
Pre-Operative procedures	1 item
Basic Knowledge	99 items
Driving Situations	34 items
Vehicle and Driver	13 items
Driver Responsibilities	2 items
	149 items
Vehicle Code: Laws and Regulations	58 items
Traffic Control Signs, Signals and Markings	39 items
TOTAL	246 items[98]

The STS represented a scaled-down version of the IP. It was constructed from the IP and used cluster analysis, difficulty indices, reliability data and taxonomy check to establish it as representative of the IP. The STS compared favorably with the IP on the four measures described above.

Item Evaluation Activities

Construction of the class "C" item pool completed phase I of the Item Bank project. Phase II consisted of three stages of item evaluation activity. The item pool was evaluated on its language adequacy, content validity and psychometric characteristics. Phase III reported the STS evaluation activities.

Language adequacy. Language adequacy was evaluated on two measures. The first measure of language adequacy was a Flesch count of reading ease. The Flesch count showed a 7th grade reading level for the item pool.[99] The second measure of language adequacy was

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[98] Ibid.

[99] Pollock and McDole, Handbook, p. 8.

a language review by nine local (Ann Arbor) high school students.[100] The language review for unclear items resulted in modification of over half of the item pool.[101]

Content validity. Content validity was checked by using "64 primary authorities," some of which participated in the HumRRo study, to compare HumRRo task statements to their corresponding item pool questions.[102] Over half of the items were modified to remove ambiguity and inaccuracy after review by the authorities.[103]

Psychometric evaluation. Psychometric data were collected on measures of item difficulty, item reliability and item correlation to unrelated variables.

Item difficulty was "expressed as the proportion of respondents correctly answering the item."[104] Any item with an item difficulty of .50 or less was rewritten.[105]

Item reliability was "expressed as the correlation between responses in a test-retest situation."[106] A test-retest coefficient of less than .30 resulted in rewriting of the question.[107]

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[100] Pollock and McDole, Item Bank, p. 33.

[101] Ibid., p. 35.

[102] Ibid., p. 36.

[103] Pollock and McDole, Handbook, p. 10.

[104] Ibid.

[105] Ibid., p. 11.

[106] Ibid., p. 10.

[107] Ibid., p. 11.

Item correlation to unrelated variables was expressed as "a correlation with verbal ability scores."[108] Verbal ability correlations of .30 or more resulted in the revision of an item.[109]

The psychometric analysis caused nearly 500 items to be rewritten.[110] The rewritten items went through the Iowa test-retest procedure. Test-retest correlation, verbal ability correlation and p-value data were reported for each of the 1,313 items in the Handbook for Driving Knowledge Testing.

Special Test Set evaluation. The STS items were selected from the IP. All data reported for the IP were also reported in the same volume for the STS items. The STS was chosen to serve as a practical vehicle with which to collect item normative data on a representative sample of questions from the IP.

Item normative data for the 246 item STS were collected on 227 Cape May Coast Guard recruits.[111] Item normative data were also collected on 2,940 Michigan original license applicants, 34,251 Michigan renewal license applicants, 1,090 problem drivers and 511 transfer license applicants.[112] Item normative data were reported for the STS items in the Handbook for Driving Knowledge Testing for all classes of Michigan and Cape May drivers.

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[108] Ibid., p. 10.

[109] Ibid., p. 11.

[110] Ibid.

[111] Ibid., p. 12.

[112] Ibid., p. 13.

Other Users of the HSRI Item Pool

The HSRI Item Pool is not a static document. Other users of the IP found it a valuable document for their research because of the extensive analysis and normative data on its items. Four recent projects identified as using the IP that are briefly reported in this section are: the California Department of Motor Vehicles Study; the Iowa PRIDE Project; the Mesa, Arizona project; and the University of Michigan Driver License Project.

California department of motor vehicles study. A 1975 study by the California Department of Motor Vehicles compared the IP to the Department's present test. This project was designed to find the best test to use to predict future driving performance. They tested 48,000 driver license applicants and found the IP more related to biographical data (educational level) than was the Department's test.[113] Neither test was found to be more or less related to driving records.[114] They chose the IP as a comparison document because "it was based on a task analysis of the driving task."[115]

Iowa project PRIDE. Another user of the IP was the State of Iowa in its 1975 project, Program Research in Driver Education, PRIDE. They wanted to develop a test with items that would allow for driver education course comparisons across many programs as well as test for

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[113] D. W. Carpenter, An Abstract of an Evaluation of the California Driver Knowledge Test and the University of Michigan Item Pool (Sacremento: State of California, Department of Motor Vehicles, 1975), p. 1.

[114] Ibid.

[115] Ibid., p. 3.

safe and efficient driving.[116] They chose the IP because its relationship to the HumRRo task analysis made the items "appropriate."[117] They pilot tested 2,500 Iowa driver education students in the development of their final 50 item test.[118]

Mesa project. The Mesa, Arizona, Public Schools used the IP to pre- and post-test 4,500 driver education students. This project was designed to facilitate program improvement and develop a system of matrix testing for driver education in their school system.[119] The IP was chosen as a source document because of its "test-retest and verbal ability correlations, and response distributions."[120]

Driver license project. The IP was used by the University of Michigan's Highway Safety Research Institute in a joint contract with the Michigan Secretary of State's Office. They pilot tested the STS on 3,451 Michigan drivers in four groups: original applicant, transfer applicant; renewal and driver improvement.[121] The STS was divided into seven equivalent content forms of 40 items each.

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[116] L. R. Tack, Iowa Driver Education Evaluation Study: Final Report, Program Research in Driver Education, PRIDE (Des Moines: Iowa Department of Public Instruction, 1975), p. 131.

[117] Ibid. [118] Ibid.

[119] R. J. Dempster, An Analysis of Driver Knowledge Test Results for School Year 1974-75: Technical Memorandum (Mesa, Arizona: K-12 Highway Safety Education Project, 1975), p. 2.

[120] Ibid., p. 1.

[121] W. T. Pollock and T. L. McDole, Development of a National Item Bank for Tests of Driving Knowledge: Final Technical Report (Ann Arbor: Highway Safety Research Institute, 1973), p. 63.

The seven forms were then balanced with Iowa psychometric data to obtain equal content difficulty levels.[122] The forms for the renewal examinations were reduced into 28 tests of 10 items each that represented a "reasonable" balance of content and difficulty level.[123] The results of the pilot test led to HSRI receiving a contract to develop new original applicant and renewal license examinations for the State of Michigan based on the STS.[124]

Relevance of HSRI Item Pool and Special Test Set

The IP and its STS were the basic documents for this study. They were constructed from the task analysis, Uniform Vehicle Code, and Manual on Uniform Traffic Control Devices which are respected, well recognized source documents for traffic facts. Item construction followed uniform rules which were rigorously applied. The questions of the IP and STS were representative of the HumRRo task analysis. The STS provided a group of items that tested very and most critical driving knowledge. The STS items presented analysis and normative data that were accepted for use in other research projects. The STS was chosen as the source document for items to test Critical Driver Knowledge in this project.

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[122]Ibid., p. 57.

[123]Ibid., p. 58.

[124]Statement by T. L. McDole, telephone conversation, March 28, 1978.

Summary

The STS provided well constructed items for use in a comprehensive test of critical driver knowledge. Results of the testing were not confounded for reasons of unclear language, a level of language that was too difficult, improper correlations with verbal ability, too little or too much item difficulty, or low test-retest reliability. The STS was used for federally funded research projects in California, Arizona, Michigan and Iowa. The STS was a complete item source authority that provided a good measure of critical driver knowledge.

Summary

This chapter presented a review of the literature dealing with an inventory of critical driver knowledge for senior drivers.

The senior driver has experienced driving difficulty due to a number of interrelated medical, attitudinal, cognitive and neuromuscular problems. It was shown that senior drivers are expected to increase in number and proportion for the next twenty years. Their driving problems are expected to be felt with great effect in the future. Lack of driving knowledge was indicated as a major difficulty for senior drivers; but little agreement was found on the level or types of driver knowledge found lacking in senior drivers.

The HumRRo study provided a comprehensive framework of driving tasks called the task analysis. The task analysis identified the necessary tasks for safe, efficient driving of the automobile. Each

identified task was rated for criticality. The results of the HumRRo task analysis were widely accepted and used in other research. Due to its completeness and rated criticalities the task analysis was the basic document used in the construction of the item pool

The item pool provided 1,313 questions about driving knowledge. The item pool was written on the very and most critical driving tasks identified by the HumRRo task analysis study. The item pool provided validity, reliability, and psychometric and normative data for test questions.

The items in the special test set were a representative sampling of questions from the item pool. Both the item pool and the special test set were used in research and curriculum development projects. The questions of the special test set contained the same data as the questions from the item pool. The special test set items had additional information in the form of normative data which allowed comparisons of responses to other similar populations. The special test set was found to be a respected, well constructed, often used instrument for data collection. The special test set was the best instrument to use to obtain a good measure of critical driver knowledge in the senior driver population.

The next chapter will describe the population and sample selection. Chapter III will also describe the design, methodology and instrument used to complete the study.

CHAPTER III

DESIGN AND METHODOLOGY

This chapter outlines the design and methodology used in the study. Topics described in detail are: selection of the population; selection of the sample; the variables of interest; measurement of the variables; data collection; description of the test instrument; and organization of the data and findings that were relevant to the study.

Population Selection

The population for this study consisted of all motor vehicle operators listed in the Michigan Department of State driver license file who were born before January 1, 1913 and resided in Ingham County. The senior driver population of Ingham County was chosen because the driving locations of Ingham County represented a good cross section of most driving situations in Michigan. This was due to the fact that Ingham County included the metropolitan area of Lansing/East Lansing where city streets, urban residential, urban freeway, and urban interstate highway environments were found. Mason, Williamston, Leslie, Stockbridge, Dansville and Webberville provided small town street, rural state and county trunkline and and rural interstate driving situations. Suburbs such as Haslett, Holt and Okemos included typical suburban street and highway

situations. The townships provided rural trunkline and interstate driving experiences. Ingham County provided drivers with many driving experiences which were likely to be similar to other areas of Michigan.

Sample Selection

The sample frame for this study was 1,134 drivers randomly selected from the estimated 15,802 senior drivers residing in Ingham County, Michigan.[1] The 15,802 senior driver records were stored with those of all other licensed drivers on 40 tapes at the Michigan Department of State. Tapes 1, 14, 25 and 34 were selected by using four consecutive numbers from a random number list.[2] All driver records for persons age 65 and older, residing in Ingham County, were printed as the sample frame for this study. Each of the 1,134 selected drivers had the same chance of being selected as any of the remaining 14,633 Ingham County senior drivers. Past studies by the Department of State have shown that the numerical/alphabetical ordering of names on the computer tapes did not introduce any known periodicity in their measured results. It was also found that composite performance of drivers on one tape is the same as composite

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[1] J. A. Hayes, Michigan Driver Statistics, #10 (Lansing: Department of State, 1977), pp. 23-25.

[2] G. V. Glass and J. C. Stanley, Statistical Methods in Education and Psychology (Englewood Cliffs: Prentice Hall, Inc., 1970), p. 510.

performance on any other tape.[3,4] Bloomfield used the same sampling procedure in his study of senior drivers and mentioned that:

> there was no reason to believe that the driving performances or the proportion of senior drivers was any different for the sample computer reel selection or any other reel which might have been randomly selected.[5]

The 1,134 senior driver records were then stratified on the basis of sex (male and female) and two-year accident history (none--one or more). A random selection process, where subjects' names were selected from an urn, was conducted to fill each sub-cell in the design. The random selection process was continued until 52 senior drivers were selected to receive form A, B, and C of the driver knowledge inventory.

The actual sample cells appeared in a two-by-two design. The knowledge inventory of 246 items was too large to be given to one person. Thus, the knowledge inventory was divided into three equivalent forms, Forms A, B, and C. Within each cell a set of three randomly selected sub-cells with equal size was created. Each sub-cell was designated to receive a different form of the knowledge inventory. The combination of three persons, one in each sub-cell, receiving one form of the 82-item knowledge inventory was the same

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[3]Statement by Mr. J. Lucia, Michigan Department of State, personal interview, January 20, 1978.

[4]Statement by Mr. J. A. Hayes, Michigan Department of State, personal interview, January 20, 1978.

[5]G. J. Bloomfield, "A Descriptive Study of Senior Driver Accident Records in the State of Michigan by Age Group, Sex, Urban and Rural Residency" (Ph. D. dissertation, Michigan State University, 1971), p. 37.

as if one subject in each cell received a full knowledge inventory of 246 items. The Tukey bridge argument allowed for collapsing sub-cell means into cell means when assumptions of equal cell size and random selection were met.[6] The logic of the argument held for the study because of equal cell sizes and random selection for sub-cells. The results represented a random estimation of the population from which they were selected.

According to the study design, a sample size of 52 subjects would necessitate interviewing, or contacting, 156 senior drivers. In order to maintain equal cell and sub-cell sizes, the next possible sample size would increase to 56 subjects. That would have necessitated an additional 12 contacts. Since interviews, including travel time, were estimated to take two or more hours each, a maximum practical number was set at a sample size of 52 subjects, or 156 contacts.

Study Variables

Dependent Variable

The dependent variable for the study was critical driver knowledge. Deficient critical driver knowledge was hypothesized as not being equal to 80 percent correct.

$$H_0: \text{ S.D. } \mu = 80$$

$$H_1: \text{ S.D. } \mu \neq 80$$

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[6] J. Cornfield and J. Tukey, "Average Values of Mean Squares and Factorials," The Annuals of Mathematical Statistics, vol. 27, no. 4 (December 1956), p. 909.

Critical driver knowledge as a measure of the variance between group means was hypothesized as being equal, or no variance. Group means tested with a 2-way ANOVA using the following three hypotheses:

1. The main effect of sex was tested by answering the following question: Was the mean score for males and the mean score for females equal?

$$H_0: \mu M = \mu F$$

$$H_1: \mu M \neq \mu F$$

2. The main effect of accidents was tested by answering the following question: Was the mean score for senior drivers with one or more accidents in the past two years equal to the mean score for senior drivers with no accidents in the past two years?

$$H_0: \mu \text{ ACC} = \mu \text{ No ACC}$$

$$H_1: \mu \text{ ACC} \neq \mu \text{ No Acc}$$

3. The 2-way interaction effect between sex and accidents was tested by answering the following question: Were the mean scores for females with no accidents in the past two years, females with one or more accidents in the past two years, males with no accidents in the past two years, and males with one or more accidents in the past two years equal?

$$H_0: \mu F_n = \mu F_y = \mu M_n = \mu M_y$$

$$H_1: \mu F_n \neq \mu F_y \neq \mu M_n \neq \mu M_y$$

Independent Variables

Sex was an independent variable in this study. It was reported as male or female from the notation on the driver records obtained from the Department of State.

Accident history was the second independent variable. The accident history of an individual was reported from his driver record as "no" or "one or more" accidents during the past two years. Accidents considered in this study occurred in the time period from March 1, 1976 until April 13, 1978. This allowed a 45 day time period for posting accident records on the Department of State's driver license files.[7] This two year plus 45 day time period allowed for the study of a two year accident history for each driver that was not confounded by system delays in posting accident reports. No attempt was made to allow for fault in any given accident. The drivers were listed as either "in" or "not in" an accident in the past two years.

Measurement of the Variables

The data were collected on the test form. Data were transferred by the writer to mark-sense sheets for use in the item analysis program. The item analysis was programmed to punch individual data cards from each mark-sense sheet for use in the analysis of variance program.

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[7]Statement by Ms. J. Pixley, Michigan Department of State, personal interview, April 10, 1978.

Dependent Variable

Critical driver knowledge was measured by two methods. The first method of measuring critical driver knowledge was by reporting a frequency count that was rank ordered from the most to the least missed item. An item analysis was done on the data to determine the frequency and performance of the test items. The frequencies of each of the 246 items were determined by item difficulty. Item difficulty was defined as the proportion of the total group who marked an item incorrectly.[8] The items were rank ordered and displayed (see Appendix A) from most to least missed. Item discrimination was also included in the item analysis data. Item discrimination is "the difference between the proportion of the upper group who got an item right and the proportion of the lower group who got the item right."[9] An item with a discrimination value of 0.0 or less was flagged as a possibly defective item with ambiguities, hidden clues or other technical problems.[10] The item discrimination data were displayed in a table.

Individual test scores were summarized and presented by group and percent correct. The total test mean score was computed and a "t" test was performed on that mean. The "t" test compared the total test mean with the hypothesized level of 80 percent correct.

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[8]The Scoring Office, "Item Analysis" (Michigan State University: Learning and Evaluation Service, 1977), p. 2., (mimeographed).

[9]Ibid.

[10]N. Gronlund, Measurement and Evaluation in Teaching, Third Edition (New York: MacMillan, 1976), p. 279.

A "t" test was used because the populations' variation was unknown and had to be estimated from the sample's standard deviation. Since 80 percent correct was used in a recent Michigan driver education study,[11] and "the criterion level or cutting score is generally set subjectively on the basis of judgment or experience,"[12] it was considered an appropriate level for the study.

The second method of measuring critical driver knowledge was the reporting and comparing of group scores for each of the four groups in the study: M_n--male senior drivers with no accidents in the past two years; M_y--male senior drivers with one or more accidents in the past two years; F_n--female senior drivers with no accicents in the past two years; F_y--female senior drivers with one or more accidents in the past two years. In this manner critical driver knowledge was the mean score for each group of senior drivers. Each group had equal cell sizes. Equal cell sizes allowed for making the assumptions necessary for using analysis of variance (ANOVA). These assumptions were normality, equal variance and independence. When equal variance was violated, equal cell sizes still allowed ANOVA to be used.[13] A 2-way ANOVA was used to determine equality for all sample mean scores. The four cells in this study required a 2-way ANOVA for analysis to show differences in multiple means without

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[11]K. Schmitt, Michigan Driver Education Evaluation Project (Lansing: Department of Education, 1978), p. 11.

[12]R. A. Berk, "Determination of Optional Cutting Scores in Criterion-Referenced Measurement," Journal of Experimental Education (Winter 1976), p. 5.

[13]Glass, op. cit., p. 369.

increasing the alpha level. ANOVA was a good statistic to use because the design met the necessary assumptions for its use. The .05 level of significance was selected for the study. The 2-way ANOVA was run on the Michigan State University CDC 6500 computer, utilizing the program packages from the second edition of the Statistical Package for the Social Sciences.[14]

Independent Variables

Both independent variables, sex and accident history, were recorded from subjects' driver records as obtained from the Michigan Department of State. (See Appendix B for a sample driver record.)

Data Collection

The collection of data for this study consisted of three distinct phases: initial contact by letter, telephone contact and testing.

Contact Letters

Five letters were of interest to the study. One letter was written to request subjects. Another letter was written to request publicity. Three letters were written to obtain participation in the study.

A letter was written to Mr. George Stevens, Traffic and Vehicle Administrator of the Michigan Department of State. This

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[14] N. H. Nie, et. al., Statistical Package for the Social Sciences, Second Edition (New York: McGraw-Hill Book Company, 1975), pp. 410 and 428.

letter requested driver records to be used as subjects for this study. A total of 1,134 driver records were obtained for use in the study through Mr. Stevens' department. (See Appendix C for the letter to Mr. Stevens.)

Another letter was written to Ms. Marion Owen of the Tri-County Office on Aging. This letter requested publicity in the Senior Forum of the State Journal. A small article was published in the April 28, 1978 edition of the State Journal.[15] (See Appendix D for the letter to Ms. Owen containing the newspaper article.)

A third letter was written and sent to the prospective subjects. This letter explained the study, requested their participation and assured the subjects of their anonymity. (See Appendix E for a copy of this subject contact letter.)

Two letters were included with the researcher's letter to prospective subjects. These letters explained the importance and value of the project and asked the prospective subjects to participate in the study. The letters were written by Dean Armand Hunter of Lifelong Education Programs and Mr. Richard Austin, Michigan Secretary of State. (See Appendix F for the letter from Dean Hunter and Appendix G for the letter from Secretary Austin.) After the sub-cells were filled packets containing the contact letter, the letter from Dean Hunter and the letter from Secretary Austin were mailed to the prospective subjects.

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[15] State Journal (Lansing), April 28, 1978, p. G1, Col. 4.

Telephone Contact

Approximately five days after the contact letter was mailed, a telephone call was placed to the subjects requesting a convenient time for them to fill out the knowledge inventory. Where no telephone was listed, a personal visit was used for this purpose. Refusals were asked to provide the information on the demographic data sheet. (See Appendix H for the demographic data sheet.) Non-English speaking and non-reading senior drivers were dropped from the study.

Testing

Senior drivers were tested under similar, but not identical, conditions. All tests were administered in the home environment. All materials for taking the inventory were provided. A card table and folding chair were taken to the "in-home" testing sites to reduce variance. The respondents were asked not to talk about the test to reduce inter-respondent contamination.

Instrument

The test instrument was an exact copy of the 246-item Special Test Set (STS) found in the Handbook for Tests of Driving Knowledge.[16] The STS was selected from a pool of 1,311 items in the original item bank. The original item bank was written from, and can be tied directly to, knowledge objectives from the most and very critical

[16] W. T. Pollock and T. L. McDole, Handbook for Driver Knowledge Testing (Ann Arbor: Highway Safety Research Institute, 1974), pp. 39-343.

driving tasks in the HumRRo task analysis.[17] The STS was compiled by using full-pool psychometric data developed with Iowa driver education students and Coast Guard recruits. The STS was further refined by using cluster analysis, item difficulty, reliability and taxonomy comparison data. Normative and validation data were then collected on the STS by use of four classifications of Michigan drivers.[18]

The STS was considered to be too large in its present form to be given to senior drivers. The STS was divided into three equivalent forms, A, B, and C. All three forms were 82 questions in length. Each form had identical instructions, demographic data sheets, and were identical in format. The STS was divided into 28 content areas that were evenly divided across all three forms. The mean difficulty level for Michigan Renewal Drivers on the questions in all three forms was 75.8. The three forms were equivalent forms of the STS. (See Appendix I for sample questions from Forms A, B, and C of the knowledge inventory.)

Organization of Data

The data were organized in two patterns for analysis. Items were first rank ordered by frequency from most to least missed. The rank-ordered items were displayed in Appendix A which showed relative deficiency of critical driver knowledge.

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[17] W. T. Pollock and T. L. McDole, Development of a National Item Bank for Tests of Driving Knowledge: Final Technical Report (Ann Arbor: Highway Safety Research Institute, 1973), p. 20.

[18] Ibid., p. 56.

The mean score for each of the four groups was then computed and displayed in a 2x2 design. A 2-way analysis of variance was used to test for significant differences between the four group means.

Summary

This chapter outlined the design and methodology used in the study. Topics described in detail were: selection of the population; selection of the sample; the variables of interest; measurement of the variables; data collection; description of the test instrument; and organization of the data and findings that were relevant to the study.

The data and results obtained in the study are organized and displayed in tables in the next chapter.

CHAPTER IV

ANALYSIS OF RESULTS

The preceeding chapter described the design and methodology used in the study. This chapter presents the sample data, demographic data, data for item difficulty, item discrimination and data for analysis of individual and group scores.

The Sample Data

In this section data are presented which were obtained as a result of stratifying, determining the sample size, and selecting the sample.

Stratification

A total of 1,134 senior driver records were obtained from the Michigan Department of State. The 1,134 senior drivers were stratified with: 88 senior drivers in the male with accidents group; 481 senior drivers in the male with no accidents group; 57 senior drivers in the female with accidents group; and 508 senior drivers in the female with no accidents group. There were 569 male senior drivers and 565 female senior drivers in the sample frame (see Table 4.1).

TABLE 4.1.--Stratification of the Sample Frame: Accident--No Accident and Male--Female.

Accidents	Number		Total
	Male	Female	
Accidents	88	57	
No Accidents	481	508	
TOTAL	569	565	1,134

Determining the Sample Size

The sample size was set at the maximum number of 52 subjects, or 156 contacts, by using the error term computed from a 24-subject pilot test of the driver knowledge inventory. The error term computation called for a sample size of 168 subjects, or 504 contacts, as three contacts were equivalent to one subject.

After the study was completed and the data analyzed, an ANOVA was performed to increase the statistical power of the 52-subject sample. Table 4.2 indicates that an "f" ratio of 1.601 was obtained from a 1-way ANOVA performed on the mean total test scores of Forms A, B, and C. This indicated no significant difference between the forms as an "f" ratio of 3.00 was needed to reject equality at the .05 level. Since the forms were equivalent in content and construction, and showed no difference in total mean scores, Forms A, B and C were testing the same things. This allowed for statistical purposes, the use of each contact as an individual

subject, not one-third of a subject. Therefore, a total N of 156 was used in the statistical analysis of the study.

TABLE 4.2.--1-Way ANOVA Table of the Three Test Form Means.

Source of Variance	Sum of Squares	DF	Mean Square	F	Significance of F
Form	31.744	2	15.872	1.601	.205
Residual	1517.231	153	9.917		

*Critical value = 3.00.

Sample Selection

The mean, median and modal age for all senior drivers contacted for purposes of this study are shown in Table 4.3. The mean, median, and modal age for: male participants was 72.5, 71.3, and 71; female participants was 71.7, 70.6 and 71; all participants was 72.1, 76.1 and 71; male non-participants was 73.3, 73 and 74; female non-participants was 73.2, 74 and 76; all non-participants was 73.3, 74.3 and (bimodal) 71 and 74; all persons contacted was 72.3, 73.2 and 71, respectively. All groups show similar age divisions (see Table 4.3).

Table 4.4 shows that age range of the sampled senior drivers with and without accidents is similar. The male with accidents group had 11 drivers in the 65-69 age range; 14 drivers in the 70-74 age range; 10 drivers in the 75-79 age range; 3 drivers in the 80-84 age range; and 1 driver in the 85-89 age range. The female with

TABLE 4.3.--Mean, Median and Modal Ages of All Senior Drivers Contacted for Purposes of this Study.

Groups	Age		
	Mean	Median	Mode
Male participants	72.5	71.3	71.0
Female participants	71.7	70.6	71.0
All participants	72.1	76.1	71.0
Male non-participants	73.3	73.0	74.0
Female non-participants	73.2	74.0	76.0
All non-participants	73.3	74.3	71.0 & 74.0
All persons contacted	72.3	73.2	71.0

TABLE 4.4.--Age Range of Sampled Senior Drivers.

Age Range	Number			
	Males with Accidents	Females with Accidents	Males no Accidents	Females no Accidents
65-69	11	15	12	11
70-74	14	12	17	20
75-79	10	10	3	5
80-84	3	1	7	3
85-89	1	1	0	0
TOTAL	39	39	39	39

accidents group had 15 drivers in the 65-69 age range; 12 drivers in the 70-74 age range; 10 drivers in the 75-79 age range; and 1 driver in the 80-84 age range. The male without accidents group had 12 drivers in the 65-69 age range; 17 drivers in the 70-74 age range; 3 drivers in the 75-79 age range; and 7 drivers in the 80-84 age range. The female without accidents group had 11 drivers in the 65-69 age range; 20 drivers in the 70-74 age range; 5 drivers in the 75-79 age range; and 3 drivers in the 80-84 age range.

There were 14 senior drivers who could not be located from the address listed on their driver records. Some were found to be in Florida, Northern Michigan, and Europe. The "not found" drivers were also dropped from the study. The totals for the sample frame are presented in Table 4.5.

TABLE 4.5.--Distribution of Sampled and Non-Sampled Senior Drivers.

Groups	Numbers				
	F_y	F_n	M_y	M_n	Total
Sampled	39	39	39	39	156
Refused	10	15	12	3	40
Not found	3	3	3	5	14
Died	0	0	1	1	2
Non-English speaking	0	0	1	0	1
Not used*	8	3	4	12	27
TOTAL	60	60	60	60	240

*Subjects held in reserve and not contacted in the study.

Demographic Data

The non-sampled drivers totaled 57. In the sample selection process 40 people did not agree to participate in this study. Demographic data were collected from non-participants in this study when they received a telephone call or interview, requesting a time period for their participation in this study. The demographic data provided a basis for comparing the participants and non-participants in this study. No one group seemed to have largely different demographic data. Table 4.6 is a summary of the demographic data collected in this study. Two senior drivers had died and one was a non-English speaking person. They represented less than two percent of the persons contacted who were dropped from the study.

Item Difficulty and Discrimination

Each 82-item form (A, B and C) was tested on 52 subjects from each of the four groups: males with accidents; females with accidents; males without accidents; and females without accidents. An item analysis was run at the Michigan State University scoring office on the OpScan 100M to determine item difficulty and item discrimination values for each question. The MSU scoring pattern "AL" was used to obtain an item analysis that included data cards for each subject in the study.

Item Difficulty

Item difficulty, defined as the proportion of the group who answered the item and marked it correctly, ranged from a high of 90

TABLE 4.6.--Summary of Demographic Data by Participant--Non-participant and Accident--Non-accident Groups.

Demographic Data	Number			
	Refusals with Accidents	Subjects with Accidents	Refusals without Accidents	Subjects without Accidents
Days driven per week	5.7	5.5	6.2	5.6
Years of license	52.0	53.7	55.0	51.8
Miles driven per year	9,000	8,705	11,500	7,966
Male	12	39	3	39
Female	10	39	15	39
Highest grade in school	11.5	11.2	10.7	11.8
Received formal driving instruction	0	3	0	3
Own a vehicle	22	78	18	77
Always use seat belt	3	20	1	17
Some use of seat belt	5	21	6	43
Never use seat belt	14	37	11	18
Married	9*	46	11	52
Widowed	7	27	7	21
Single	0	4	0	3
Divorced	0	1	0	2

*Six persons declined to answer this question.

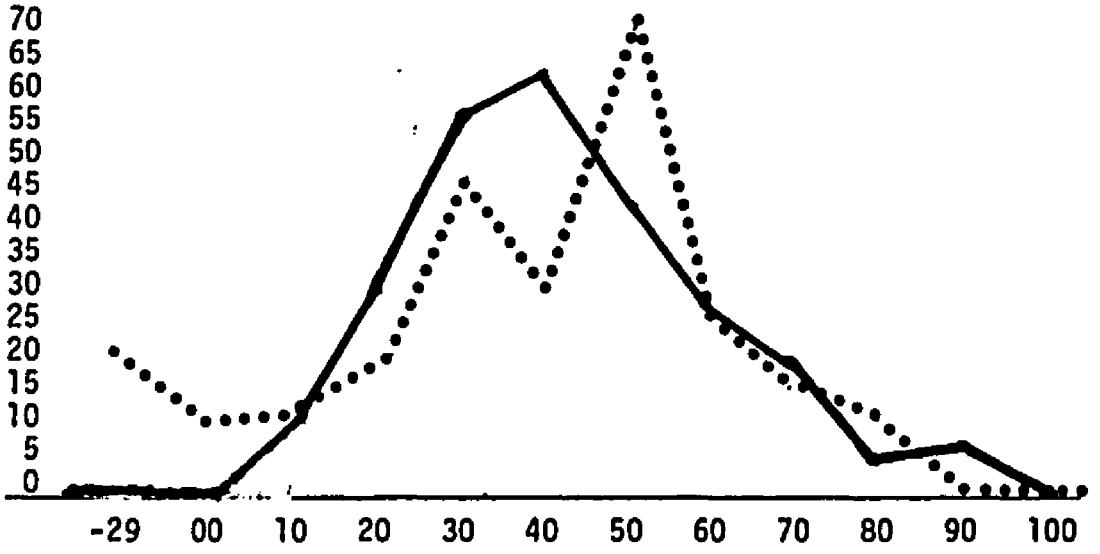
to a low of 2. The distribution of item difficulties is presented in Appendix A.

Item Discrimination

Item discrimination ranged from a high of 93 to a low of -29. Eighteen items were found to have a discrimination value of 0 or less. Such items could not give a true indication of the level of knowledge for which they test because of confounding variables in the item's construction. Discrimination values were reported for the 156 items in Appendix A.

Item difficulty for the entire knowledge inventory had a mean value of 37 and appeared to follow a normal distribution. The mean item discrimination value was 36.6 and appeared to be negatively skewed. Figure 1 shows the curve for item difficulty and item discrimination.

The 24 most missed questions with an item difficulty above 60 were grouped into seven categories. Vehicle control questions comprised the largest related category of missed items. The six vehicle control questions included items on: skid control; stopping on snow; pulling a trailer; water on the brakes; night stopping distance; and slowing for obstructed intersections. The second largest related category of missed items was traffic control signs and signals. The five sign and signal items were questions on: school zone signs; obstruction in the road signs; yield signs; and traffic signals. The third largest category contained four questions on license and vehicle registration procedure. Three items from



Key: ——— Indicates item difficulty

••• Indicates item discrimination

Figure 1.--Distribution of Item Difficulty and Discrimination Indices.

this group concerned suspended or no driver license and the remaining item dealt with vehicle registration law. The three items on freeway driving and three items on right and left turns were the next most missed categories. Two items on dimming headlights in the face of on-coming traffic were the sixth most missed category. One item on drugs and alcohol was the final category. Table 4.7 shows a rank ordering of the top 24 missed items.

The 246-item knowledge inventory was divided into three equivalent forms in the study. Forms A, B and C contained items from 28 topical divisions of the knowledge inventory. These 28 topical divisions represented a second manner of looking at most

TABLE 4.7.--Rank Ordering of Top 24 Missed Items with Related Content Areas.

Item Number	Item Difficulty	Item Discrimination	Content Area
C-78	90	0	Yellow light on traffic signal.
C-27	83	-29	Stopping a car on snow.
C-38	81	15	Left exit on freeway.
A-13	77	29	Slowing vehicle for obstructed view at an intersection.
C-63	77	7	Alcohol, drugs and driving.
A-45	73	15	On-coming car with bright lights.
B- 4	67	15	Pulling a trailer.
C-11	67	57	Right turns.
C-15	67	0	Left turns.
C-53	67	43	License suspension.
B-70	67	43	Yield signs.
B-21	65	22	Missed exit on freeway.
C-43	65	21	When to dim bright lights.
B-15	63	-14	Left turns.
C-47	63	50	Traffic signal colors.
C-51	63	36	Vehicle registration.
C-54	63	57	No driver license.
B-10	62	- 7	Driving multi-lane roads.
B-26	62	65	Water on brakes.
C-42	62	50	Night stopping distances.
C-55	62	36	Suspended license.
B-75	62	29	Traffic construction sign.
C-82	62	50	School zone sign.

missed items. A mean item difficulty was computed for each of the 28 topical divisions of the knowledge inventory. The mean item difficulty for topical divisions ranged from 51 to 21. The five topical divisions with a mean item difficulty above 45 were: railroad crossings, bridges and tunnels; emergency situations and manuvers; skid control; driver license questions; and night driving. The six least missed divisions with a mean item difficulty below 25 were: vehicle equipment; vehicle care and service; highway driving; anti-theft laws; vehicle inspection; and accidents and accident reports. Table 4.8 presents a rank ordering of the 28 topical divisions by their mean item difficulty indices.

Analysis of Individual and Group Scores

The 156-subject sample group of the study was divided into four groups containing 39 senior drivers each. The groups were identified as: M_n, males with no accidents in the past two years; F_n, females with no accidents in the past two years; M_y, males with one or more accidents in the past two years; and F_y, females with one or more accidents in the past two years. Sex and accident data used to group each subject were recorded from driver records obtained from the Michigan Department of State.

Individual Scores

The first hypothesis was that senior drivers would not show a critical driver knowledge level of 80 percent correct. A "t" test was performed on the total test mean of 63 percent correct. The "t"

TABLE 4.8.--28 Topical Divisions of the Knowledge Inventory Rank Ordered by Their Mean Item Difficulty.

Rank Order	Mean Item Difficulty	Topic
1	51.00	Railroad crossings, bridges, and tunnels.
2	48.50	Emergency situations and manuvers.
3	47.25	Skid control.
4	46.62	Driver license.
5	46.50	Night driving.
6	44.50	Post-accident responsibilities.
7	44.16	Vehicle registration and title.
8	43.36	Physical and emotional conditions.
9	41.86	Basic manuvers.
10	41.30	Driver perception and communication.
11	40.00	Urban driving.
12	38.80	Speed control.
13	37.60	Braking and stopping.
14	37.30	Traffic signs, signals, and markings.
15	36.09	Freeway driving.
16	33.16	Road and weather conditions.
17	32.71	Rules of the road.
18	32.50	Reacting to traffic and emergencies
19	30.40	Fundamental control and manuvers.
20	30.25	Directional control.
21	29.00	Pre-operative procedures.
22	27.00	Financial responsibility.
23	24.55	Vehicle equipment.
24	23.00	Vehicle care and service.
25	22.33	Highway driving.
26	22.00	Anti-theft laws.
27	21.33	Vehicle inspection.
28	21.00	Accidents and accident reports.

test yielded a value of -16.50. A value greater than +1.96 or less than -1.96 was needed to reject the null hypothesis at the .05 level of significance. The null hypothesis was tested and rejected.

$$H_0: \text{ S.D. } \mu = 80$$

$$H_1: \text{ S.D. } \mu \neq 80$$

Deficient critical driver knowledge, a score below 80 percent correct, was shown by 131 senior drivers. Individual performance on the knowledge inventory ranged from two high scores of 92 percent correct to a low score of 12 percent correct. Individual scores were listed by group and percent correct in Table 4.9.

TABLE 4.9.--Individual Test Scores by Group and Percent Correct.

Percent Correct	F_y	M_n	M_y	F_n	Total
90-99	0	4	1	0	5
80-89	3	2	9	6	20
70-79	10	8	14	9	41
60-69	7	11	8	11	37
50-59	14	4	3	6	27
40-49	1	5	0	1	7
30-39	1	3	3	2	9
20-29	2	2	1	4	9
10-19	1	0	0	0	1
TOTAL	39	39	39	39	156

The 25 senior drivers, 16 percent, who scored 80 percent or more correct were in the following four groups: six in group M_n; six in group F_n; three in group F_y; and ten in group M_y.

Group Scores

A 2-way ANOVA using the Michigan State University CDC-6500 computer was performed on the four group means. Presented in Table 4.10 are the data from the 2-way ANOVA for hypotheses two, three and four.

The second hypothesis was that the mean scores for males and females would not be equal.

$$H_0: \mu M = \mu F$$

$$H_1: \mu M \neq \mu F$$

TABLE 4.10.--2-Way ANOVA Table of the Group Means.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
Sex	1.256	1	.641	.124	.939
Accidents	.026	1	.026	.003	.960
Accidents/Sex	6.564	1	6.564	.647	.422
Residual (Error)	1541.128	152	10.139		

*Critical value = 3.84

The main effect for sex yielded an "f" ratio of .124. An "f" ratio of 3.84 was needed to reject the null hypothesis at the .05 level of significance. The null hypothesis of equal mean scores for males and females was not rejected.

The third hypothesis was that the mean scores for senior drivers with no accidents in the past two years would not be equal to the mean scores for senior drivers with one or more accidents in the past two years.

$$H_0: \mu \text{ ACC} = \mu \text{ NO ACC}$$

$$H_1: \mu \text{ ACC} \neq \mu \text{ NO ACC}$$

The main effect for accidents yielded and "f" ratio of .003. An "f" ratio of 3.84 was needed to reject the null hypothesis at the .05 level of significance. The null hypothesis of equal mean scores for senior drivers with and without accidents was not rejected.

The fourth hypothesis was that the mean scores for: females with no accidents; females with one or more accidents in the past two years; males with no accidents; and males with one or more accidents in the past two years would not be equal.

$$H_0: \mu F_n = \mu F_y = \mu M_n = \mu M_y$$

$$H_1: \mu F_n \neq \mu F_y \neq \mu M_n \neq \mu M_y$$

The 2-way interaction effect of sex and accidents yielded an "f" ratio of .647. An "f" ratio of 3.84 was needed to reject the null

hypothesis at the .05 level of significance. The null hypothesis of equal mean scores for: females with no accidents; females with one or more accidents in the past two years; males with no accidents; and males with one or more accidents in the past two years was not rejected.

Summary

This chapter presented an analysis of the results of the study. The findings included: sample data, demographic data, a rank ordering of deficient critical driver knowledge found in senior drivers; a rank ordering of categories of most missed items; a rank ordering of group means of most missed items; a summary of individual scores by group and percent; and a comparison of the four group means on the knowledge inventory. The following chapter contains the summary, conclusions, recommendations, recommendations for further research and a discussion.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter IV contained the major findings of the study. This chapter contains a brief summary of the study; methods of procedure; findings; conclusions; recommendations; recommendations for further research; and a discussion.

Summary of the Study

It was the purpose of this study to determine the level of deficient driver knowledge in senior drivers of Ingham County, Michigan, and to discover differences between mean scores of four groups of senior drivers. It was felt that these questions could best be answered by testing the following hypotheses:

1. Was critical driver knowledge equal to 80 percent correct?

$$H_0: \text{ S.D. } \mu = 80$$

$$H_1: \text{ S.D. } \mu \neq 80$$

2. Was the mean score for males and the mean score for females equal?

$$H_0: \mu M = \mu F$$

$$H_1: \mu M \neq \mu F$$

3. Was the mean score for senior drivers with one or more accidents in the past two years equal to the mean score for senior drivers with no accidents in the past two years?

$$H_0: \mu \text{ ACC} = \mu \text{ NO ACC}$$

$$H_1: \mu \text{ ACC} \neq \mu \text{ NO ACC}$$

4. Were the mean scores for: females with no accidents in the past two years; females with one or more accidents in the past two years; males with no accidents in the past two years; and males with one or more accidents in the past two years equal?

$$H_0: \mu F_n = \mu F_y = \mu M_n = \mu M_y$$

$$H_1: \mu F_n \neq \mu F_y \neq \mu M_n \neq \mu M_y$$

Methods of Procedure

The population which comprised the sample frame for the study consisted of all Ingham County senior drivers on file with the Michigan Department of State. A group of four tapes were randomly selected from the 40 computer tapes that contained an alpha-numerical listing of all Michigan drivers. A total of 1,134 Ingham County senior driver records were printed from the selected tapes. The driver records were then stratified into four groups by sex and two year accident history. A total of 39 subjects were randomly selected from each stratified group to fill the four cells in the study. Letters and follow-up telephone calls were met by a 25 percent refusal rate for the study. An additional 17 subjects could not be located or were known to have died. A total of 156 senior drivers were tested with the knowledge inventory. Test sessions were conducted in the subjects' homes and lasted about one hour. The data were coded on mark-sense sheets for use in data analysis. A "t"

test of the total test mean and 2-way ANOVA were used to test the null hypotheses.

Findings

Hypothesis 1

Senior drivers would not show a critical driver knowledge level of 80 percent correct.

Major finding. Senior drivers were significantly deficient in critical driver knowledge. The mean score for senior drivers was 63 percent correct and the pre-set cutting score for non-deficient critical driver knowledge was 80 percent correct. The difference between the means was significant at the .05 level.

Additional Findings. Twenty-five senior drivers or 16 percent of the sample were not deficient in critical driver knowledge as they attained or surpassed a score of 80 percent correct on the knowledge inventory.

The 24 most missed questions dealt with vehicle control, traffic control signs and signals, license and vehicle registration, freeway driving, right and left turns, dimming headlights, and drugs and alcohol.

The five topical divisions of the knowledge inventory with the highest mean item difficulty scores were railroad crossings, bridges and tunnels, emergency situations and manuvers, skid control, driver licensing and night driving.

The six topical divisions of the knowledge inventory with the lowest mean item difficulty scores were vehicle equipment,

vehicle care and service, general highway driving, anti-theft laws, vehicle inspection, and accidents and accident reports.

Eighteen items in the special test set were found to have an item discrimination value of 0.0 or less.

Hypothesis 2

The mean scores for male and female senior drivers would not be equal.

Major finding. There was no significant difference between scores of male and female senior drivers.

Hypothesis 3

The mean scores for senior drivers with no accidents in the past two years would not be equal to the mean scores for senior drivers with one or more accidents in the past two years.

Major finding. There was no significant difference between the mean scores of senior drivers who had been in one or more accidents and senior drivers who had not been in an accident in the past two years.

Hypothesis 4

The mean scores for: females with no accidents; females with one or more accidents in the past two years; males with no accidents; and males with one or more accidents in the past two years would not be euqal.

Major finding. The mean scores of male or female senior drivers did not depend on their level of accident experience.

Conclusions

The following are conclusions based upon the findings of the study:

1. Senior drivers have a critical driving knowledge deficiency. The mean scores for all senior drivers on the knowledge inventory was 63 percent correct. The cutting score for deficient critical driving knowledge was 80 percent correct. A "t" test of the means, 63 and 80, showed them to be significantly different at the .05 level.

2. Senior drivers have deficient critical driver knowledge in high stress areas requiring quick judgments, vehicle handling and skillful manuvers. Six of the 24 most missed questions dealt with vehicle control. Three of the most missed questions dealt with freeway driving. Three of the most missed questions dealt with right and left turns. Two of the most missed questions dealt with dimming headlights at night. The second most missed topical division of the knowledge inventory was emergency situations and manuvers. The third most missed topical division of the knowledge inventory was skid control. The fifth most missed topical division of the knowledge inventory was night driving.

3. Senior drivers have deficient critical driver knowledge in the area of traffic control sign and signal recognition. Two of the 24 most missed items dealt with traffic signals. Three of the most missed items dealt with traffic control signs. The most missed topical division of the knowledge inventory was the area of

railroad crossings, bridges and tunnels. The fourteenth most missed topical division was traffic signs, signals and markings.

4. Senior drivers have critical driver knowledge in non-stress, non-driving situations. The six least missed topical divisions of the knowledge inventory were vehicle equipment, vehicle care and service, anti-theft laws, vehicle inspection, vehicle accident procedures and reports, and general highway driving.

5. Twenty-five of the knowledge inventory items were improperly written. Eighteen of the knowledge inventory items had an item discrimination value of 0.0 or less. Seven of the items had an item difficulty below ten.

6. There is no difference in critical driver knowledge between male and female senior drivers. The 2-way ANOVA for the main effect of sex showed an "f" value of .124. An "f" level of 3.84 was needed to show a significant difference.

7. There is no difference in critical driver knowledge between senior drivers who have been or who have not been involved in an accident in the past two years. The 2-way ANOVA for the main effect of accidents showed an "f" value of .003. An "f" level of 3.84 was needed to show a significant difference.

8. Male or female senior drivers did not show different levels of critical driver knowledge because of their having or not having had an accident in the past two years. The 2-way ANOVA for the interaction effect of accidents/sex showed an "f" value of .647. An "f" level of 3.84 was needed to show a significant difference.

Recommendations

The following are recommendations based on the findings and conclusions of the study:

1. Programs should be established to offer driver refresher classes for senior drivers.

2. Programs established for senior drivers should focus on increasing senior drivers' awareness and understanding of traffic control signs and signals, and high stress, high density, high volume traffic situations.

3. When designing a driver refresher course curriculum for senior drivers, accident experience and sex need not be used to group students for different treatments.

4. Eighteen knowledge inventory items of the special test set need to be checked for: hidden clues, ambiguity, unclear meanings, and incorrect or missing responses.

Recommendations for Further Research

The following are recommendations for further research based upon the findings, conclusions and recommendations of the study:

1. A study should be conducted to discover what variables are related to the level of critical driver knowledge in senior drivers.

2. A study using the knowledge inventory to test critical driver knowledge in youth and middle age drivers should be conducted and compared with the results obtained for senior drivers.

3. A study should be conducted of senior driver attitudes as related to the driving task.

4. A study should be conducted to measure senior driver performance in on-road driving situations.

5. A study should be conducted to create a measure or factor to rate senior driver exposure in traffic.

6. A study should be conducted to devise a system that would identify those senior drivers who are no longer fit to operate a motor vehicle.

7. A study should be conducted to measure the speed and accuracy with which a senior driver processes incoming information and the point at which the processing begins to break down.

Discussion

Most Missed Items

It was interesting to note that the most missed knowledge items occurred in the areas where there was also poor behind-the-wheel performance by senior drivers. Traffic signs were missed by senior drivers both on the pencil and paper tests and in the on-road environment. Areas that require quick and skillful judgments such as skid recovery, merging and lane changing posed a problem on the test as well as on the road. The data clearly point to a correlation between lack of knowledge and poor on-road performance by senior drivers.

Deficient Knowledge by Senior Drivers

Senior drivers have shown a deficient level of critical driver knowledge. Knowledge is not always the best measure of performance. It is part of "good driving" but, just because they don't perform well on a "paper and pencil" test doesn't mean they are not performing well in on-road, driving situations. Sometimes people do things correctly even though they answer it wrong on a test paper.

Testing situations often make people tense which might be causing them to have a difficult time relating their knowledge to questions being asked on the test instrument. Senior drivers might also be having problems reading and understanding the "technical jargon" so often involved in the field of traffic safety.

A better way of evaluating knowledge might be to observe senior drivers in a real world driving situation.

The Main Effect of Accidents

The main effect for accidents was no difference. The obtained "f" ratio of .003 leads the writer to believe that accidents are truly chance events. Therefore it is believed that an increase in the usual two-year study period of accident history would still show no difference.

Sample Size

It was unfortunate that, for practical reasons, the sample could not meet the recommended size of 168. It was interesting to note, however, that a sample size above 120 on the "f" table was rated the same as a sample of infinite size. It should also be noted

that the "f" ratios for main effects were very low at .124 and .003. It is the opinion of the writer that, had the sample size been increased from 156 to 168, an "f" ratio of significance at the .05 level, 3.84, still would not have been achieved. It is felt that the results of the study were not hurt by the lack of an additional 12 subjects.

Negatively Worded Items

Twenty items in the item inventory were worded in a negative manner. These questions typically asked what not to do, offering three correct options and one incorrect option. To answer an item correctly one had to pick which was incorrect. This caused quite a bit of hesitation and frustration in senior drivers. Most complained that the questions "didn't make good sense," etc. The writer feels these questions could easily have been changed to eliminate much of the frustration and uncertainty for senior drivers taking license renewal tests.

Senior Driver Competence

While doing this study the writer visited 156 senior drivers in Ingham County. There were 15-20 persons who appeared unfit to operate a motor vehicle because of health reasons. There is no existing screening process to detect senility, severe heart condtion, stroke, severe arthritis and other debilitating health problems. It is the opinion of the writer that some sort of health screening procedure should be established to remove from the road persons who are unfit to operate a motor vehicle.

Comparison of Groups

The study was not designed to compare senior driver mean scores with mean scores obtained from other samples. It was, however, of interest to note that the mean scores for the six groups used to validate the item pool and special test set were all higher than the mean score for senior drivers. That is to say that senior drivers scored lower than any of the validation or comparison groups. Mean item difficulty scores for each of the four groups were: Iowa driver education students, 78; U.S. Coast Guard recruits, 73; Michigan original license applicants, 74; Michigan renewal applicants, 75; and Michigan transfer applicants, 81. The senior driver mean item difficulty score of 63 was well below the lowest comparison group.

Some thoughts on the reasons for these differences might be:

1. The senior driver sample was picked randomly from all senior drivers in Ingham County, Michigan. The subjects used in the validation studies were either driver education and driver refresher students or some class of Michigan driver license applicant. In either case the validation or comparison groups had good reason for being up-to-date on their critical driver knowledge.

2. Senior drivers might have considerably less critical driver knowledge than did the comparison groups.

3. Senior drivers might not have been as test-wise as the younger subjects in the comparison groups.

4. Senior drivers might have shown a higher level of test fatigue than the younger drivers in the comparison groups.

Suggestions for a Follow-Up Study

The study took almost as much travel time as it did in interviewing subjects. A suggestion would be to limit a study of this kind to a geographic area below the county level. An alternative suggestion would be to have some manner for the senior drivers to come to a central place for testing.

A second suggestion would be to check on-road performance as well as driving knowledge. This would provide a double check on the level of knowledge, and allow for making interpretations of just what the lack of a certain type of critical driver knowledge means in terms of safe driving performance.

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APPENDICES

APPENDIX A

ITEM DIFFICULTY AND DISCRIMINATION

ITEM DIFFICULTY AND DISCRIMINATION

Item Number	Item Difficulty†	Item Discrimination§	Item Number	Item Difficulty†	Item Discrimination§
C-78	90	0*	B-78	58	72
C-33	87	-29*	A-19	56	0*
C-27	83	15	C-30	56	72
C-38	81	36	B-39	56	58
A-13	77	29	B-52	56	79
C-63	77	7	C-46	56	35
A-45	73	15	B-22	54	21
B - 4	67	15	B-31	54	- 7*
C-11	67	57	A-51	54	21
C-15	67	0*	C-64	54	65
C-53	67	43	C- 6	52	57
B-70	67	43	A-47	52	28
B-21	65	22	C-62	52	14
C-43	65	21	A-73	52	7
B-15	63	-14*	A- 7	50	58
C-47	63	50	C-31	50	50
C-51	63	36	B-38	50	50
C-54	63	57	B-64	50	58
B-10	62	- 7*	C-71	50	43
B-26	62	65	B-55	50	7
C-42	62	50	A-21	48	329
C-55	62	36	C-26	48	36
B-75	62	29	B-48	48	21
C-82	62	50	A-65	48	50
A-22	60	- 7*	B-54	48	35
B-14	60	-21*	B-67	48	50
B-17	60	21	C-72	48	43
C-16	60	72	A- 5	46	35
C-22	60	35	B- 2	46	14
B-32	60	36	C- 8	46	64
C-45	60	0*	C-19	46	35
C-77	60	21	A-34	46	57
C - 9	58	21	B-33	46	36
B-12	58	0*	B-61	46	14
A-39	58	50	C-80	46	57
A-50	58	21	A- 3	44	72
C-44	58	64	B-18	44	14

Item Difficulty and Discrimination
(continued)

Item Number	Item Difficulty†	Item Discrimination§	Item Number	Item Difficulty†	Item Discrimination§
B-23	44	21	A-62	37	43
C-18	44	50	A-64	37	57
C-20	44	57	A-71	37	57
C-21	44	57	C-69	37	43
B-42	44	72	B- 6	35	43
B-45	44	65	C-10	35	64
B-79	44	43	C-12	35	93
C-70	44	43	C-17	35	22
C-79	44	65	B-41	35	50
B-20	42	0*	C-35	35	86
B-30	42	14	B-47	35	43
C-39	42	36	C-48	35	29
A-44	42	50	C-60	35	65
B-43	42	50	B-68	35	43
B-51	42	50	B-81	35	50
C-76	42	64	C-73	35	42
A- 8	40	50	C-37	33	79
B- 5	40	-14*	A-49	33	29
C- 4	40	22	A-52	33	43
B-34	40	57	B-60	33	36
C-36	40	57	A-70	33	36
A-63	40	14	A-74	33	36
C-65	40	72	B-66	33	57
A-80	40	72	A- 4	31	57
A-82	40	7	A-10	31	36
B- 8	38	50	A-11	31	21
A-18	38	50	B- 9	31	-14*
B-24	38	7	C- 7	31	43
C-23	38	57	B-50	31	50
C-34	38	36	A-54	31	79
C-40	38	22	A-55	31	65
B-71	38	36	A-59	31	50
B-80	38	64	B-63	31	29
B-82	38	14	C-56	31	50
B- 1	37	-28*	A-76	31	43
A-25	37	71	B-74	31	7
A-28	37	50	A- 1	29	-22*
B-27	37	35	A- 9	29	43
C-14	37	50	A-15	29	50
C-32	37	28	A-26	29	50
C-41	37	22	B-19	29	22
A-48	37	50	C-24	29	36

Item Difficulty and Discrimination
(continued)

Item Number	Item Difficulty†	Item Discrimination§	Item Number	Item Difficulty†	Item Discrimination§
A-40	29	57	A-53	21	57
A-46	29	57	A-60	21	50
B-46	29	22	B-53	21	57
C-49	29	8	B-56	21	57
B-59	29	50	B-76	21	15
B-62	29	36	C-75	21	50
B-72	29	22	A-12	19	71
B-73	29	43	A-16	19	43
A-20	27	50	A-58	19	50
A-30	27	50	A-61	19	29
B-13	27	8	B-58	19	50
B-44	27	28	A-78	19	57
A-56	27	50	A-32	17	43
C-66	27	64	A-38	17	43
C-67	27	50	B-49	17	14
A-37	25	29	C-50	17	50
B-35	25	29	B-57	17	0*
C-57	25	72	A-67	17	29
A-79	25	64	A-17	15	43
B-77	25	22	B-11	15	14
C-74	25	50	B-28	15	15
A- 6	23	64	C-13	15	43
C- 1	23	14	A-41	15	43
C- 5	23	43	A-43	15	36
A-27	23	36	A-57	15	50
A-31	23	22	A-72	15	36
B-25	23	22	A- 2	13	14
C-25	23	43	A-24	13	43
C-29	23	50	B-29	13	14
A-36	23	57	A-75	13	43
B-36	23	64	C-81	13	50
B-40	23	43	C- 3	12	29
B-65	23	29	B-37	12	14
C-52	23	36	C-58	12	29
C-59	23	50	A-66	12	36
C-61	23	57	A-68	12	43
B-69	23	29	A-81	12	22
B- 7	21	36	A-33	10	36
A-23	21	22	A-77	10	22
B-16	21	0*	C-68	10	36
C-28	21	57	A-14	8	21

Item Difficulty and Discrimination
(continued)

Item Number	Item Difficulty†	Item Discrimination§	Item Number	Item Difficulty†	Item Discimination§
A-29	6	21	A-35	4	14
A-42	6	21	A-69	4	14
C- 2	4	14	B- 3	2	7

Key: * - A discrimination value of 0 or less
A - Test Form A
B - Test Form B
C - Test Form C
† - Item difficulty--proportion (percentage) of subjects who missed the item
§ - Item discrimination--how well an item performed

APPENDIX B

SAMPLE DRIVER RECORD

SAMPLE DRIVER RECORD

```
9090909-0909090909                              04/10/78  INQ #1234

D-000-000-000-000                    R-OPER       80  051805    F
Doe, Jane                            12345 E. TURNER
LANSING 48900 33                     012345  K0671  24-40

CORRECTIVE LENS
ADDRESS HISTORY          K3224  110777
000000  LANSING                 013073 IMPROPER LANE USE
MC SOS
```

APPENDIX C

LETTER TO MR. STEVENS

MICHIGAN STATE UNIVERSITY EAST LANSING • MICHIGAN 48824

CONTINUING EDUCATION SERVICE • HIGHWAY TRAFFIC SAFETY CENTER • KELLOGG CENTER

March 31, 1978

Mr. George Stevens
Driver and Vehicle Administrator
Michigan Department of State
Lansing, Michigan 48918

Dear Mr. Stevens:

I am a doctoral student at the Highway Traffic Safety Center of Michigan State University. I am interested in completing a research project dealing with the general level of driving knowledge in motor vehicle operators age 65 and older in Ingham County, Michigan. A research project of this kind is required for the degree Ph.D. in traffic safety.

The proposed research is to be conducted under the supervision and approval of the Highway Traffic Safety Center and Michigan State University. The project will be supervised by a four man committee consisting of: Dr. Robert E. Gustafson, Chairman, Dr. Norman T. Bell, Dr. Robert O. Nolan and Dr. Donald L. Smith. The researcher will be Thomas Miller. The title of my proposed research will be: "Inventory of Critical Driver Knowledge for Motor Vehicle Operators Age 65 and Older in Ingham County, Michigan."

This letter is to request use of computer time to generate subjects for this doctoral dissertation at Michigan State University. After consultation with Mr. John Lucia it was determined that the following procedure would be the most cost effective method of obtaining subjects for this research. Your approval is requested for the following:

1. Random selection of two tapes of driver records.

2. From the two selected tapes print driver records for all drivers born in or before 1913 that now reside in Ingham County, Michigan.

3. Include in the driver records all accident histories for these subjects. (This will be one of the study groups in the research design.)

4. Run the driver records on or before April 10, 1978.

5. Allow these identified drivers to be used as the subjects for this proposed research project. The project will involve the administration of a validated, standardized driver knowledge test to a group of randomly selected subjects from the above group.

The experimental treatment will consist of: An article in the State Journal and senior citizen newsletters describing the proposed research; A letter addressed to the selected subjects requesting their participation; A phone call requesting a time for their participation; A one hour testing time as agreed upon by the phone call; and a follow-up letter thanking them for their participation and advising them of the results of the experiment.

It is estimated that two tapes will be used and that between 700 and 800 driver records will be printed in this manner. All driver records will be kept confidential. All driver records will be returned to your department at the conclusion of this study.

I will be glad, at your convenience, to discuss this proposed research with you. A copy of the results of this study will be sent to your office and made available to the people of Michigan. Again, the subjects in this study will remain anonymous.

Sincerely,

Thomas L. Miller

Thomas L. Miller

Robert E. Gustafson

Dr. Robert E. Gustafson, Professor
Committee Chairman

Fred E. Vanosdall

Mr. Fred E. Vanosdall, Acting Director
Highway Traffic Safety Center

APPENDIX D

LETTER TO MS. OWEN AND NEWSPAPER ARTICLE

April 21, 1978

Marion Owen
Tri-County Office on Aging
505 W. Allegan
Lansing, Michigan 48933

Dear Ms. Owen:

Here is the notice for the Senior Forum of the State Journal. I will begin the experiment on Monday April 24, 1978. Please run this notice in the Senior Forum as soon as possible.

N O T I C E

A driver knowledge research project is being conducted by Thomas Miller of Michigan State University. About 160 Ingham County senior drivers will be asked to give one hour of their time to fill out a driver knowledge inventory. It is expected this project will provide information to help senior drivers maintain their driver license longer, have their insurance premiums reduced and be safer drivers. It is urged that you participate in this project when asked. The information you provide can help to make Michigan a safer place for everyone to drive.

Thank You,

Thomas Miller

Thomas Miller

APPENDIX E

SUBJECT CONTACT LETTER

My name is Thomas Miller. I am doing a graduate research project to obtain a Ph.D. in traffic safety at Michigan State University.

This research project is important because it is expected to produce information that will help drivers age 65 and over. This project is considered valuable by the Michigan State University Highway Traffic Safety Center and Office of Lifelong Education Programs. The Michigan Secretary of State also supports this project. (See the enclosed letters.)

The purpose of this project is to find out how much all Ingham County drivers age 65 and over know about driving. It is not possible for me to talk to all drivers age 65 and over in Ingham County. Therefore, you have been selected to be part of a sample needed to complete this project. I need one hour of your time to help answer a driver knowledge inventory. This is <u>not</u> a driver license test.

Sometime in the next week I will contact you by telephone to find out if you will agree to fill out the inventory. If you agree, a convenient time and place for you to help will also be arranged. There will be no cost to you for your participation in this project. Your name will not be recorded or used in any manner when the results of this project are reported. Your kind assistance in this project will be greatly appreciated.

Thank you,

Thomas Miller

APPENDIX F

LETTER FROM DEAN HUNTER

MICHIGAN STATE UNIVERSITY

LIFELONG EDUCATION PROGRAMS • OFFICE OF THE DEAN
KELLOGG CENTER

EAST LANSING • MICHIGAN • 48824

April 15, 1978

Dear Ingham County Resident:

This letter is to introduce Thomas Miller. He is doing a graduate research project in traffic safety here at Michigan State University. We feel this project will make a valuable contribution to traffic safety in Michigan.

You have been computer selected to represent 150 Ingham County drivers in this project. The only thing you will be asked to do as a participant of this project is to fill out a one hour driving inventory. Your help is needed to make this project a success. And, your participation in this project will bring you at least these two benefits: By completing this inventory you will refresh your driving knowledge for your next driver license examination; and, the knowledge gathered by this inventory will make Michigan a safer place for all of us to drive.

Please help us and the drivers of Michigan by taking part in this project.

Sincerely,

Armand L. Hunter

Armand L. Hunter
Dean

APPENDIX G

LETTER FROM MR. AUSTIN

RICHARD H. AUSTIN
SECRETARY OF STATE

MICHIGAN
DEPARTMENT
OF STATE
LANSING, MICHIGAN 48918

April 24, 1978

Dear Michigan Driver:

I am concerned that sometimes not enough is being done to help senior drivers in Michigan. I feel that many times, in spite of our best intentions, we fail to understand the special problems faced by drivers over 65.

Therefore, I would like to ask you to help by participating in a study being conducted by Thomas Miller, a graduate student at Michigan State University. Mr. Miller will contact you in the near future to schedule approximately one-hour of your time to fill out an inventory of your knowledge concerning Michigan's traffic law and safe driving practices. Your participation in this study is important as it will help us understand better what special materials or special programs may be needed to help senior drivers operate a vehicle more safely.

The study is in no way connected with your license renewal. I hope you will make time to participate. You have my thanks.

Sincerely,

Richard H. Austin
Secretary of State

APPENDIX H

DEMOGRAPHIC DATA SHEET

MICHIGAN STATE UNIVERSITY
DEMOGRAPHIC DATA SHEET

(Do NOT Write Your Name On This Sheet)

Do you own a motor vehicle? _____

How many miles do you drive in a year? _____

How many years have you been driving a motor vehicle? _____

Number of days that you drive each week? _____

What is your marital status? _____

Have you ever attended a driver education or driver refresher class? _____

How many accidents have you been involved in (as the driver) in the last two years? _____

How many traffic tickets (do not count parking tickets have you received in the last two years? _____

What is the highest grade level you attended in school? _____

How often, if at all, do you use a seat belt when you drive a motor vehicle? _____

How often, if at all, do you use a seat belt when you ride in a motor vehicle? _____

Why did you participate in this study?

Turn the page and fill in the knowledge inventory.....

MF/YN/ABC

APPENDIX I

FORM A, B AND C OF THE KNOWLEDGE INVENTORY

KNOWLEDGE INVENTORY

Thank you for participating in this study. Your help in this project will provide information that will be of benefit to all drivers age 65 and older.

This is a research project designed to find out how much is known by all drivers age 65 and older in Ingham County, Michigan. You were selected in a random process and your answers represent those of 150 other drivers age 65 and older in this County. This is not a driver license test. Your name is not being collected with the inventory results and, therefore, can not be reported to the Secretary of State's office.

Please fill in the data sheet on page two. Then turn the page and begin answering the knowledge inventory. Pick the best answer for each question and please answer all questions. There is no time limit for taking this inventory. You may take a coffee break at any time during the session. Please feel free to ask any questions while taking this inventory.

Please do not talk to anyone about the contents of this inventory until you receive the study results by mail. They will be sent to you in September, 1978. Again, your name will be kept confidential and not shown to any official of the State.

Please answer all questions by circling the letter of the best answer to each question as follows:

* * * EXAMPLE QUESTION * * *

D 88. You should drive:

a) At the posted speed limit.
b) About 5 mph below the speed limit.
c) About 5 mph above the speed limit.
d) According to the road and weather conditions.

Turn the page and fill in the data sheet.....

A 13. If you come to an intersection that is hard to see around because of trees or buildings:

a) Proceed as if there was a yield sign at the intersection.
b) Stop near the center of the intersection and then continue when it is safe.
c) Slow down and blow your horn to warn drivers who cannot see you.
d) Stop at the intersection and edge forward slowly.

A 14. If an oncoming vehicle has started to turn left in front of you:

a) Speed up to get by him before he makes the turn.
b) Slow down and allow him to turn in front of you.
c) Steer to your right to get around him.
d) Steer to your left to get around him and allow him to turn.

A 15. When turning left at an intersection:

a) You have the right-of-way over oncoming traffic.
b) You should blow your horn and proceed with caution.
c) Check cross traffic from both directions.
d) Pull halfway into the intersection and edge into cross traffic.

B 41. Before leaving the road to avoid a head-on crash you should slow down by:

a) Pumping the brakes.
b) Applying constant pressure on the brakes.
c) Turning off the engine.
d) Shifting into neutral.

B 42. When approaching a traffic accident or fire you should:

a) Stop and offer your help to the police.
b) Turn on your emergency flashers before you drive by.
c) Drive closer than usual to the vehicle in front of you.
d) Slow down and watch for people near the scene.

B 43. If you pass pedestrians near the road at night you schoul:

a) Turn off your headlights if there are lights on the street.
b) Use your high beam headlights if there are no oncoming vehicles.
c) Only use your parking lights.
d) Keep your headlights on low beam.

B 44. When driving at dusk or dawn on a dark day:

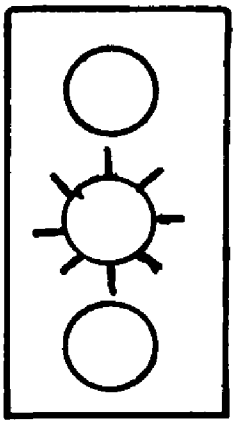
a) Turn on your parking lights.
b) Keep your sunglasses on to cut down headlight glare.
c) Turn on your lights on high beam.
d) Turn on your lights on low beam.

C 77. This sign means:

a) Watch for cross traffic ahead.
b) Stop sign or signal ahead.
c) No through traffic; prepare to turn.
d) Prepare to change routes.

C 78. This traffic signal means:

a) Slow down and continue with caution through the intersection.
b) Speed up and continue through the intersection before the light changes to red.
c) Stop before entering the intersection if you can safely do so.
d) Stop immediately; do not continue through the intersection.



YELLOW (STEADY)

C 79. These lane lines mean:

a) Lane changing permitted for all vehicles.
b) Trucks may not change lanes; other vehicles are permitted to do so with care.
c) Changing lanes is not allowed.
d) Changing lanes is permitted if done with care.