ASSESS WEST VIRGINIA'S OLDER DRIVERS' UNDERSTANDING OF TRAFFIC CONTROL DEVICES AND DESIGN FEATURES

West Virginia Department of Transportation Research Project #133

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16. Abstract

West Virginia has one of the oldest populations in the country. As the Appalachian Development Highway System expands, many older drivers are, for the first time in their driving experience, encountering at-grade intersections on high-speed divided roadways. Since older drivers generally demonstrate an increased accident involvement at at-grade intersections, a study was undertaken to assess West Virginia's older driver understanding of the associated geometric design features and traffic control devices.

A self-administered survey form was completed by 172 participants at 15 senior centers in counties having corridor highways within their boundaries. Almost two-thirds of the respondents were female. Detailed demographic data about age, sex, education levels and driving characteristics are contained in the report.

Among the more significant results are the following. About 44 percent of respondents indicated that they voluntarily limit their driving, mainly because of difficulties driving at night. Overall, crossing the divided highway was perceived as less difficult than making left turns. Making left turns onto the divided highway was perceived as the more difficult of the turning movements. Approximately one-half of participants indicated that they did not have problems making left turns onto the divided highway. Large trucks and rudeness or dangerous actions of other drivers were the most commonly cited dislikes about sections of divided highway.

Responses indicated a lack of understanding about how to drive through the middle of the at-grade intersection. This issue can be addressed through traffic engineering techniques such as delineation and/or channelization and through development of driver educational materials.

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The WVU Survey Research Center deserves thanks for providing review comments on early drafts of the questionnaire. The insights they offered improved the quality of the survey instrument.

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EXECUTIVE SUMMARY

Introduction

West Virginia has one of the oldest populations in the country. For much of this century, West Virginia drivers used two-lane, two-way roadways for their travel. In recent years, the Appalachian Development Highway System (ADHS) has undergone considerable expansion in West Virginia. The horizontal and vertical alignments and cross-sections of ADHS facilities are near Interstate Standards. While access is controlled, the access points are typically at-grade intersections rather than the interchange grade separations and ramps associated with the Interstate Highway System.

With the development of the "corridor" system, many West Virginia older drivers are, for the first time in their driving experience, encountering at-grade intersections on divided highways. Previous research has shown that, generally, older drivers demonstrate an increased accident involvement at at-grade intersections. Given the recognized decrements in physical and psychological capabilities associated with aging, older West Virginia drivers face problems in not only making speed, distance and gap judgments but also in understanding both the roadway geometry and traffic control associated with such intersections.

The Federal Highway Administration's Older Driver Design Handbook, has identified design and signing strategies to accommodate older drivers at *signalized* intersections. Less well understood is older driver behavior at *unsignalized* intersections where drivers must make speed, distance, and gap judgments in order to enter or cross the

through roadway. In view of these gaps in understanding, it is appropriate to examine older driver behavior at unsignalized at-grade intersections on corridor highways in West Virginia.

Project Scope and Objectives

The overall goal of this project was to assess West Virginia's older drivers' understanding of traffic control devices and roadway design features associated with unsignalized at-grade intersections on corridor highways in the state and to make recommendations to improve that understanding through education or training programs. Also considered were engineering recommendations relative to traffic control devices and roadway geometry. Specific objectives to the meet the project goal were:

1. To review the literature relative to older drivers and their experiences with various geometric design features and traffic control devices, with particular emphasis on unsignalized at-grade intersections on high-speed divided highways.
2. To develop a self-administered survey instrument to be completed by West Virginia older drivers and a sampling plan to be used in conjunction with the questionnaire.
3. To distribute the survey to a sample of West Virginia's older drivers.
4. To analyze the results obtained to determine any correlations, trends, or patterns and to develop appropriate conclusions and recommendations from the data.
5. To identify needed educational materials for older drivers as well as potential traffic engineering improvements at such intersections.
6. To document the work in a final report.

Methodology

A closed-form survey instrument (questionnaire) was developed to determine basic demographic information and to learn how West Virginia older drivers handle particular situations at unsignalized at-grade intersections on corridor highways. Liberal use was made of drawings and photographs to assist participant understanding of

intersection locations and vehicle movements. The instrument was pilot tested on a small sample of older drivers.

Questionnaires were distributed at senior centers in counties having corridor highways within their boundaries. Questionnaires were distributed in 15 of these 16 counties. A total of 172 survey forms were filled out and collected.

Results

Respondents ranged in age from 50 to 91 years old with a median age of 74 years. Over 40 percent of respondents were in the 70 to 79 age group. The length of time each person lived in their particular county ranged from 1 to 91 years with a median of 55 years. The length of time that a person had been driving ranged from 5 to 73 years with a median of 50 years.

Almost two-thirds of the respondents were female. About 5 percent of the respondents indicated that they did not currently drive, although all respondents held valid West Virginia drivers' licenses. Interestingly, none of the respondents stated that they stopped driving because a family member suggested they do so, a physician recommended doing so, or they were restricted by a government agency.

The distribution of highest educational level was determined. The largest percentage of participants (38.7 percent) was high school graduates. The percentage of participants that enrolled in some college or was a college graduate was fairly equal at around 22 percent.

About three-quarters of the respondents drove five or more times per week. Only five percent drove less than once per week. However, there was considerable variation in the number of miles driven on an annual basis. Over one-quarter drove less than 1,000

miles per year while at the same time over 20 percent drove more than 12,000 miles. It was clear that participants drove regularly on all classes of roads: city streets, two-lane rural roads, Interstates and corridor highways. Two-thirds of respondents drove on corridor highways at least once a week. Only 20 percent seldom or never used these highways. Females did not drive as often or as many miles as males.

About 44 percent of the respondents indicated that they voluntarily limit their driving and did not do so on doctor's orders or family recommendation. The majority of those who limited their driving did so because of difficulties driving at night. Almost one-half of the respondents indicated that they seldom or never drove at night on corridor highways. Second most frequent response was limiting driving due to bad weather. Fast traffic or confusing intersections were not a major factor in limiting driving.

The survey included paired comparisons to determine the perceived difficulty associated with turning and crossing maneuvers at unsignalized intersections. Overall, crossing the divided highway was perceived as less difficult than making left turns. Making left turns onto the divided highway was perceived as the more difficult of the turning movements. This is not surprising since the maneuver involves making speed, distance and gap judgments (one for crossing and one for merging) for two high-speed roadways as well as possibly assessing traffic in the median.

Interestingly, females were essentially equally divided in perceiving the crossing maneuver and the left-turn onto the divided highway as most difficult. However, over three-fourths of the males rated the left-turn onto the divided highway as more difficult than the crossing maneuver. For the other two paired comparisons, there were no significant difference between male and female responses.

About one-half of participants indicated that they did not have problems making left turns onto the divided highway. For those who did, the greatest difficulty was judging the speed of oncoming vehicles. Only about 10 percent believed that the greatest difficulty was judging the distance to oncoming vehicles. Approximately 15 percent indicated that their greatest difficulty was knowing how to travel through the middle of the intersection. Results of a pictorial question about how to travel through a hypothetical intersection confirmed this confusion.

Participants were asked to select from a list, the factor presenting the greatest difficulty in trying to find a side road when traveling on a divided highway. Over 20 percent indicated that they did not have problems finding the proper side road. The most frequently cited perceived greatest difficulty was "fast moving traffic on my rear bumper." A close second, in terms of frequency, was "road name sign is too small to read."

From a list of nine factors, participants were asked to identify the five factors which they disliked the most about sections of divided highway. Large trucks and rudeness or dangerous actions of other drivers were the most commonly cited factors. Also ranking high was signs that are difficult to see or confusing.

Respondents were asked whether they had ever entered a divided highway going the wrong direction; 13.2 percent of the participants had done so. A higher percentage of male respondents (17.5 percent) than female respondents (10.3 percent) indicated that they had done so. Another question asked whether the respondents had been in an accident on a divided highway; 4.1 percent indicated "yes".

Engineering and Education Implications

While for the most part, older drivers are able to negotiate the at-grade intersections on corridors highway safely, several problem areas and driver behavior issues were identified. About one-half of the older driver respondents indicated that they had problems making turning or crossing maneuvers at the unsignalized at-grade intersections on corridor highways. Responses to other questions revealed a lack of understanding about how to travel through the middle of the intersection. The relatively high percentage of respondents who had gone the wrong way on a divided highway also suggests a problem. One way to address this issue is through traffic engineering techniques. Enhanced delineation in the form of additional channelization and/or additional indications of the directionality of the roadway are suggested for certain intersections based on the survey.

Driver education material is another way to address the issue of lack of understanding about how to travel through the intersection. The American Association of Retired Persons (AARP) "55 Alive Mature Driving" course workbook provides instruction on making left turns at intersections of city streets. The topic of intersections with medians and how drivers should deal with them are not addressed in the AARP workbook. Educational materials, targeted for older drivers, which describe how to safely negotiate at-grade intersections on divided highways with medians are needed. In addition to being included in driver education workbooks, such materials could be distributed as a handout or brochure at senior centers, AARP meetings, fairs and festivals and similar venues. The brochure could also be included as an insert in driver licensing or motor vehicle registration mailings.

Conclusions

Based on the demographic characteristics of the sample, the gender and age distribution is felt to be representative of the older driving population in West Virginia. However, due to the nature of the study, the sample is biased toward the healthier, better educated and more physically active and socially interactive seniors.

Consistent with national data, West Virginia older drivers tend to make frequent short trips. However, a significant proportion of the West Virginia sample drove more than 12,000 miles per year. This implies regular commuting and/or longer trips such as those associated with vacations/touring.

Large trucks and rudeness or dangerous actions of other drivers were the most commonly cited "dislikes" about corridor highways. There are really no viable highway agency actions that can be taken to address these concerns. However, it should be noted that also ranking high was "signs that are difficult to see or confusing." These same three factors were noted in terms of problems encountered since the speed limit was increased to 65 miles per hour on corridor highways.

Results for the photographic questions about pulling out from a side road across the divided highway, given different views of oncoming traffic, were felt not to be representative of research findings in the literature or of older driver accident experience. This was attributed to the static nature of the photographs and to the amount of time available for participants to consider the situation. Both the literature and the survey results show that older driver judgment of speeds and distances is critical to the safe negotiation of at-grade intersections. Therefore, laboratory experiments which would

study the effects of speed, vehicle type/size and the phenomenon of looming are recommended.

CHAPTER 1

BACKGROUND AND INTRODUCTION

Background

Due to the high birth rate in the U.S. from 1945 to 1970 and improvements in health care and medicine which have allowed more people to live to an old age, the American population is growing older. The Transportation Research Board (1988) notes that demographers refer to these changes in the age structure of the population as the "squaring of the pyramid." The population structure was once pyramidal; there were many young people at the base and very few old people at the top. However, for the reasons outlined above, the shape of the structure is changing into a rectangle with an equivalent number of people in each age group.

The current older population is different from earlier cohorts. Increasingly large proportions of them are more affluent and healthier than their earlier counterparts. They tend to depend on automobiles for mobility. This is especially true for older persons who are isolated in rural locations, such as occurs in many counties in West Virginia.

The older driver is of particular concern to traffic engineers. Due to decrements in their physical and psychological capabilities, older drivers frequently have difficulty dealing with certain driving situations.

It is generally understood that vision diminishes with age. McKnight (1988) summarizes that an older person's vision is impaired in a variety of ways, including static visual acuity, dynamic visual acuity, low-illumination acuity, visual field, contrast sensitivity, binocular depth perception, dark adaptation, glare resistance, and glare recovery.

Motor control skills also tend to become deficient in older drivers. Motor control skills include backing, lane-keeping, maintaining speed, coming to a stop and negotiating left turns.

McKnight (1988) also notes that older drivers also tend to suffer from performance-related problems. These can relate to speed, i.e., driving too slowly, misjudging speed, or excessive braking. Performance also relates to search patterns which include problems of inattention, inadequate scanning, failing to observe the rear, and pulling out without looking.

The last category summarized by McKnight (1988) is vehicle control. For older drivers, the problem is usually less precise vehicle control, including deficiencies in maintaining path, maintaining speed, changing lanes and coming to a smooth stop.

Many of the driver attributes just mentioned are needed to safely traverse at-grade intersections. The Federal Highway Administration's Older Driver Design Handbook (Staplin, Lococo, and Byington, 1998) points out that the single greatest concern in accommodating older road users is the ability of these persons to safely maneuver through intersections. The authors note that, for drivers 80 years and older, more than one-half of fatal accidents occur at intersections, compared with 24 percent or less for drivers up to 50 years of age. Driving situations involving complex speed-distance judgments under time constraints, the typical scenario for intersection operations, are more problematic for older drivers than their younger counterparts due to slower reaction times for any complex motor-cognitive task.

Considerable research has been conducted to address this problem. Synthesizing the results of much of this research, the Older Driver Highway Design Handbook

(Staplin, Lococo and Byington, 1998) has been prepared to assist engineering professionals in accommodating older drivers at at-grade intersections. While this publication is comprehensive, there are particular situations at certain types of intersections common in West Virginia that are not addressed.

Problem Statement

U.S. Census Bureau data for 1990 estimated that 15 percent of West Virginia's population was 65 years old and over. This placed West Virginia in a tie for fifth place nationally as one of the top "graying" states. It was recently announced in the media that West Virginia has the highest median age of any state. By any measure, West Virginia has one of the oldest populations in the country and this trend is likely to continue. Consequently, there is concern for older driver issues.

For much of this century, West Virginia drivers used two-lane, two-way roadways for their travel. While the construction of the Interstate Highway System in the 1960's and 1970's facilitated long-distance intercity travel, there remained a number of counties in the state with no divided highways and/or signalized intersections.

Since the late 1960's, construction of the Appalachian Development Highway System (ADHS) has been underway in West Virginia. An original objective of the system was to stimulate the flow of people and goods to and through remote areas that have development potential. The horizontal and vertical alignments and cross sections of ADHS facilities are near interstate standards, i.e., they are high-speed divided highways. While access is controlled, the access points are typically at-grade intersections rather than the interchange grade separations and ramps associated with the Interstate Highway System.

West Virginia has six Appalachian Development Highway corridors. Corridor E is Interstate 68 and has full control of access. Thus, there are five Appalachian Development "Corridors", involving at-grade intersections, in West Virginia. With the completion of the Appalachian Corridor system, many West Virginia older drivers in these areas are, for the first time in their driving experience, encountering at-grade intersections on high-speed divided highways. Given the previously mentioned decrements in physical and psychological capabilities, older West Virginia drivers face problems in not only making speed, distance, and gap judgments but also in understanding both the roadway geometry and traffic control associated with such intersections. Thus, it is appropriate to determine how older West Virginia drivers handle particular situations at these intersections.

The aforementioned FHWA Older Driver Design Handbook (Staplin, Lococo and Byington, 1998) identifies design and signing strategies to accommodate older drivers at signalized intersections. Those signs and signal configurations which tend to cause difficulty or confusion for older drivers are clearly identified. Similarly, a West Virginia University research report for the Division of Highways (Eck and Vedula, 1995) identified solutions to the special problems posed by signalizing at-grade intersections on the "corridor" highways. These countermeasures should benefit all drivers.

Less well understood is older driver behavior at unsignalized intersections where drivers must make speed, distance, and gap judgments in order to enter or cross the through roadway. In their National Cooperative Highway Research Program report on Median Intersection Design, Harwood, et al. (1995) acknowledge that older drivers generally have problems selecting appropriate gaps in oncoming traffic and estimating

the speeds of approaching opposing vehicles with respect to left turns off of a mainline roadway. They suggest that most intersection accidents are related to higher cognitive functions such as attention or multi-task processing lapses. In view of these gaps in understanding, it is appropriate to examine older driver behavior at unsignalized at-grade intersections on corridor highways in West Virginia.

Project Objectives

The overall goal of the project was to assess West Virginia's older drivers' understanding of traffic control devices and roadway design features associated with unsignalized at-grade intersections on expressways (corridor highways) in the state, to document areas of strength and weakness of that understanding and to make recommendation to improve that understanding through education or training programs. A by-product of the work may be engineering recommendations relative to traffic control devices and roadway geometry. Specific objectives to meet this goal are outlined below.

1. To review the literature relative to older drivers and their experience with various geometric design features and traffic control devices (including discussions with traffic engineers and law enforcement personnel) with particular emphasis on unsignalized at-grade intersections on high-speed divided highways.
2. To develop a self-administered survey instrument to be completed by West Virginia older drivers and a sampling plan to be used in conjunction with the questionnaire.
3. To distribute the survey to a sample of West Virginia's older drivers.
4. To analyze the data to identify any correlation, trends, or patterns and to develop appropriate conclusions and recommendations from the data.

5. To prepare appropriate sample educational materials to be used by older drivers in West Virginia.

6. To document the work in a final report.

Organization of Report

This report is divided into six chapters. Chapter 1 has presented background to the problem, the problem statement, and project objectives. Chapter 2 presents a critical review of the literature on older drivers and their experiences with various geometric design features and traffic control devices. Chapter 3 describes the process used to develop and administer the older driver survey. Chapter 4 presents the analysis of the questionnaire data. Chapter 5 describes the engineering and education implications of the results. Chapter 6 presents the conclusions and recommendations derived from the research.

CHAPTER 2

LITERATURE REVIEW

Introduction

A review of the traffic engineering, traffic safety and human factors literature was conducted. Given the recent interest in aging and its effects on driving and traffic safety, there is a considerable body of literature on this subject. Therefore, this review focused primarily on the effects of aging with respect to driver performance at unsignalized at-grade intersections since that is the issue being addressed in this study.

Gaps in knowledge of older driver behavior/performance relative to unsignalized at-grade intersections were sought so that the survey instrument to be developed might address some of these topics. The first part of this review of the literature identifies several of the physical and psychological performance decrements facing older drivers. This is followed by a review of the literature relative to older driver performance at unsignalized at-grade intersections.

Performance of Older Drivers

Smith (1968) described driving as consisting of four discrete phases. A driver must (1) see or hear a situation developing and (2) recognize it. The driver must then (3) decide how to respond and then (4) execute the physical maneuver. The Transportation Research Board (1988) notes that given the cognitive and physiological changes that accompany aging, there are questions about how well drivers perform in these four phases.

The ability to see, certainly one of the most important functional abilities for driving, declines with age. TRB (1988) states that in spite of the caveats that must be applied to generalizations about older persons and their abilities, older persons commonly experience loss of visual function. In particular, the lens of the eye yellows and hardens with age, which reduces the amount of light reaching the retina and contributes to diminished ability to focus on near objects. For those over 65, cataracts and glaucoma are roughly eight times more common than in the general population. Loss of ability to focus on static and moving objects is more common among older persons, as is sensitivity to glare.

Older persons tend to experience a contraction in their field of view. In one study (TRB, 1988), almost half of the older drivers with reduced visual field were unaware of their impairment. The study found that the rate of convictions and accidents for drivers with loss of visual field in both eyes was twice as high as that for individuals with normal vision who were matched on the basis of age and sex.

TRB (1988) indicates that other visual abilities important to driving decline through the aging process. Studies have not yet established a link between the frequency of accidents and age-related reductions in visual abilities such as contrast sensitivity, glare recovery, distance perception, and visual search. They note that the failure to link visual performance with accidents is not surprising. Accidents have many causes, few of which are ever measured. Statistically significant findings and large correlations are rare in cross-sectional accident research. However, despite the difficulty of establishing any relationship between the many contributing factors in crashes and driver physical abilities, significant relationships have been observed between accidents and static acuity

under normal and low illumination, dynamic visual acuity, and reduced field of view. Performance of these visual functions declines with age.

The TRB report (1988) points out that driving requires a combination of perceptual skills in which cognitive performance plays a major part. In terms of the four-phase model outlined earlier, cognitive performance is fundamental to attentiveness to the driving task, recognition of stimulus, and choice of the appropriate way to respond.

According to the TRB report (1988), studies indicate that driver inattention contributes to 25 to 50 percent of motor vehicle crashes. The ability to focus attention on a task is widely perceived to diminish with age. There is evidence to suggest that older persons are more easily distracted by irrelevant stimuli.

In addition to perceiving relevant information, a key component of cognitive performance is perceiving it accurately. For example, the TRB report (1988) mentions that laboratory tests of the ability to judge the distance between objects accurately show that persons over age 60 are much more likely to underestimate the relative depth separating visual targets than are persons between the age of 18 and 45. Another study reviewed by TRB (1988) indicated that older persons overestimated the velocity of oncoming vehicles, but not enough to compensate for their underestimation of the distance between the vehicle and themselves. It was suggested that such misperceptions in real life would make older drivers more likely to encroach on the lane of an oncoming vehicle than younger persons. It was noted that although this hypothesis had not been tested in accident research, it may contribute to an explanation of the turning accident characteristics of older drivers.

The TRB report (1988) notes that there is a large body of knowledge indicating that the speed of simple motor responses diminishes with age. Data suggest that the motor responses needed for driving a car are not limited by muscular changes that accompany aging; therefore any slower reaction time among older drivers is probably a result of a slower decision-making process, particularly as the number of choices increases.

Unsignalized At-Grade Intersections

As noted in the introduction, according to FHWA's Older Driver Highway Design Handbook (Staplin, Lococo and Byington, 1998), the single greatest concern in accommodating older drivers is their ability to safely maneuver through intersections. The authors report that for drivers age 80 and over, more than half of fatal accidents occur at intersections, compared to 24 percent or less for drivers up to age 50. These data confirm that driving situations involving complex speed-distance judgments under time constraints (the typical scenario for intersection operations) are more problematic for older drivers than their younger counterparts.

A variety of studies have been conducted looking at specific accident types and vehicle movements at intersections. Some of the more important ones dealing with older drivers at unsignalized at-grade intersections are reviewed below.

Brainin (1980) used in-car observations of driving behavior with 17 drivers on a standardized test route. The two older age groups showed more difficulty making left and right turns at intersections. The left-turn problems resulted from a lack of sufficient caution and poor positioning on the road during the turn. Right turn difficulties were primarily a result of failing to signal. Errors demonstrated at STOP signs included failing

to make complete stops, poor vehicle positioning at STOP signs, and jerky and abrupt stops.

In addition to the accident analyses and observational studies, research includes subjective reports of intersection driving difficulties. In a statewide survey of 664 senior drivers, Benekohal, et al. (1992) found that the following activities become more difficult for drivers as they grow older (the proportion of drivers responding is indicated in parentheses):

- reading street signs in town (27 %)
- driving across an intersection (21%)
- finding the beginning of a left-turn lane at an intersection (20%)
- making a left turn at an intersection (19%)
- following pavement markings (17%)

Benekohal, et al. (1992) also found that the following highway features become more important to drivers as they age (proportion of drivers responding in parentheses):

- lighting at intersections (62%)
- pavement markings at intersections (57%)
- number of left turn lanes at an intersection (55%)
- width of travel lanes (51%)
- raised channelization for turns at intersections (47%)

Benekohal, et al.'s (1992) comparisons of responses from drivers ages 66 to 68 versus those age 77 and older showed that the older group had more difficulty following pavement markings, finding the beginning of the left-turn lane, and driving across intersections. Likewise, the level of difficulty for reading street signs and making left turns at intersections increased with increasing senior driver age. Turning left at intersections was perceived as a complex driving task. This was made more difficult

when raised channelization providing visual cues was absent and only pavement markings designated which were through versus turning lanes ahead.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) discusses 16 design elements relative to at-grade intersections. Only those relevant to the case of unsignalized corridor intersections will be reviewed here; elements dealing with signalized intersections will be not discussed. Similarly, recommendations were made about angle of intersection (skew). Since the West Virginia corridor highways under consideration are high-type, limited access roadways which have been constructed to modern design standards, the angles of intersection are close to 90 degrees. Since skew is not an issue, it will not be discussed here.

Throat width for turning operations involves consideration of vehicle maneuver requirements and their demands on drivers. McKnight and Adams (1970) indicate that positioning a vehicle within the lane in preparation for turning has been rated as a critical task. Swinging too wide to lengthen the turning radius and minimize rotation of the steering wheel is a common practice of drivers lacking strength and physically limited drivers.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) notes that two factors can compromise the ability of older drivers to remain within the boundaries of their assigned lanes during a left turn. One factor is the diminished ability to share attention. The other factor involves the ability to turn the steering wheel sharply enough, given the speed at which they are traveling, to remain within the boundaries of their lanes. Some older drivers seek to increase their turning radii by initiating the turn early and rounding off the turn. The result is either to cut across the apex of the turn,

conflicting with vehicles approaching from the left, or to intrude upon a far lane in completing the turn. The FHWA document recommends a minimum receiving lane width of 12 feet, accompanied wherever practical by a shoulder of 4 feet minimum width.

Although their modern design means that sight distances at at-grade intersections on corridor highways are not a problem, the topic of older driver perception-reaction process was included in the literature review because of its importance relative to vehicle-to-vehicle conflicts and because of the insights that can be gained from understanding the process. The FHWA Handbook (Staplin, Lococo and Byington, 1998) points out that older road users do not necessarily react more slowly to events that are expected, but they take significantly longer to make decisions about the appropriate response than younger road users. This difference becomes exaggerated in complex situations.

Slowed visual scanning of traffic on the intersecting roadway by older drivers has been cited as a cause of near misses of crossing accidents at intersections during on-road evaluations. In the practice of coming to a stop, followed by a look to the left, then to the right and then back to the left again, the older driver's slowed scanning behavior allows approaching vehicles to have closed the gap by the time a crossing maneuver finally is initiated. The traffic situation has changed when the older driver actually begins the maneuver and drivers on the main road are often forced to adjust their speed to avoid a collision.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) discusses how the perceptual task of turning left from a major roadway at an unsignalized intersection requires a driver to make time-distance estimates of a longitudinally moving target as opposed to a laterally moving target. Lateral movement (also referred to as tangential

movement) describes a vehicle that is crossing an observer's line of sight, moving against a changing visual background where it passes in front of one fixed reference point after another. Longitudinal movement, or movement in depth, results when the vehicle is either coming toward or going away from the observer. In this case, there is no change in visual direction, only subtle changes in the angular size of the visual image, typically viewed against a constant background. Longitudinal movement is a greater problem for drivers because the displacement of a vehicle has a smaller visual effect than when it moves laterally.

In comparison with younger subjects, a significant decline for older subjects has been reported in angular motion sensitivity. Older persons may require twice the rate of movement to perceive that an object's motion in depth is approaching, versus maintaining a constant separation or receding, given a brief (2.0 seconds) period of exposure. Hills (1975) found that older drivers required significantly longer to perceive that a vehicle was moving closer at constant speed. The FHWA Handbook (Staplin, Lococo and Byington, 1998) opines that this evidence suggests that the 2.0 second perception-reaction process (i.e., the variable J in the AASHTO intersection sight distance equation) may not be sufficient for the task of judging gaps in opposing through traffic by older drivers.

Based on diverse research findings, the FHWA Handbook (Staplin, Lococo and Byington, 1998) suggests that an appropriate value for the critical gap in gap acceptance models lies toward the upper end of the 7 to 11 second range to accommodate older drivers, while also preserving a margin of safety. This acknowledges the diminished capability of older drivers to judge oncoming vehicle speed in a situation that places this

group of road users at particular risk, i.e., when an opposing through vehicle approaches at excessive speed.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) also makes recommendations relative to opposite left-turn lane geometry, signing and delineation. As noted earlier, research studies have consistently found older drivers to be over-involved in left-turning accidents at both rural and urban signalized intersections and have indicated that failure to yield the right-of-way (as the turning driver) was the principal violation type. Underlying problems for the maneuver errors include the misjudgment of oncoming vehicle speed, misjudgment of available gap, assuming the oncoming vehicle was going to stop or turn, and simply not seeing the other vehicle.

A relative insensitivity to approaching (conflict) vehicle speed was shown for older versus younger drivers. This result was interpreted as supporting the notion that older drivers rely primarily or exclusively on perceived distance, not time or velocity, to perform gap acceptance judgments, reflecting a reduced ability to integrate time and distance information with increasing age. Thus, a principal source of risk at intersections is the error of an older, turning driver, in judging gaps in front of fast vehicles.

Harwood, et al. (1995) conducted an observational field study and an accident analysis to develop design policy recommendations for the selection of median width at rural and suburban divided highway intersections based on operational and safety considerations. They found that at rural unsignalized intersections, both accidents and undesirable driving behaviors decrease as median width increases. The researchers acknowledged that wider medians generally have positive effects on traffic operations and safety. However, wider medians can result in sight restrictions for left-turning

vehicles due to the presence of opposite left-turn vehicles. The most common solution to this problem is to offset the left-turn lanes, using either parallel offset of tapered offset left-turn lanes.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) states that discrimination of gross highway features, as opposed to the fine detail contained in a sign message, governs drivers' perceptions of intersection geometric elements. Thus, the conspicuity of such elements as curbs, medians, and obstacles, as well as all raised channelization, is of paramount importance in the task of safely approaching and choosing the correct lane for negotiating an intersection, as well as avoiding collisions with the raised surfaces. During the conduct of their driving task analysis, McKnight and Adams (1970), identified five driving tasks related specifically to the conspicuity of intersection geometric elements: 1) maintain correct lane position, 2) survey pavement markings, 3) survey physical boundaries, 4) determine proper lane position for the intended downstream maneuver, and 5) search for path guidance cues. The visual/perceptual requirement common to the performance of these tasks is contrast sensitivity: for detecting lane lines, painted roadway symbols and characters, curbs and roadway edge features and median barriers.

Older drivers' decreased contrast sensitivity, reduced useful field of view, increased decision time (particularly in response to unexpected events) and slower vehicle control movement execution combine to put these highway users at greater accident risk when approaching and negotiating intersections. The smaller the attentional demand required of a driver to maintain the correct lane position for an intended maneuver, the greater the attentional resources available for activities such as the recognition and

processing of traffic control device messages and detection of conflict vehicles and pedestrians.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) points out that inadequate conspicuity of raised geometric features at intersections has been brought to the attention of researchers during the conduct of several focus group studies involving older drivers. Subjects reported difficulty knowing where to drive, due to missing or faded roadway lines on roadway edges and delineation of islands and turning lanes. They also reported hesitating during turns, because they did not know where to aim the vehicle.

Street name signage is also addressed in the Handbook (1998). While this signing is clearly different from the informational signing found on corridor highways, a review is included here since the general subject of guidance or directional information about the minor roads may have relevance to corridor highways.

Older drivers have consistently stated that larger street signs with bigger lettering and standardization of sign placement overhead would make driving an easier task. Problems with placement included signs that were either obstructed by trees, utility poles, billboards or large trucks, or placed too close to or across the intersection rather than on the near side. Older drivers stated that they needed more advance notice regarding upcoming cross streets and larger street-name signs placed overhead, to give them more time to make decisions about where to turn. Also noted were traffic signs with too much information in too small an area and/or with too small a typeface. Use of a supplemental street-name sign with an advance warning crossroad, side road, or T-intersection sign provides the benefit of additional decision and maneuver time if a lane change is required prior to reaching the intersection.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) also addresses the topic of one-way/wrong-way signing. Vaswani (1974, 1977) found that approximately one half of the incidents that involved wrong-way driving on multilane divided highways without access control occurred at intersections with freeway exits and with secondary roads. These wrong-way movements resulted from left-turning vehicles making a left turn into a lane on the near side of the median, rather than turning around the nose of the median into a lane on the far side.

Indiana data (Scifres and Loutzenheiser, 1975) showed that wrong-way movements most often occur under conditions of low traffic volume, low visibility, and low land-use density. It was reported that 69 percent of the wrong-way drivers were drunk, older (age 65 and older), or fatigued (driving between 12 m. and 6 a.m.). The literature review indicated that there are significantly more incidents of wrong-way driving than there are accidents and that drivers older than 60 years of age are over-represented in wrong-way movements on a per-mile basis.

The FHWA Handbook (Staplin, Lococo and Byington, 1998) notes that the ability to abstract information and make quick decisions about it are capabilities required to safely perform the driving task. Evidence has been found that older drivers' accidents often occur as the result of overly attending to irrelevant aspects of a driving scene. Older adults frequently direct attention to irrelevant information at the expense of relevant information. Especially for the elderly, the most relevant information must be signaled in a dramatic manner to ensure that it receives a high priority for processing in situations where there is a great deal of complexity.

Mace (1988) stated that age differences in glare sensitivity and restricted peripheral vision coupled with the process of selective attention may cause higher conspicuity thresholds for older drivers. Overall, these deficits point to the need for more effective and more conspicuous signs, realized through provision of multiple or advance signs as well as changes in size, luminance, or placement of signs.

Crowley and Seguin (1986) found that when medians are extremely narrow, there appears to be little confusion that the intersecting roadway is two-way and drivers have less need for special signs to indicate travel direction. Where the median is sufficiently large, the intersection will be generally signed as two separate one-way roadways. The most commonly reported sign configuration implemented by jurisdictions that responded to the survey was the MUTCD standard of a pair of ONE WAY signs on the near right-hand corners and far left-hand corners of each intersection with the directional roadway.

Crowley and Seguin (1986) reported that some jurisdictions recommend the use of optional signs, i.e., DO NOT ENTER, WRONG WAY, and KEEP RIGHT, but noted that these signs are not helpful to a motorist making decisions as he/she approaches an intersection; they are detected only when the driver begins a wrong-way movement upon reaching the intersection. Several jurisdictions reported that they required the use of the DIVIDED HIGHWAY CROSSING sign, as it is the only sign available that has a direct impact on the decision process of drivers approaching a divided highway with a median. The MUTCD states that this sign may be used as a supplemental sign on the approach legs of a roadway that intersects with a divided highway. The FHWA Handbook (Staplin, Lococo and Byington, 1998) notes that the comprehensibility of the DIVIDED HIGHWAY CROSSING sign has not been reliably documented.

The Handbook (1998) recommends several countermeasures at intersections with a divided median on the receiving leg. The countermeasures are intended to reduce the potential for wrong-way maneuvers by drivers turning left from the stop-controlled minor roadway:

- Implement proper signing
- Channelized left-turn lanes should contain white painted lane-use arrow pavement markings (left turn only).
- Pavement markings which scribe a path through the turn are recommended to reduce the likelihood of wrong-way movement.
- Use of a wide white stop bar is recommended at the end of the channelized left-turn lane as a countermeasure to aid in preventing a potential wrong-way movement.
- Placement of 23.5 foot wrong-way arrows in the through lanes is recommended for locations determined to have special needs.
- Delineation of median noses using reflectorized paint and other treatments will increase their visibility and should improve driver understanding of the intersection design and function.

Drivers approaching an unsignalized intersection must be able to detect the presence of the intersection and then detect, recognize, and respond to the intersection traffic control devices present at the intersection. Then drivers must detect potential vehicle or pedestrian conflicts. The Handbook (1998) reports research that found that older drivers often stopped and then pulled out in front of oncoming traffic, whereas younger drivers more often failed to stop at all.

Regarding pre-accident maneuvers at stop-controlled intersections for both rural and urban locations, right-angle collisions were the most frequent collisions and middle-aged drivers were more likely to be traveling straight or slowing/stopping than the two older groups. The older drivers were more likely to be turning left or starting from a stop than their younger counterparts. The pattern was similar for left-turning crashes.

Middle-aged drivers exhibited a higher proportion of no improper driving behavior, while the young-old and old-old drivers were more often cited for failure to yield, disregarding the STOP sign and driver inattention. When starting from a stop, however, the old-old drivers had a lower probability of being cited for improper driving. When cited, the old-old group was more likely to have disregarded the STOP sign than the other two driver groups.

Lane assignment on intersection approach is also addressed in the FHWA Handbook (Staplin, Lococo and Byington, 1998). As a driver approaches an intersection with the intention of traveling straight through, turning left or turning right, he/she must first determine whether the currently traveled lane is the proper one for executing the intended maneuver. This understanding of the downstream intersection geometry is accomplished by the driver's visual search and successful detection, recognition and comprehension of pavement markings (including stripes, symbols, and verbal pavement markings); regulatory and /or advisory signs mounted overhead, in the median and/or on the shoulder in advance of the intersection; and other geometric feature cues such as curb and pavement edge lines, pavement width transitions, and surface texture differences connoting shoulder or median areas. Uncertainty about downstream lane assignment produces hesitancy during the intersection approach; this in turn decreases available maneuver time and diminishes the driver's attentional resources available for effective response to potential traffic conflicts at and near intersections.

Older drivers' decreased contrast sensitivity, reduced useful field of view, increased decision time, particularly in response to unexpected events, and slower vehicle control during movement execution combine to put these highway users at greater

accident risk when approaching and negotiating intersections. Contrast sensitivity and visual acuity are the visual/perceptual requirements necessary to detect pavement markings and symbols and to read lane control signs and verbal and symbolic pavement markings. The early detection of lane control devices, by cueing the driver in advance that designated lanes exist for turning and through maneuvers, promotes safer and more confident performance of any required lane changes.

Older drivers show considerable consensus regarding sign location for lane assignment. In one study reviewed in the Handbook (1998), 79 percent of the study group reported that overhead lane-use signs are far more effective than roadside mounted signs for this type of warning. Although painted roadway markings were deemed helpful, 84 percent of all participants stated that they are useless in isolation from signs, because they are usually at the intersection and are obscured by traffic, and they are frequently worn and faded. The result is that drivers end up in the wrong lane and must go in a direction they had not planned for, or they may try to change lanes at a point where it is not safe to do so.

Concluding Remarks

Limited access corridor highways with high design standards, such as the Appalachian corridor highways, have a number of features which should be especially beneficial to older drivers. However, with their at-grade signalized and unsignalized intersections, these road also have characteristics which may present problems to many older drivers. If some of the problems these roads and their at-grade intersections present to older drivers can be recognized and understood, it should be possible to develop countermeasures which make corridor highways more appealing and safer choices for

them. Such changes could be in roadway design, traffic operations, driver training, public education, or vehicle design. To develop effective countermeasures, it is important to understand how the older driver views driving on corridor highways and their typical behavior patterns. In the following chapters, West Virginia older driver perceptions about corridor highways are addressed through the use of a printed questionnaire.

CHAPTER 3

METHODOLOGY

Introduction

Since the overall goal of this project was to determine how West Virginia's older drivers handle particular situations at unsignalized intersections on expressways, a method for obtaining input from older drivers in a systematic fashion had to be developed. Procedures used to obtain such input in related projects were reviewed. Data collection methods considered included telephone interviews, person-to-person interviews, in-vehicle observation techniques, and various types of printed surveys. Time and resource constraints precluded the use of interviews or in-vehicle techniques. A mail survey was considered. However, the lack of appropriate mailing lists for the population of interest and the notoriously poor response rate for such surveys weighed against this approach. A printed, self-administered, survey that could be hand delivered to individuals and collected upon completion was chosen as the overall best method to collect data for this particular project. It was felt that respondents would be more likely to complete the survey with someone present to explain the project and survey as well as answer questions. Such a survey would have a higher response rate than a mail survey.

This chapter describes the development of the survey instrument and the sampling plan that was utilized. The process of administering the survey to the subjects is also discussed.

Developing the Survey Instrument

The traffic safety literature relative to obtaining input from drivers was reviewed in order to help identify possible questionnaire formats that might be used and to develop

some basic guidelines for questionnaire development. For example, the survey instrument had to be of reasonable length. Respondents are likely to "give up," if the form is too long, and therefore not complete the entire instrument. In addition to questions about the intersections of interest, demographic and driving experience information needed to be obtained.

The three fundamental types of printed surveys are the closed form (e.g., check-off and fill-in-the-blank), the open-ended form, and the combination of these two types. While the closed form is easy for respondents to complete and simplifies analysis, the information obtained is limited to that requested by the survey designer, i.e., there is no opportunity for the respondent to explain or to add to their response. On the other hand, responses to a completely open-ended form may not elicit coverage of all the desired topics and present challenges in data analysis. In addition, the characteristics of the respondents are very important with respect to open-ended forms. In this case, it was recognized that many of the senior citizens responding might have physical limitations (e.g. arthritis) that make extensive handwriting difficult.

On the basis of these considerations, it was decided to use a predominantly closed-form survey instrument with appropriate opportunity for respondents to offer input and comments. Given the nature of the topic (intersection layout and roadway design), and the self-administered nature of the survey form, it was decided to make liberal use of graphics (i.e. drawings and photographs) to assist participant understanding of intersection locations and vehicle movements. In addition, the introduction to the survey included a definition of a divided highway, identification of examples of such highways in different parts of the state, and a photograph and a drawing of an intersection on a

divided highway. This information was provided to clearly distinguish for the respondents the difference between divided (corridor) highways and Interstate Highways.

As noted above, efforts were made to consider the abilities of the participants in developing the survey instrument. It was decided to use a larger than normal font size for the questionnaire to make it easier to read by those with visual limitations.

In developing the technical content of the survey instrument, the researchers relied on the project work plan and the results of the literature review. The principal area of interest was how older drivers on the minor roadway make left turns or crossings of the corridor highway at the unsignalized intersections. Specific issues to be addressed included: (1) do older drivers tend to cross the entire intersection at once or one direction at a time? (2) if turning, how do older drivers position themselves in the median? and (3) how does roadside environment affect distance judgments? Questions were developed, refined, and deleted or revised through an iterative process. Input on early drafts of the instrument was also obtained from the project technical monitor. When the researchers felt that a suitable instrument had been prepared, the draft survey was submitted to the West Virginia University Survey Research Center. The Center staff made suggestions regarding style and terminology to enhance the readability and user-friendliness of the survey. The draft survey was submitted to the West Virginia Division of Highways for final review and approval.

The survey was revised to reflect the comments made by the West Virginia University Survey Research Center and the Division of Highways. At this point, the researchers submitted the document for review and approval from the West Virginia

University Institutional Review Board for Human Subjects. Final approval was received in February 2000.

Before the instrument was formally administered to participants, it was pre-tested on a small sample of older drivers. This pilot test provided an opportunity to assess the effectiveness of the oral instructions to be given to participants, to identify any specific problems or misunderstandings posed by questions on the form, and to gauge the time required to complete the questionnaire. The Morgantown, West Virginia Senior Center agreed to cooperate by permitting the researchers to meet informally with a small group of seniors following lunch on a regularly scheduled meeting day. Questionnaires, pencils, and clipboards were distributed to the nine individuals in attendance. Participants were given the standard instructions to be used in the formal survey. In addition, they were informed about the pilot nature of the activity and were asked to fill out an additional form, the Pilot Feedback Form. This one-page form was prepared by the researchers to identify specific problems (e.g., terminology or ability to read the document) that participants might be having. A copy of the Pilot Feedback Form is contained in Appendix A of this report.

From the Pilot Feedback Form, it was determined that there were no significant problems encountered by the volunteers when completing the survey. None of the participants had special difficulty reading the survey due to the size and style of the print. One participant responded that she had difficulty understanding the black and white photographs. Of the four remaining questions (dealing with difficulty understanding the directions, confusing terms, unintelligible questions, and confusing diagrams) each received two positive responses. Based on the comments, it was decided that the printed

survey did not need to be changed but that the oral instructions given prior to administering the survey should be expanded to address these concerns. The instructions emphasized that if any participants had questions regarding the survey, the survey helper would be there to answer them.

Several of the pre-test subjects commented about how imposing the size of the form was. Although the survey consisted of only 28 questions, due to the large font size and the amount of graphics, when printed on single-sided sheets the survey gave the appearance of being much longer than it actually was. Thus, it was decided to print the survey double-sided, so a thinner document was achieved. During the pre-test, it took participants anywhere from 15 to 30 minutes to complete with an average of about 20 minutes. A completion time of 15 to 20 minutes had been estimated beforehand.

Since no changes were made to the survey instrument itself, resubmission to the West Virginia University Institutional Review Board for Human Subjects was not necessary. Appendix B contains a copy of the complete survey instrument.

Sampling Plan

Initially, the approach considered was to obtain a representative sample of the older driving population in West Virginia. However, as the research progressed, it became apparent that depending on the location in the state, older drivers may have little or no driving experience on corridor highways. In addition, an issue of interest was how older drivers adapted to change from a rural county with no multi-lane roadways to a rural county with high-speed limited access multi-lane divided highway with at-grade intersections. Thus, it was decided to sample older drivers in only those counties which

have corridor highways within their boundaries. As shown in Figure 3.1, 16 of the 55 counties in West Virginia meet this criterion.

Ideally, the sample obtained should be representative of the older driving population in West Virginia in terms of age distribution, gender, ethnicity, education level, income, driving experience and other demographic and socio-economic descriptors of this nature. However, it was recognized that, practically, a truly representative sample could not be obtained. For example, by its nature, a printed, self-administered survey is biased against those who are unable to read. An illiterate person could not be part of the sample unless the questions were read to them. Likewise, seniors unable to attend senior centers were unavailable as subjects. The researchers acknowledge that these are limitations of the study.

A variety of locations/situations at which to administer the survey instrument was considered, including places of employment, special events (e.g. fairs and festivals), civic/social functions, and senior centers. Places of employment were not used due to the relatively small population at each site. The undesirability of disrupting the work environment and the fact that such individuals were likely to be healthier than the older population generally were other factors in eliminating this approach. Many fairs/festivals are well attended by older adults; however, these would represent healthier individuals. The logistics of identifying appropriate locations and making arrangements to have a "booth" at special events were felt to be prohibitive.

In contrast, senior centers (which offer a variety of social functions) with their group activities provide the opportunity to reach a number of older drivers at one time. Since many centers offer a van or transportation service to the center, attendees are not

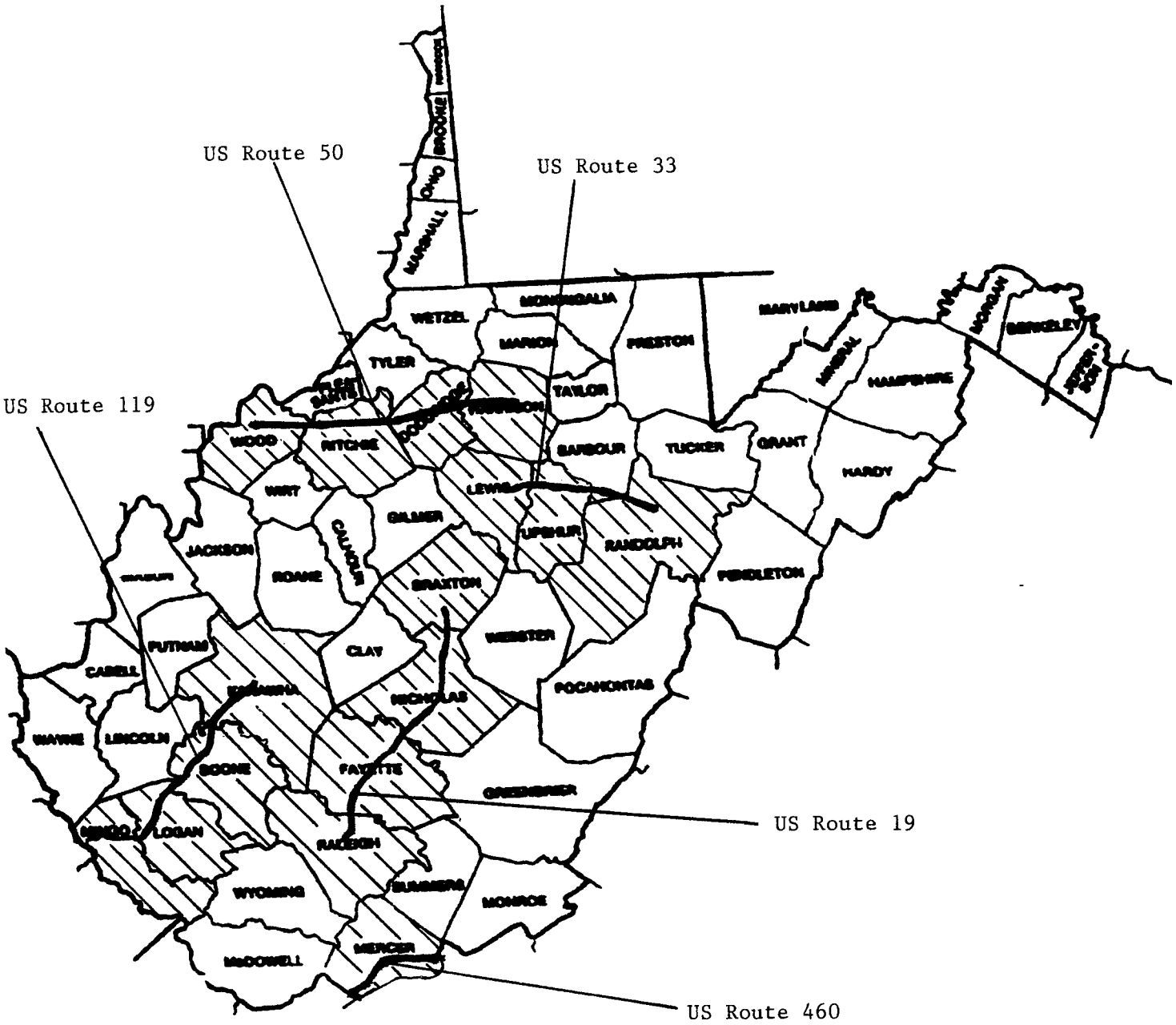

Figure 3.1. The Sixteen Study Counties in Relation to the Corridor Highway System.

limited to active drivers. For example, an individual who did not feel comfortable driving could utilize the van to get to the center to participate in activities. In addition, the West Virginia University Center on Aging maintains a list of all county "senior" organizations in West Virginia including the name and telephone number of the contact person. In view of the above, it was concluded that the most productive way of sampling older drivers would be to distribute the questionnaire at senior centers in counties with corridor highways.

One unintended effect of using senior centers as study sites was that it increased the range in age of participants. Several centers offer AARP activities. The minimum age for membership in AARP and, consequently, for participation in that organization's activities is 50. Thus, 50-year-olds would be included in the subject pool for the study. This is felt to be appropriate since the literature recognizes that the definition of "older person" is based on functional status and not on chronological age. Furthermore, the Transportation Research Board (1988) points out that visual function tends to remain fairly constant up to about age 50, after which it declines rapidly. Therefore, 50 years of age appears to be a reasonable lower bound for defining West Virginia older drivers.

It was also recognized that the approach outlined above does not necessarily provide a representative sample of older drivers. For example, participants in senior activities are likely to be in relatively good health and tend to lead active lifestyles including significant social interaction. Consequently, they may drive more than the typical senior citizen.

Note that the survey did not inquire about income level. This omission was intentional since it was felt that questions of this nature could viewed as an invasion of privacy with a corresponding detrimental effect on response rate.

Administering the Survey

Using the list of senior center program coordinators and telephone numbers obtained from the West Virginia University Center on Aging, phone calls were made to each center. The purpose of the call was two-fold: (1) to seek permission to distribute the questionnaires and (2) to make arrangements for visiting the center to conduct the survey. Calls were made to all 16 counties identified previously. In every case, the contact was agreeable to participating in the study. In most cases, seniors congregated at one centrally located senior center in the county. Usually, luncheon meals were the best-attended activities, although in some of the sparsely populated rural counties even those involved only a handful of people. From time to time, American Association of Retired Persons (AARP) meetings or similar special events were held which attracted larger numbers of people. Wherever possible, arrangements were made to distribute surveys at these times to maximize the number of responses. In most cases, sites were visited during the lunchtime hours during April and May of 2000. However, at the Harrison County site, visits were made in the evening during particular activities, such as, ceramic painting class and square dancing. This time was suggested by the program coordinator as that which would maximize participation.

In some counties, there was more than one senior center site, i.e., a main location and satellite sites. In the other cases, the sites were essentially co-equals. Discussion with the local coordinator assisted in determining which site(s) would be most promising

for survey distribution. Two sites were visited in Nicholas County, at the suggestion of the program coordinator.

All sixteen target counties contacted were visited except Mingo County. This site was contacted and the program coordinator was willing to cooperate; however, the program coordinator mentioned to the researcher before scheduling began that the opportunity to reach potential participants was limited. The relatively small number of individuals that participated with the senior center had their meals delivered to their homes as opposed to driving to a central site. On occasion, one or two people might come to the site, however, on the particular day the site was contacted, only the cook and the program coordinator were present. Since this occurred a majority of the time, it was felt that surveying this site would not be cost-effective. Consequently, the decision was made not to distribute surveys in Mingo County.

A supply of survey forms, pencils, and clipboards was taken to each site. Upon arrival at the site, the researcher spoke with the center representative to finalize the time schedule. For example, in some cases, surveys were administered before the meal and in other cases after the meal. As the surveys were distributed, the standard introductory announcement and oral instructions were made either to the entire group at once or individually as surveys were being handed out. The introduction explained the purpose of the study and emphasized that the survey was not a test; i.e., no right or wrong answers. Seniors were informed that only those individuals holding a driver's license could participate; those not holding a driver's license were excused. At the same time, participants were reassured that results were anonymous and that their driver's license

status would not be affected. It was also made clear that filling out the survey was completely voluntary.

There was considerable variation in the number of respondents at each site. The sites that set aside time for the respondents to fill out the survey had a higher number of respondents. The sites where there was not an allotted time and respondents could come and go as they pleased, did not have as many responses. The number of participants also depended on the activities occurring at the time of the visit. For example, the Mercer County site had a fitness awareness program scheduled the day of the visit. There were many people present, however, people were involved in so many activities that some did not take time out of their itinerary to fill out a survey. The program coordinator had suggested that as a good visitation day because the amount of people present, but ironically the responses were low because of the limited time due to the conflicting activities underway.

The sites where an announcement was made to the entire group at once had the highest number of respondents. This method allowed the researcher to make the introduction to everyone and follow up the survey distribution with answering questions. At some of the other sites, instructions were given on an individual basis depending on how the center representative wanted to handle the procedure of administering the survey. The response rate also depended on the organization of the site. Even though all sites were contacted and confirmation calls were placed, some sites were not as prepared as others were for the researcher's arrival.

At the sites, all the people were friendly to the researcher. Some even asked the researcher to read or mark the survey for them, since they had forgotten their reading

glasses or their hands were too shaky to write their responses. Some people commented on things they would like to have fixed or re-designed along divided highways. These items were noted in the visitation journal or directly on the survey itself. Overall, less than ten people declined to participate in the surveys once the instructions were given.

While completing the survey, respondents would sometimes ask questions. One of the most common questions/response was that they did not find one driving situation more difficult than the other on questions 17, 18, and 19. Others needed help understanding questions 26 and 27. Once the question was read slowly and the researcher helped them through the question, they had no problem marking their response.

From these visits, 172 survey forms were filled out and collected. A breakdown of completed surveys by location is shown in Table 3.1.

It is clear from Table 3.1 that some counties had more respondents than others. As explained previously, there are a number of reasons for the variation in number of responses. Obviously, responses were dependent on the number of people actually present at the site. Most sites had only a handful of people present on the day of visitation and of those, not everyone was interested in participating. For example, in Fayette County, one survey was completed. At this site, there were three senior drivers present; however, only one was interested in participating.

Table 3.1. Number of Survey Responses by County.

County	Responses
Boone	5
Braxton	3
Doddridge	16
Fayette	1
Harrison	23
Kanawha	28
Lewis	7
Logan	7
Mercer	8
Nicholas	18
Raleigh	9
Randolph	9
Ritchie	8
Upshur	25
Wood	5
Total Responses	172

CHAPTER 4

DATA ANALYSIS

Introduction

Since a large of amount of both quantitative and qualitative data was obtained from the surveys, it was determined that the best method to organize, analyze and query the data was with the use of database management software. The database management program selected for use was Microsoft Access.

Responses to the survey were entered into the database. All responses were analyzed even if the forms were only partially completed. Note that although there were 172 responses, the total number of responses to each question may be less than 172 since participants did not necessarily answer every question, which was an option extended by the researchers as part of the IRB agreement.

In addition to an overall analysis, an attempt was made to analyze the data by county and by corridor highway (i.e., grouping the counties containing a particular roadway). This was done to determine if differences could be identified between counties or between roadways, both in terms of demographic characteristics and driving behavior.

Demographics of Respondents

Respondents ranged in age from 50 to 91 years old with a median age of 74 years. The length of time that each person lived in his or her particular county covered virtually the complete range from 1 year to 91 years with a median of 55 years. The length of time that a person had been driving ranged from 5 to 73 years with a median of 50.0 years.

Almost two-thirds of the respondents (62.5 percent) were female. About 5 percent (predominantly female) of the respondents indicated that they did not currently drive, although all respondents held valid West Virginia drivers' licenses. The most frequent reason given for not driving was physical difficulties, including broken arm, dizziness, and stroke. Lack of a car and "spouse does all the driving" were also mentioned as reasons for not driving.

Interestingly, none of the 172 respondents indicated that they stopped driving because a family member suggested they do so, a physician recommended doing so, or they were restricted by a government agency. Similarly, no respondents indicated that confusing intersections or fast traffic deterred them from driving.

The age distribution of respondents is shown in Figure 4.1. Over 40 percent of participants were in the 70 to 79 age group. Almost 70 percent of the respondents were over 70 years of age.

Figure 4.2 presents the distribution of highest education level of respondents. From Figure 4.2, it is apparent that the largest percentage of participants (38.7 percent) was high school graduates. Only 16.6 percent of the participants completed school from primary through high school. The percentage of participants that enrolled in some college or was a college graduate was fairly equal at around 22 percent.

The survey inquired about the frequency of driving of the participants. As shown in Figure 4.3, about three-quarters of the respondents drove 5 or more times per week. Only five percent of respondents drove less than once per week.

While respondents displayed a relatively high frequency of driving, as shown in Figure 4.4, there was considerable variation in the number of miles driven on an annual

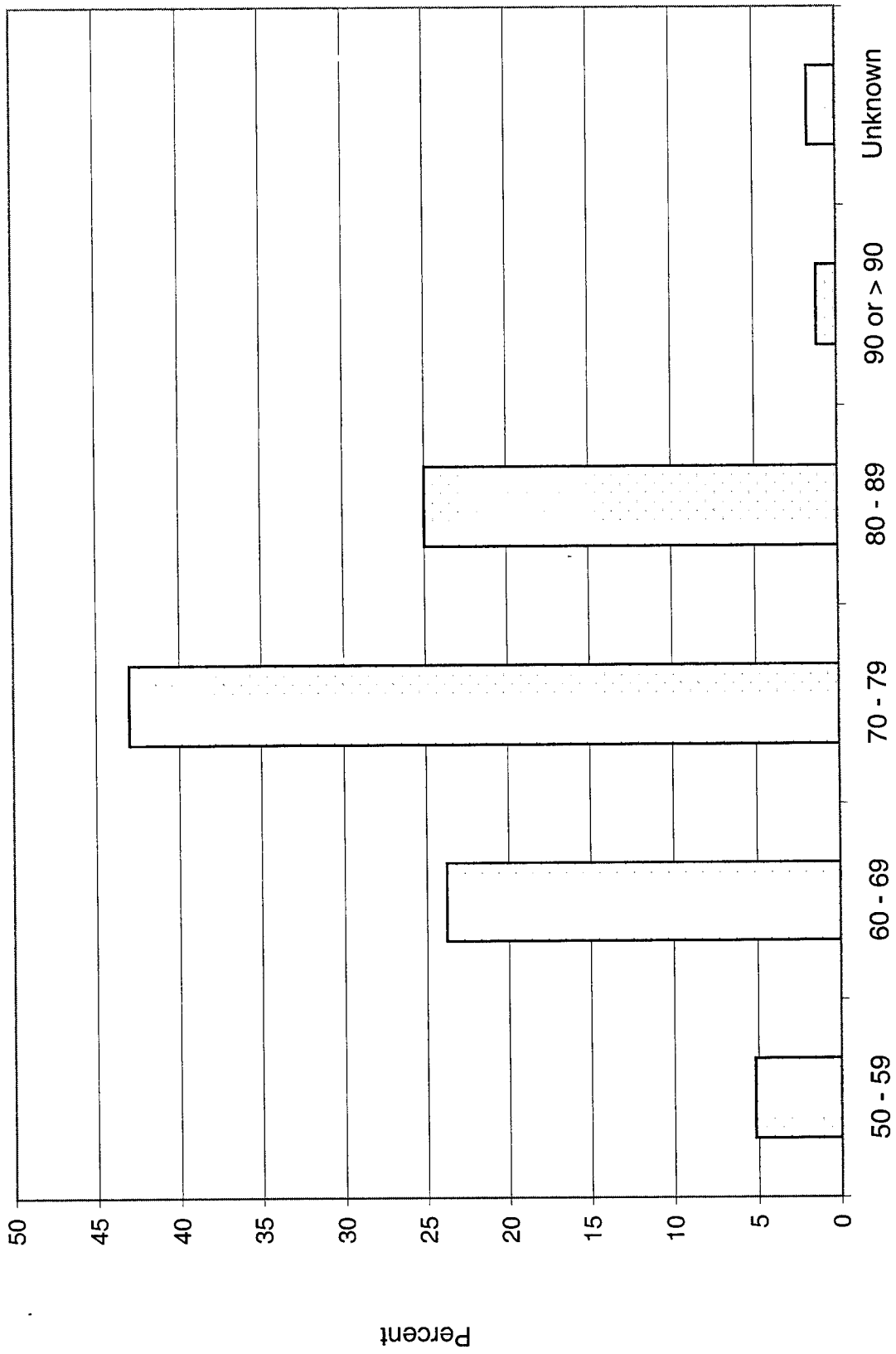

Fig 4.1 Age Distribution of Respondents.

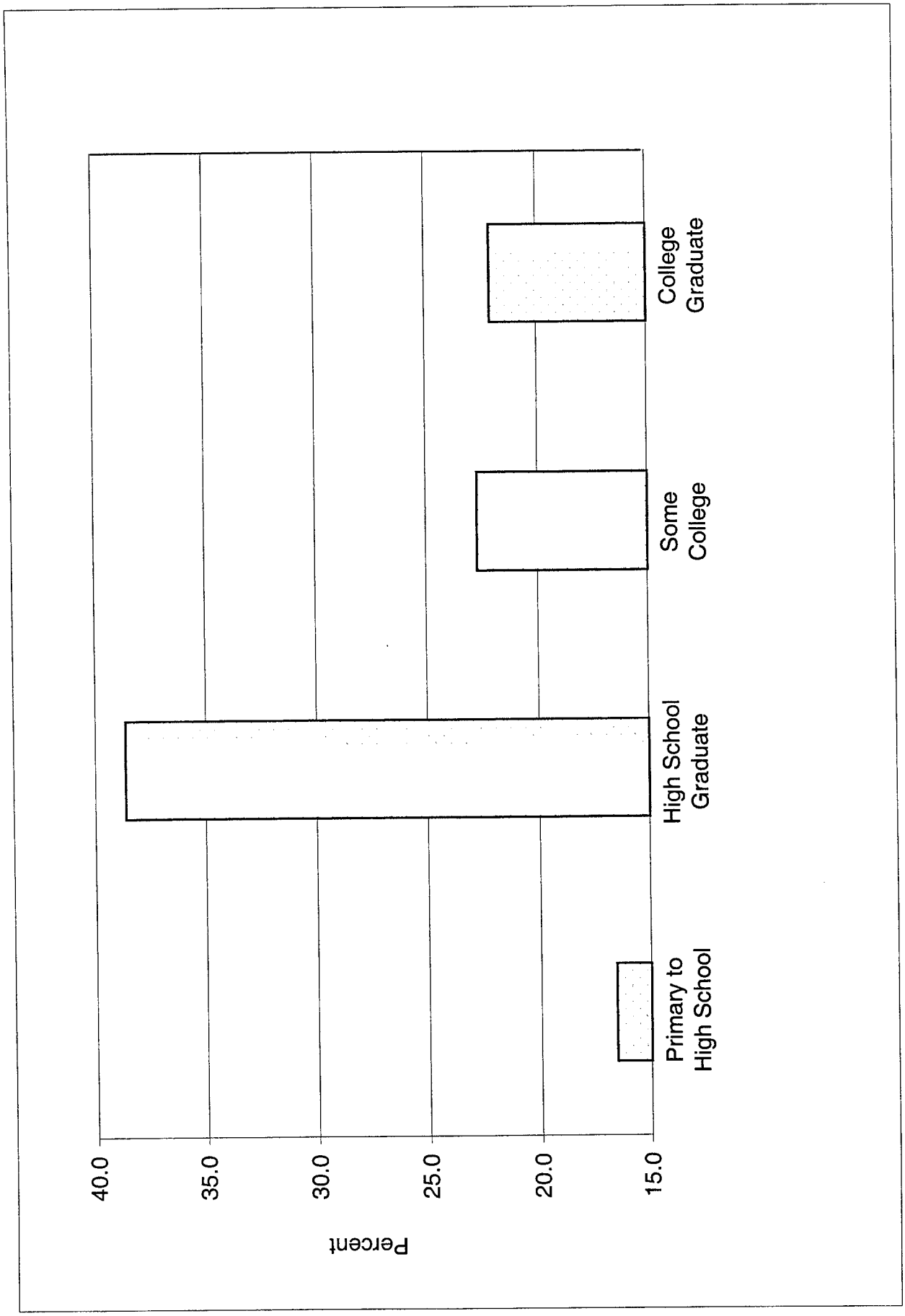

Fig 4.2. Highest Education Levels.

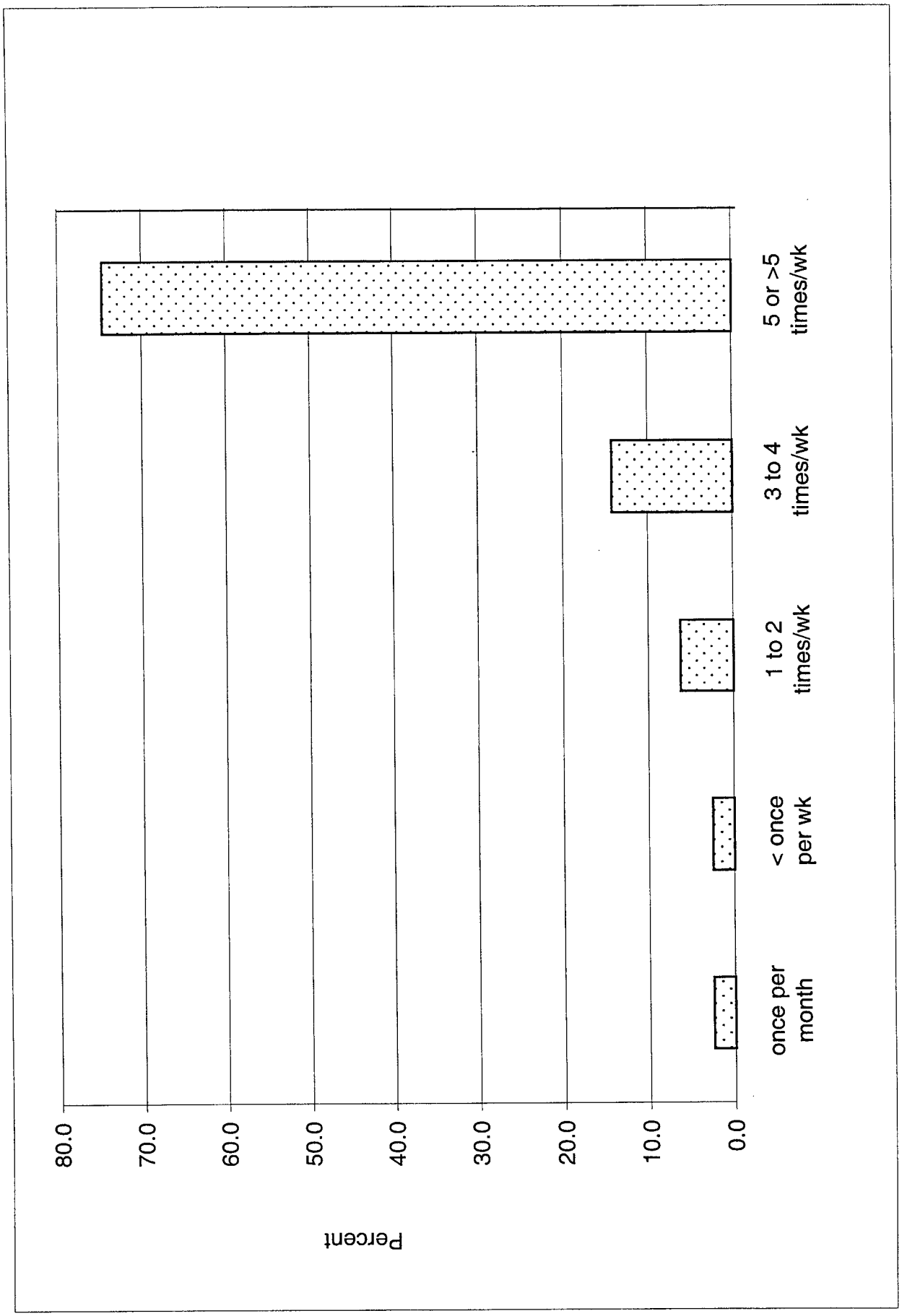

Figure 4.3 Driving Frequency of Respondents.

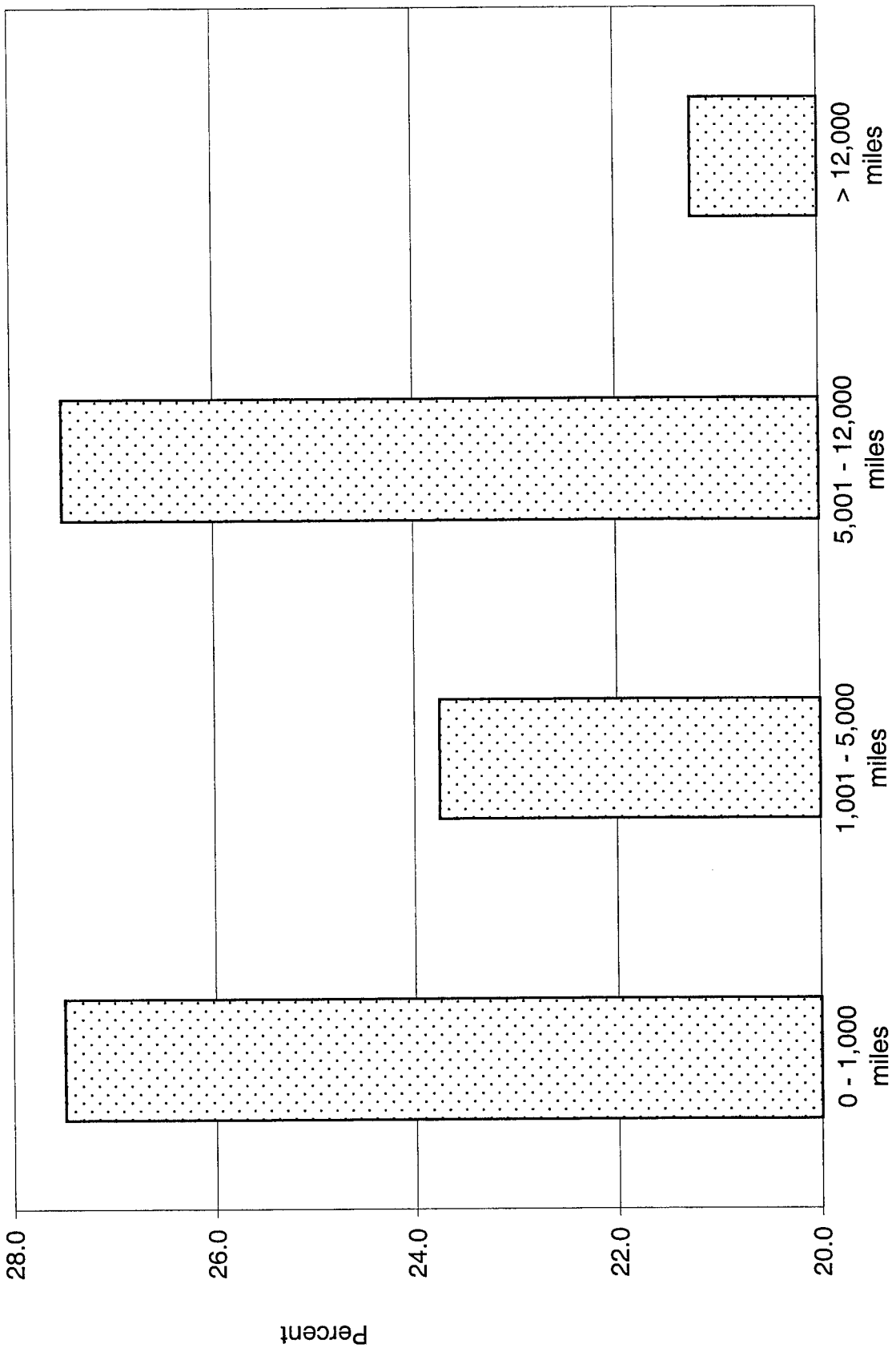

Fig 4.4 Annual Miles Driven by Respondents.

basis. Over one-quarter of the respondents drove less than 1,000 miles per year. This implies short trips such as home to church, home to shopping, and other trips of this nature. At the same time, over 20 percent of respondents drove more than 12,000 miles per year which implies either regular home-to-work trips or at least some long trips, such as touring or a vacation. These results are consistent with the findings of the TRB Special Report (1988) which indicated that older persons make shorter, more frequent trips than younger travelers.

Figure 4.5 presents the distribution of overall driving experience of participants by roadway type. Although two-lane rural roads and city streets are slightly higher than limited access highways, it is clear that participants drive regularly on all four classes of roads.

Figure 4.6 depicts the distribution of driving experience on these same types of roadways in the past twelve months. Although more respondents cited city streets and fewer cited Interstate highways, the distribution was very similar to that for overall driving experience.

Participants were asked if they have presently limited their driving and, if so, to indicate the reason. Approximately 44 percent of the respondents indicated they voluntarily limit their driving, and did not do so on doctor's orders or family recommendation. The distribution of reasons for currently self-limiting driving is shown in Figure 4.7. The majority of participants who limited their driving did so because of difficulties driving at night. Second most frequent response was limiting driving due to bad weather. Fast traffic or confusing intersections were not a major concern.

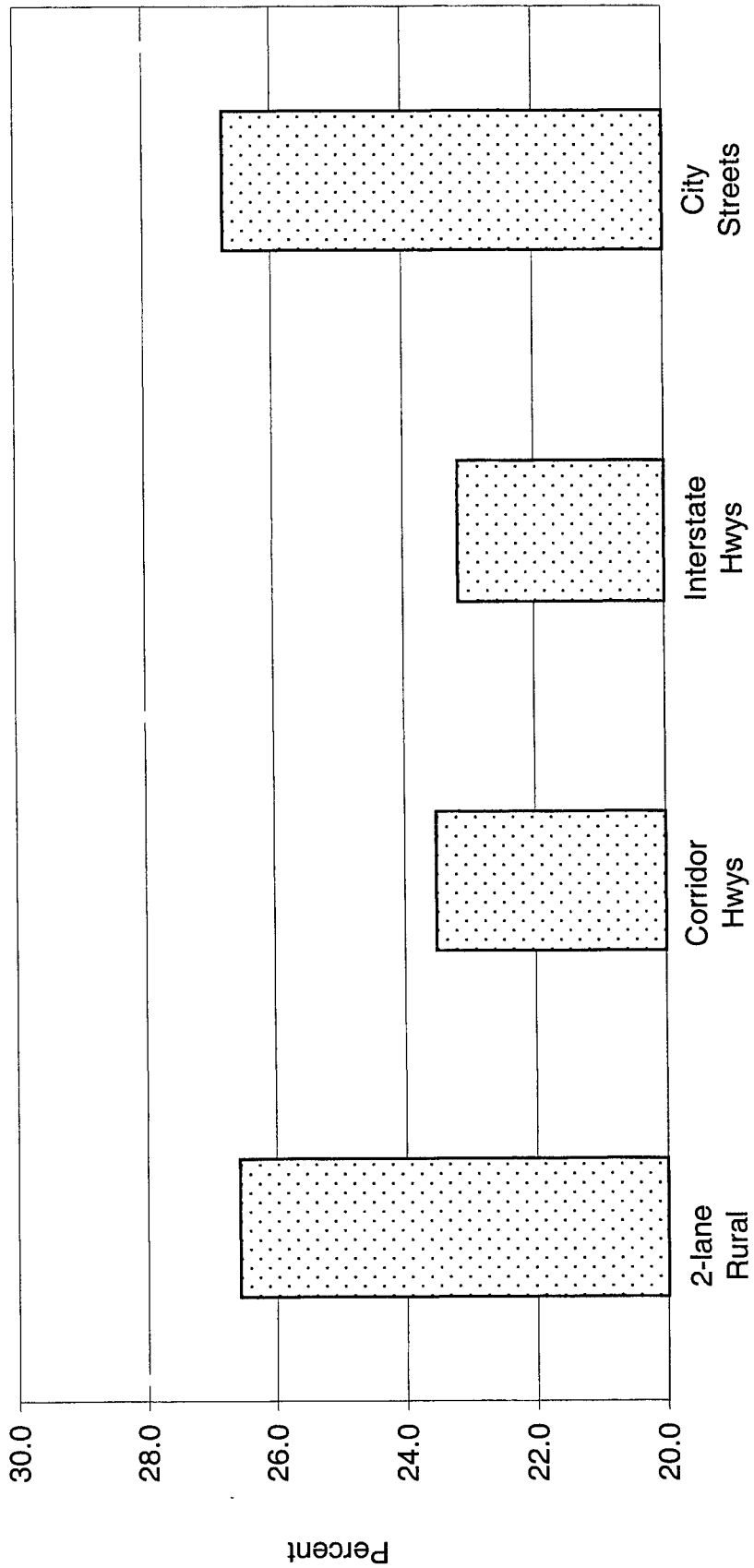

Fig 4.5 Overall Driving Experience, by Roadway type.

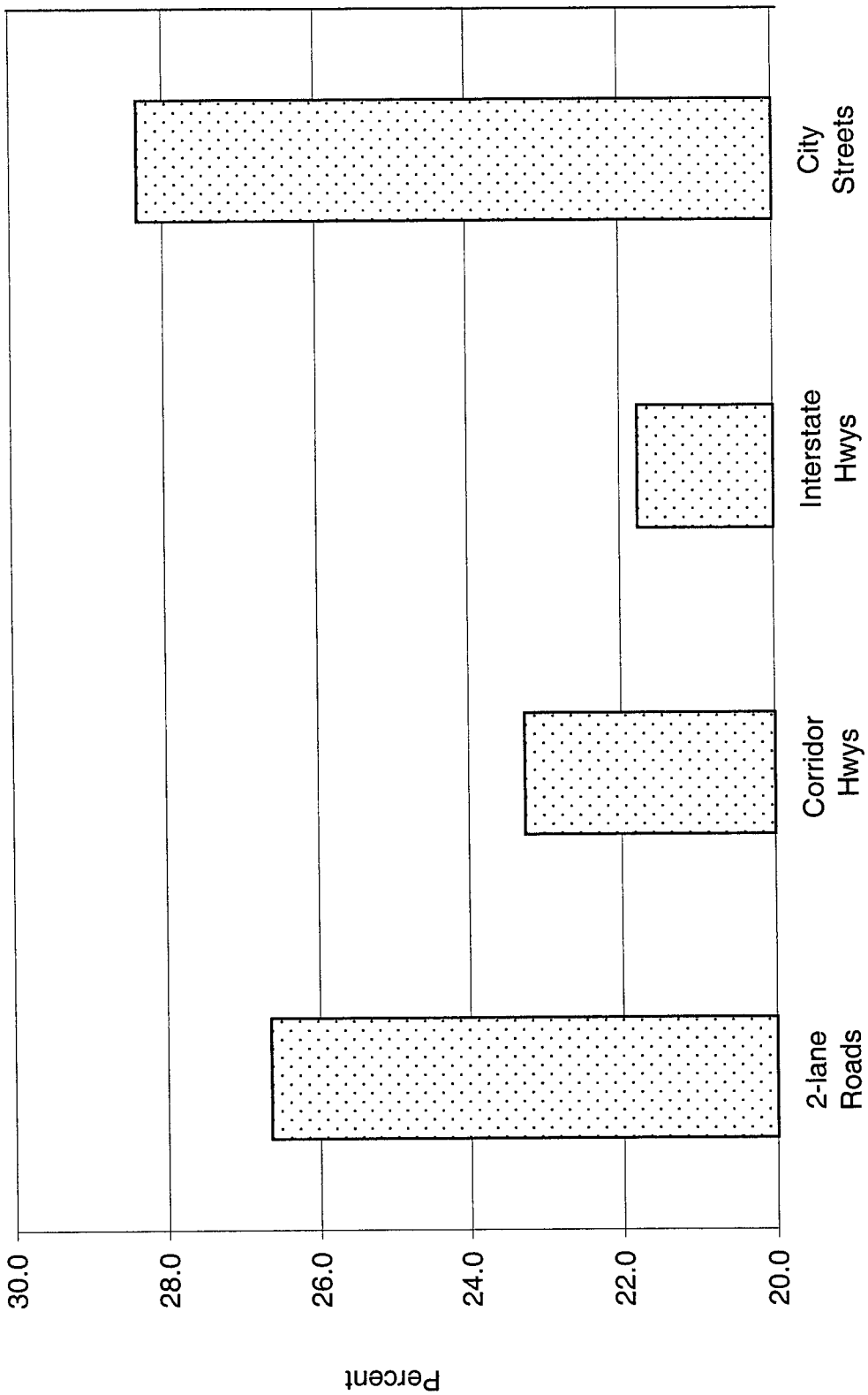

Fig 4.6 Driving Experience, in last Twelve Months, by Roadway type.

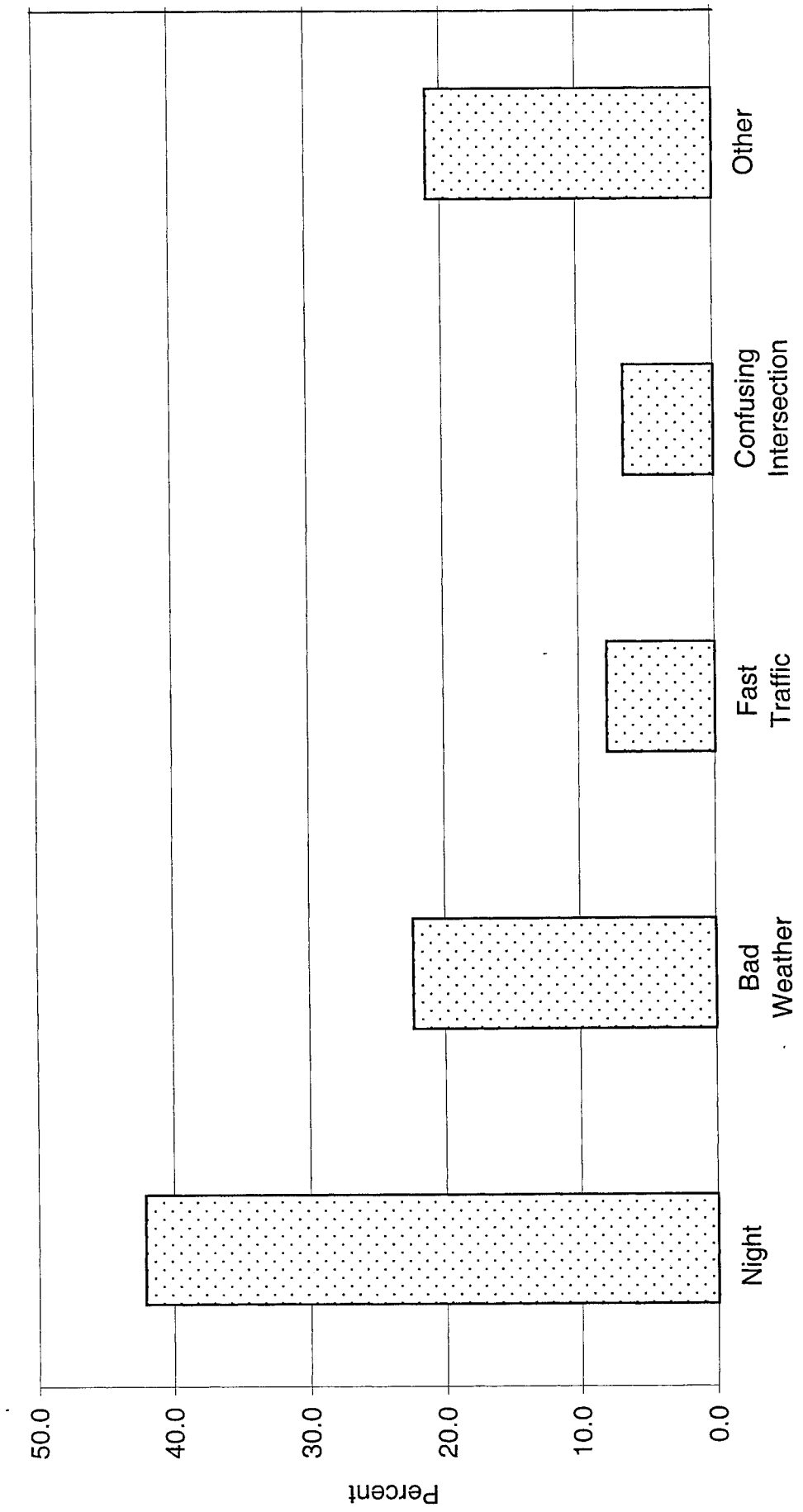

Fig 4.7 Reasons for Currently Self-Limiting Driving.

Over 20 percent of the respondents gave "other" as the reason. As shown in Table 4.1, a wide variety of reasons were given for limiting their driving. Illness/injury was the most commonly cited reason followed by vision limitations and lack of a car.

Table 4.1. "Other" Reasons Cited for Limiting Driving Presently.

Reason	No. of Responses
Illness/Injury	5
Vision limitations	2
No car	2
Spouse drives	1
"Read and hear about too many accidents"	1
"Don't get out at night"	1
"Reflexes not as quick"	1
"Not as much need for driving a lot now"	1
"Too much traffic"	1
"Can't leave spouse"	1

Participants were also asked about how often they drive on divided highways. Results are presented in Figure 4.8. Two-thirds of the respondents drove on corridor highways at least once a week. Only 20 percent seldom or never used such highways. Of these, over three-fourths indicated that did not need to use these types of roadway. The remainder stated that they did not want to use this type of roadway. Thus, it appears that only a small number of drivers are avoiding travel on corridor highways.

Participants were also asked about how often they drive on divided highways at night. Results are shown in Figure 4.9. As expected, these results differed significantly from responses to the previous question. Only about 45 percent of respondents drove on corridor highways at least once a week at night.

Almost one-half (47.8 percent) of the respondents indicated that they seldom or never drove at night on corridor highways. These respondents were asked why they did

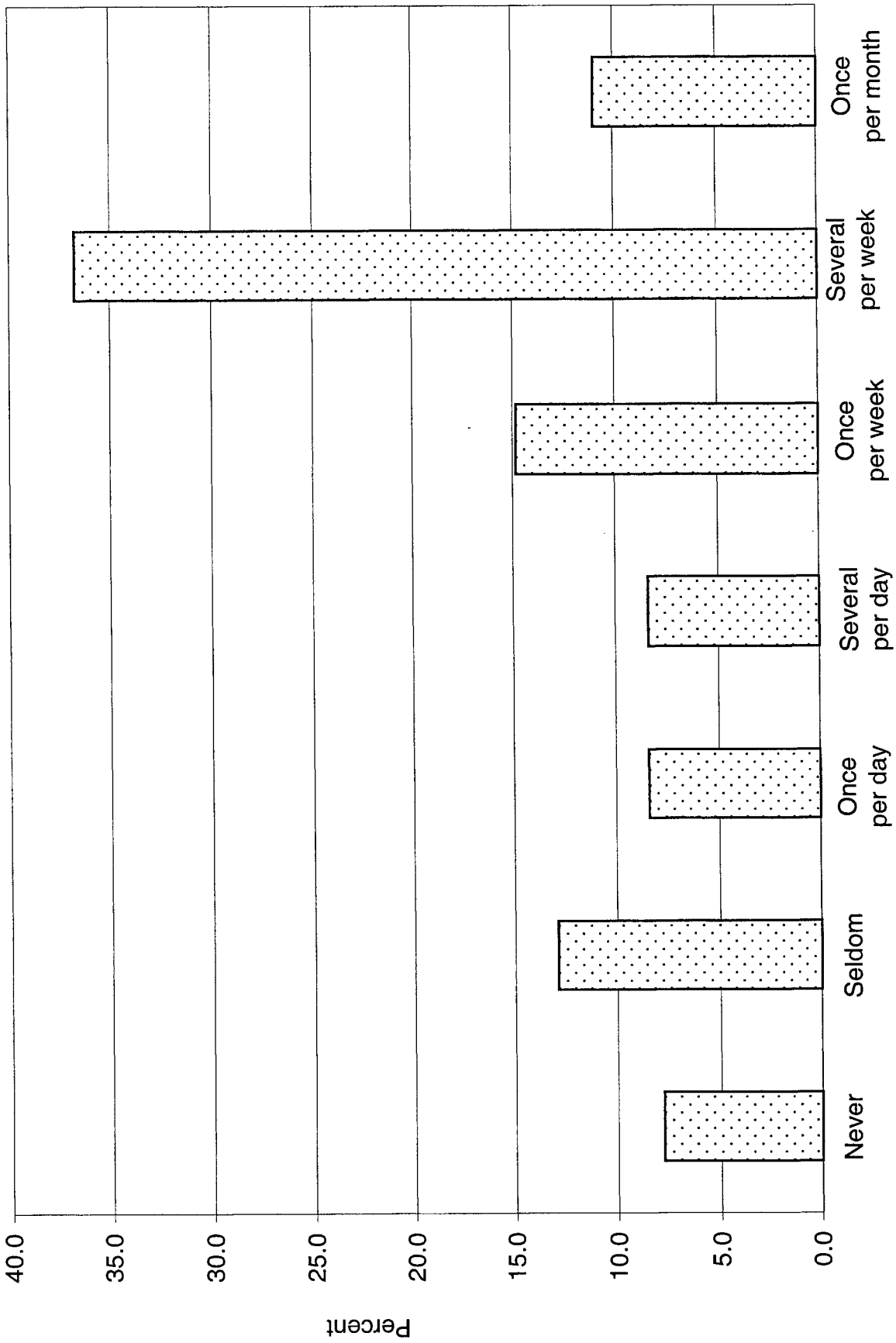

Fig 4.8 Driving Frequency on Divided Highways.

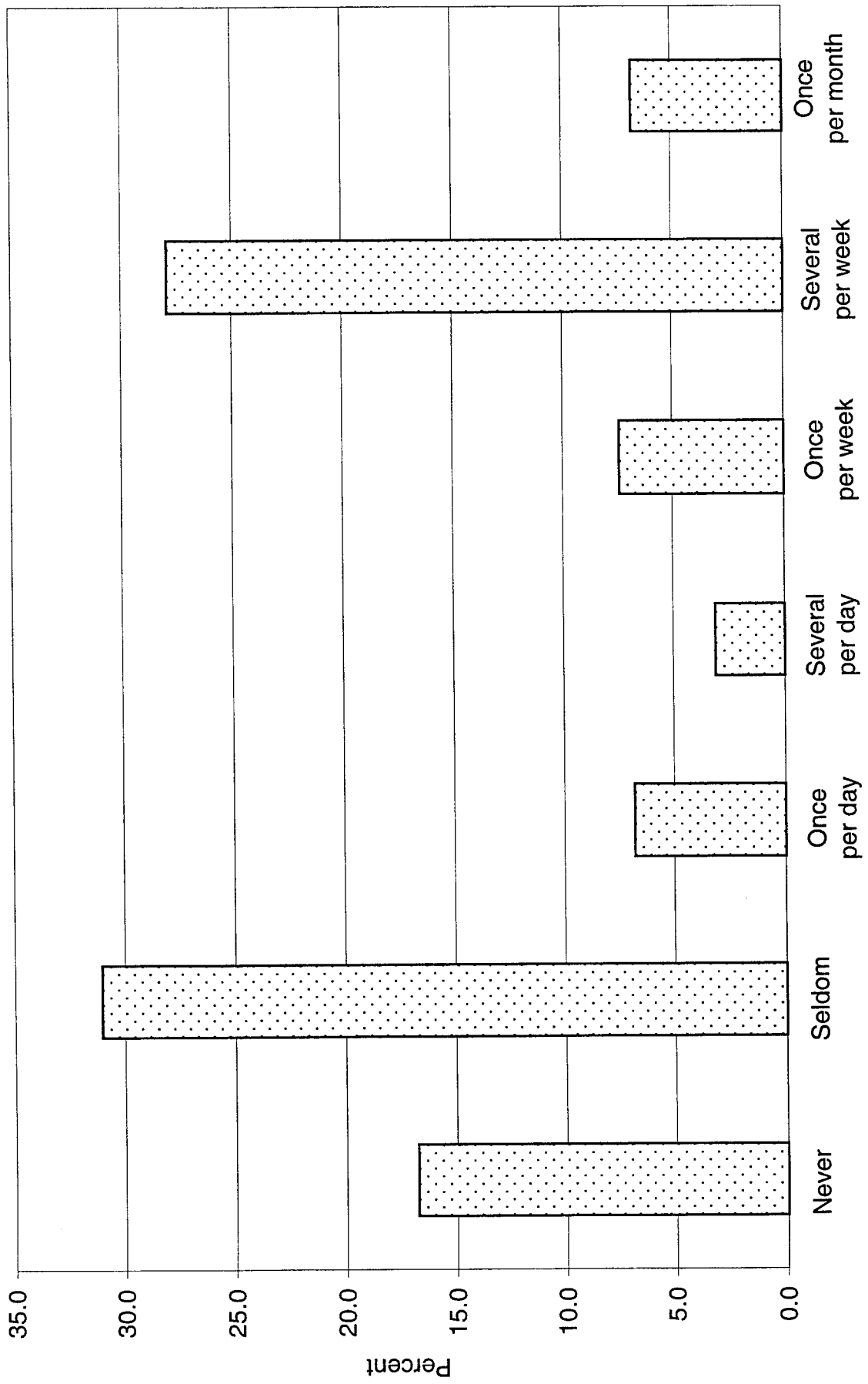

Fig 4.9 Driving Frequency on Divided Highways at Night.

not drive at night; results are presented in Figure 4.10. Headlight glare was the primary reason, followed closely by concern for personal safety. Other visual-related factors, namely difficulty in seeing pavement markings and in seeing people or animals in the roadway ranked third and fourth, respectively.

Driving Behavior

Questions 17, 18, and 19 involved paired comparisons intended to assess the perceived difficulty associated with turning and crossing maneuvers at unsignalized intersections. Table 4.2 presents the summary of responses. From the results, it is clear that crossing the divided highway is perceived as less difficult than making left turns. It is also apparent that making left turns onto the divided highway is perceived as the more difficult of the turning movements. This is not surprising since this maneuver involves making speed, distance and gap judgments (one for crossing and one for merging) for two high-speed roadways as well as possibly assessing traffic in the median.

Table 4.2. Summary of Responses to Paired Comparisons – "Which of the two situations is more difficult for you at an intersection that does not have a traffic light?"

Question	Comparison	% Responding "More Difficult"
17	Crossing Divided Highway	37.0
	Making Left Turns onto Divided Highway	63.0
18	Making Left Turns onto Divided Highway	58.3
	Making Left Turns from Divided Highway	41.7
19	Crossing Divided Highway	45.1
	Making Left Turns from Divided Highway	54.9

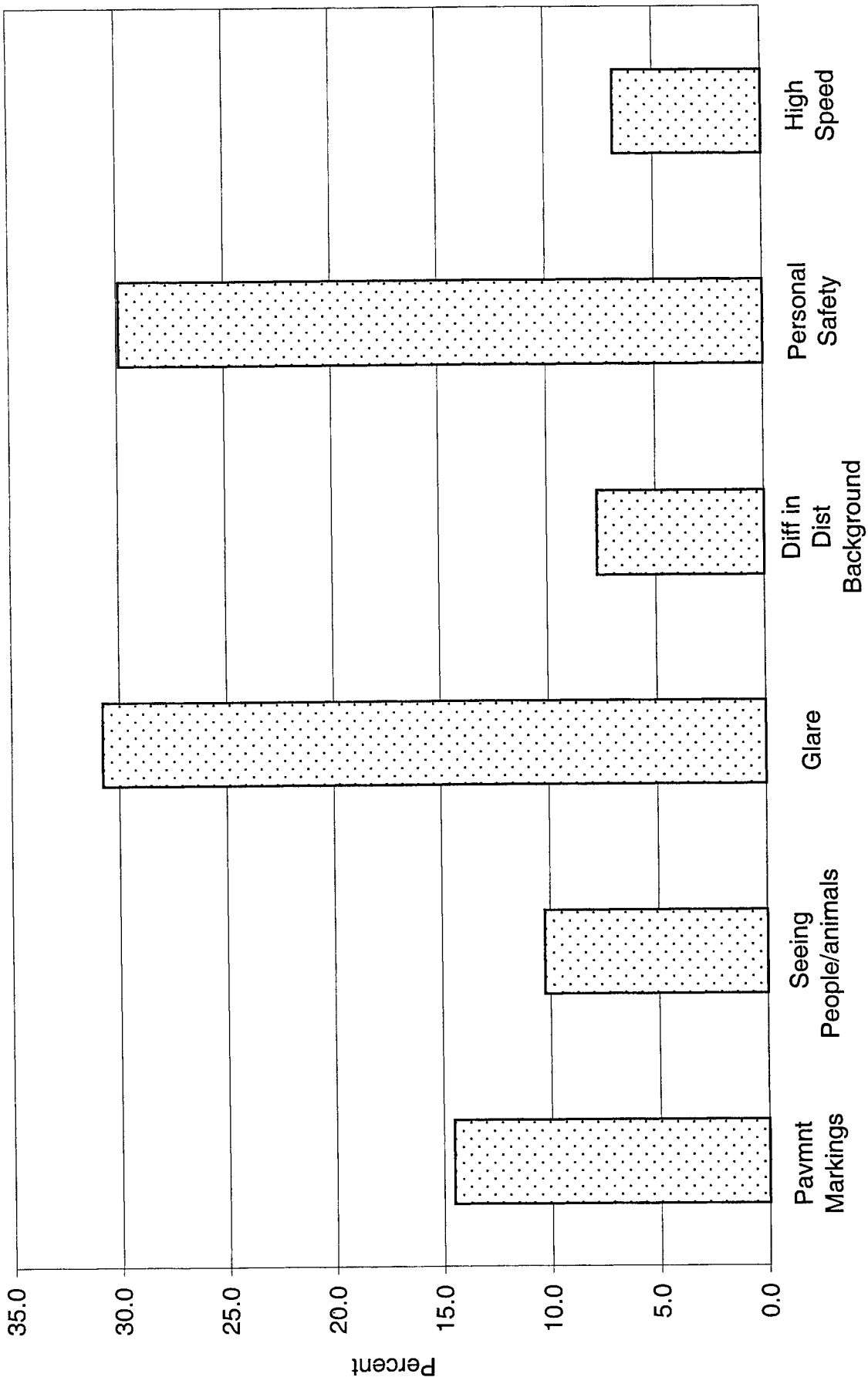

Fig 4.10 Reasons for Not Driving on Corridor Highways at Night.

Relative to these same maneuvers, participants were asked to select from a list, the factor presenting the greatest difficulty when making a left turn onto a divided highway. Results are shown in Figure 4.11. Interestingly, almost one-half of the respondents (43.7 percent) indicated that they did not have problems at these intersections. This is surprising in light of findings in the literature and comments made to project staff during questionnaire distribution.

Over one-fourth of the respondents indicated that the greatest difficulty was judging the *speed* of oncoming vehicles. Only about ten percent believed that the greatest difficulty was judging the *distance* to oncoming vehicles. These results agree with what would be expected intuitively.

Almost 15 percent of respondents indicated that their greatest difficulty was knowing how to travel through the middle of the intersection. Based on the results of the literature review, it was anticipated that some drivers would have concern about this. Therefore, a question addressing this issue in more detail was included in the survey. Additional discussion is presented below.

Participants were asked to select from a list, the factor presenting the greatest difficulty in trying to find a side road when traveling on a divided highway. Figure 4.12 presents the results. Over 20 percent of the respondents indicated that they did not have problems finding the proper side road. The most frequently cited perceived greatest difficulty was "fast moving traffic on my rear bumper." A close second, in terms of frequency, was "road name sign is too small to read." Difficulty seeing the sign due to background clutter was cited by only about 6 percent of the respondents. One comment

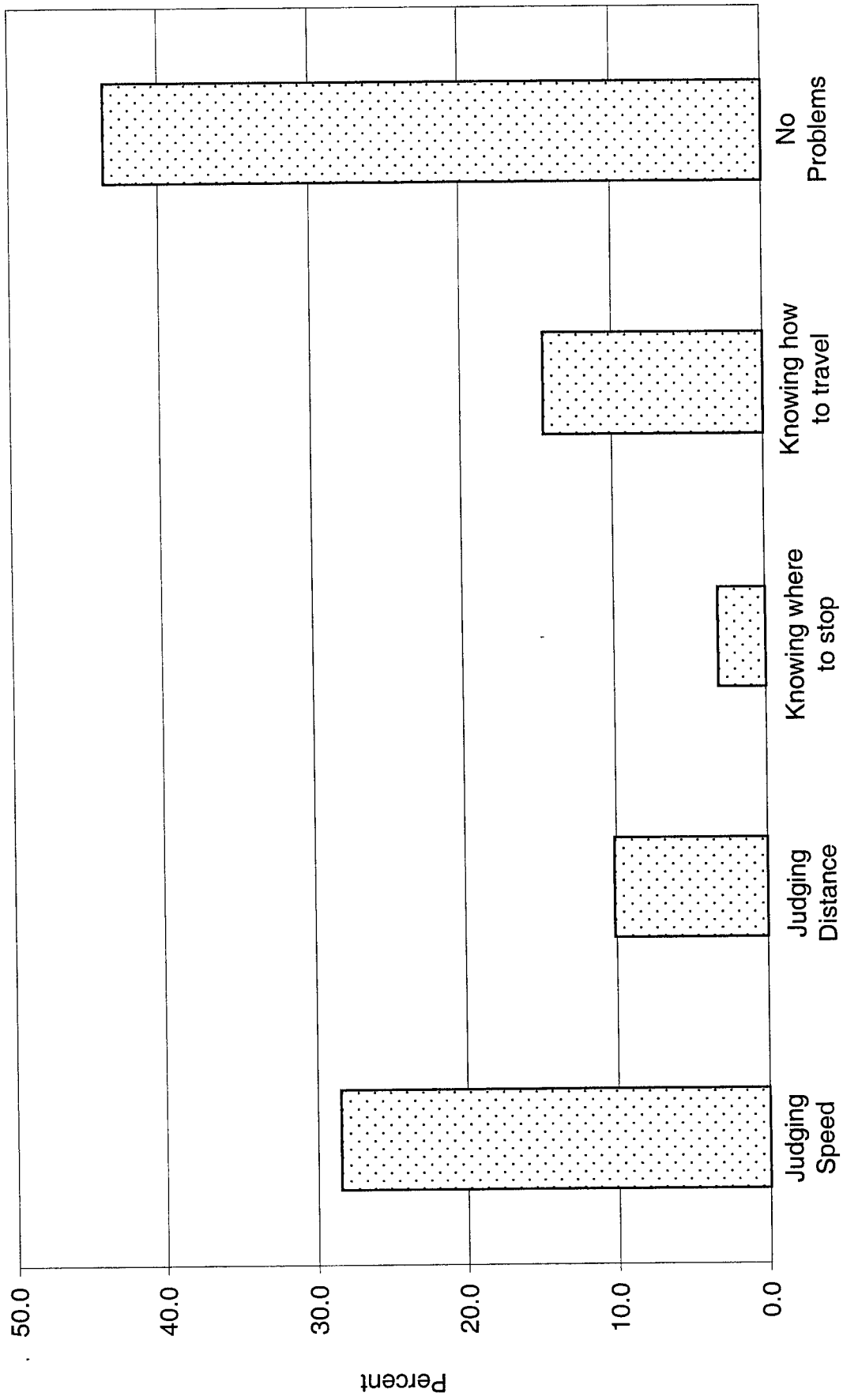

Fig 4.11 Greatest Difficulty When Making Left Turns onto a Divided Highway.

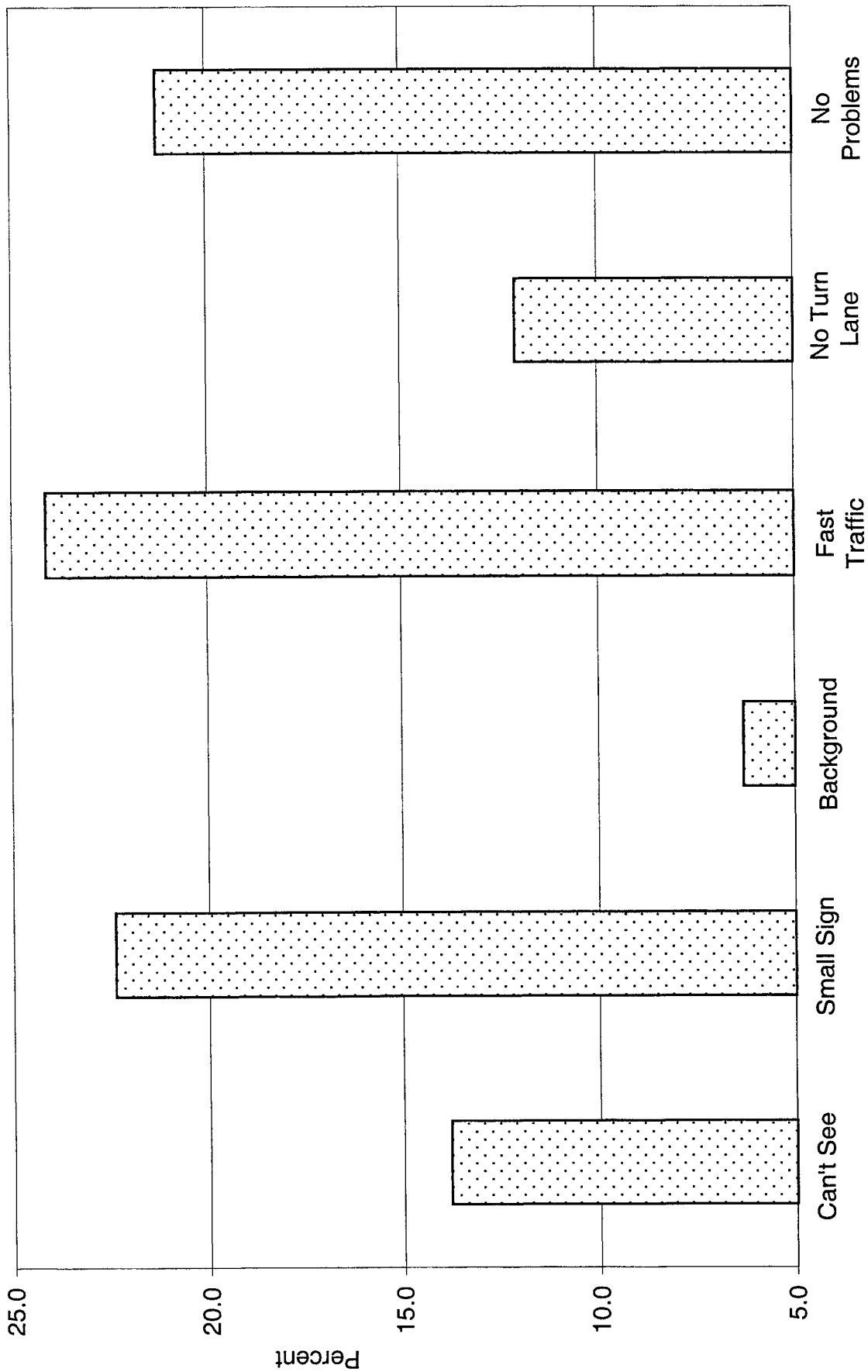

Fig 4.12 Greatest Difficulty in Trying to Find a Side Road When Traveling on Divided Highway.

was noted about this question. The respondent stated on the questionnaire that they thought this was the most important question on the survey.

From a list of nine factors, participants were asked to identify the five which they dislike the most about sections of divided highway. Results are presented in Table 4.3. Large trucks and rudeness or dangerous actions of other drivers were the most commonly cited factors, each receiving an identical score of 19.9 percent. Also ranking high was signs that are difficult to see or confusing.

The remaining factors on the list received on the order of only one-half as many responses as the three factors noted above. Things happen too quickly and difficulty entering divided highway were cited by about 11 percent of respondents.

From a similar list, participants were also asked to identify problems they have encountered since the speed limit was increased from 55 to 65 mph on corridor highways. Table 4.4 shows the results. Note that about 15 percent of respondents indicated that they did not have problems after the speed limit was increased.

The same two factors cited in the previous question (large trucks and rudeness of other drivers) also ranked highest, at approximately the same level of frequency, in this case. Similarly, signs difficult to see ranked third. Overall, this distribution of responses was almost identical to that just discussed.

Respondents were asked whether they had ever entered a divided highway going the wrong direction; 13.2% of the participants had done so. One respondent commented "almost." Although the researchers have no quantitative data for comparison, intuitively, the percentage seems considerably higher than that for drivers in general. These results

Table 4.3. Factors Most Disliked About Sections of Divided Highways That Do Not Have Traffic Lights.

Factor	Percent of Responses
Large Trucks	19.9
Rudeness or Dangerous Actions of Other Drivers	19.9
Signs Difficult to See or Confusing	18.3
Things Happen Too Quickly	11.4
Difficulty Entering Divided Highway	10.8
Difficulty Exiting Divided Highway	7.4
Difficulty Maneuvering in Traffic	5.8
Getting Lost	4.0
Boring View	2.6

Table 4.4. Problems Encountered After Speed Limit Increase.

Problem	Percent of Responses
Large Trucks	20.1
Rudeness or Dangerous Actions of Other Drivers	19.3
Do Not Have Problems	15.2
Signs Difficult to See or Confusing	13.8
Things Happen Too Quickly	11.2
Difficulty Entering Divided Highway	8.9
Difficulty Maneuvering in Traffic	4.9
Difficulty in Exiting Divided Highway	4.3
Getting Lost	1.1
Boring View	1.1

are also consistent with findings from the literature which indicate that older drivers are over-involved in wrong-way crashes.

Another question asked whether the respondents had been in an accident on a divided highway within the last ten years. Only 4.1 percent indicated "yes."

The last three questions on the survey presented visual information and asked respondents to make judgments about the information presented. Questions 26 and 27 showed "driver's eye" photographs (as viewed from the minor roadway) of intersections on a divided highway with cars approaching the driver from the left. The question indicates that there is no traffic coming from the right and that the approaching vehicles are traveling at 65 mph. The question asked if the respondent would pull out to cross the roadway. In the first question, the single oncoming vehicle is a considerable distance away. However, in the second question, there are two vehicles close to the intersection.

On Question 26, just over 12 percent of respondents indicated they would pull out. An identical percentage indicated that they could not tell from the photograph. Just over three-quarters of respondents indicated they would not pull out. These results are somewhat surprising since it was expected that there would be greater numbers of positive responses.

In response to the second question, only one respondent (0.7 percent) indicated they would pull out. On the other hand, 86.9% would not pull out. Given the proximity of the approaching vehicles, this result was expected. The same percentage (12.4 percent) as before indicated that they could not tell from the photograph.

The last question presented a plan view of a typical at-grade intersection on a corridor highway. Three distinct areas in the median portion of the intersection were

identified by capital letters. Participants were asked to indicate the location at which they would stop before completing a left turn onto the divided highway. Results are shown in Figure 4.13.

Over one-half of the respondents indicated that they would stop in the middle of the intersection. Almost 20 percent indicated that they would stop in their lane of traffic in the median.

Surprisingly, about 19 percent of respondents said they would stop at none of these locations. It is not immediately clear if this indicates a lack of understanding of the question or if they would not stop in the traveled way of the corridor highway. The 11 percent of respondents who indicated they would stop at location A are a concern since this puts them in direct conflict with crossing maneuvers from the opposite direction. These results tend to confirm the results from Question 20 which indicated that knowing how to travel through the intersection ranked second in difficulty to judging speeds of oncoming vehicles. This suggests that driver educational materials and/or additional guidance in the form of channelization may be helpful to older drivers.

As well as answering the questions on the survey, some participants commented either verbally to the survey administrator or wrote comments directly on the survey. One comment was in regard to overhead directional signs. It was thought that more of these should be installed for lane clarification. The other two comments were in regards to entering and exiting the roadway. The respondents noted the need for more ramps to enter and exit the divided highway.

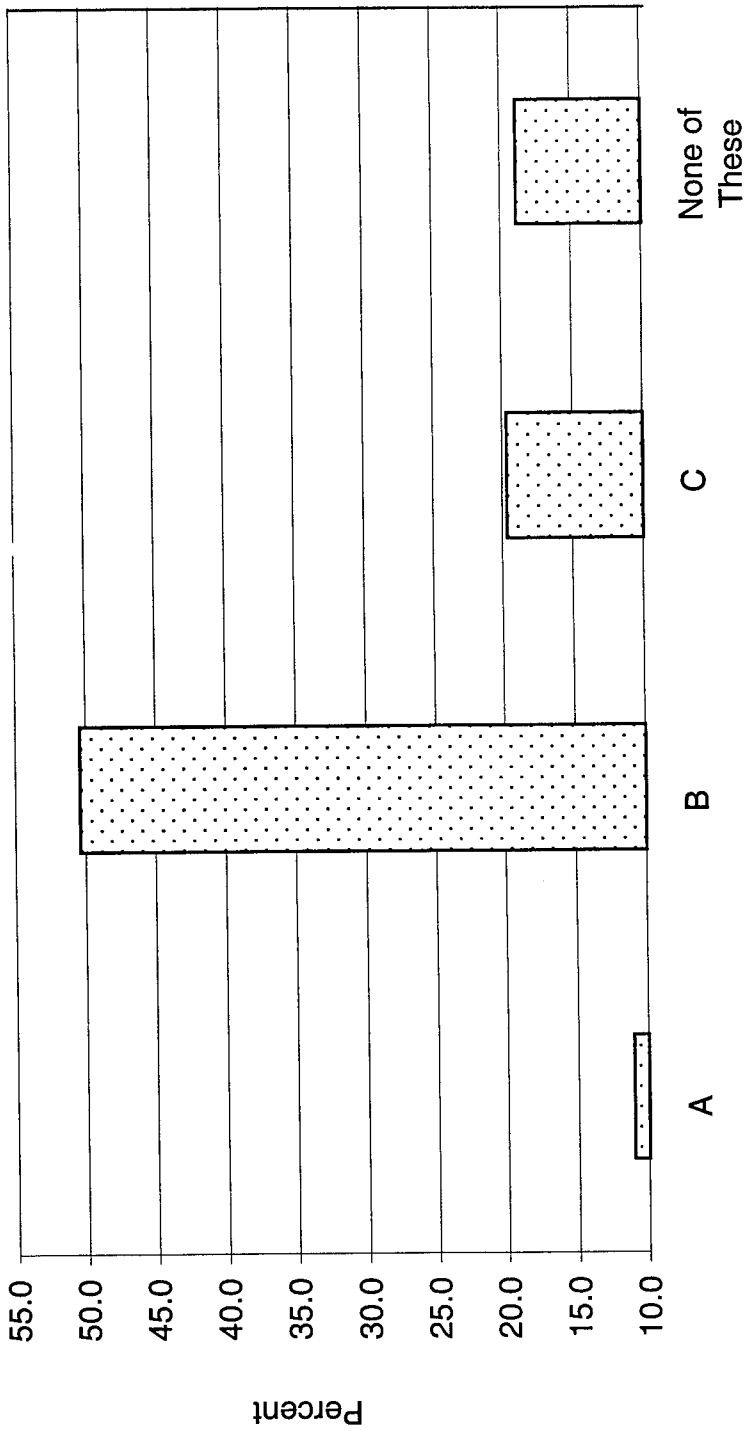

Fig 4.13 Stopping locations at Median.

Results by Gender

As noted previously, almost two-thirds of the participants were female. The age distribution, by gender, is shown in Figure 4.14. The median age of female respondents was 73 versus 74 for male respondents. On average, males had been driving for 6.1 years longer than their female counterparts. The distribution of highest education level completed was similar for males and females.

In terms of frequency of driving, as shown in Figure 4.15, females do not drive as often as males. Just over 90 percent of the males drove five or more times per week, whereas less than two-thirds of the females drove this often. Seven percent of the females drove once a month or less and less than once a week.

This same tendency was reflected in terms of miles driven annually. As shown in Figure 4.16, over three-quarters of the males traveled over 5,000 miles per year. On the other hand, only 32 percent of the females drove more than 5,000 miles; over one-third (38 percent) drove 1,000 miles or less. Over two-thirds of the females drove less than 5,000 miles annually. While it had been anticipated that males would drive greater distances than females, the magnitude of the difference was not expected.

Figure 4.17 presents the distribution of overall driving experience of participants by roadway type. For males, the responses were approximately equally distributed among all four classes of roads. For females, there was more travel indicated on two lane roads and city streets than on corridor highways and interstates. In spite of these differences, it is fair to say that both males and females drive regularly on all four classes of roads.

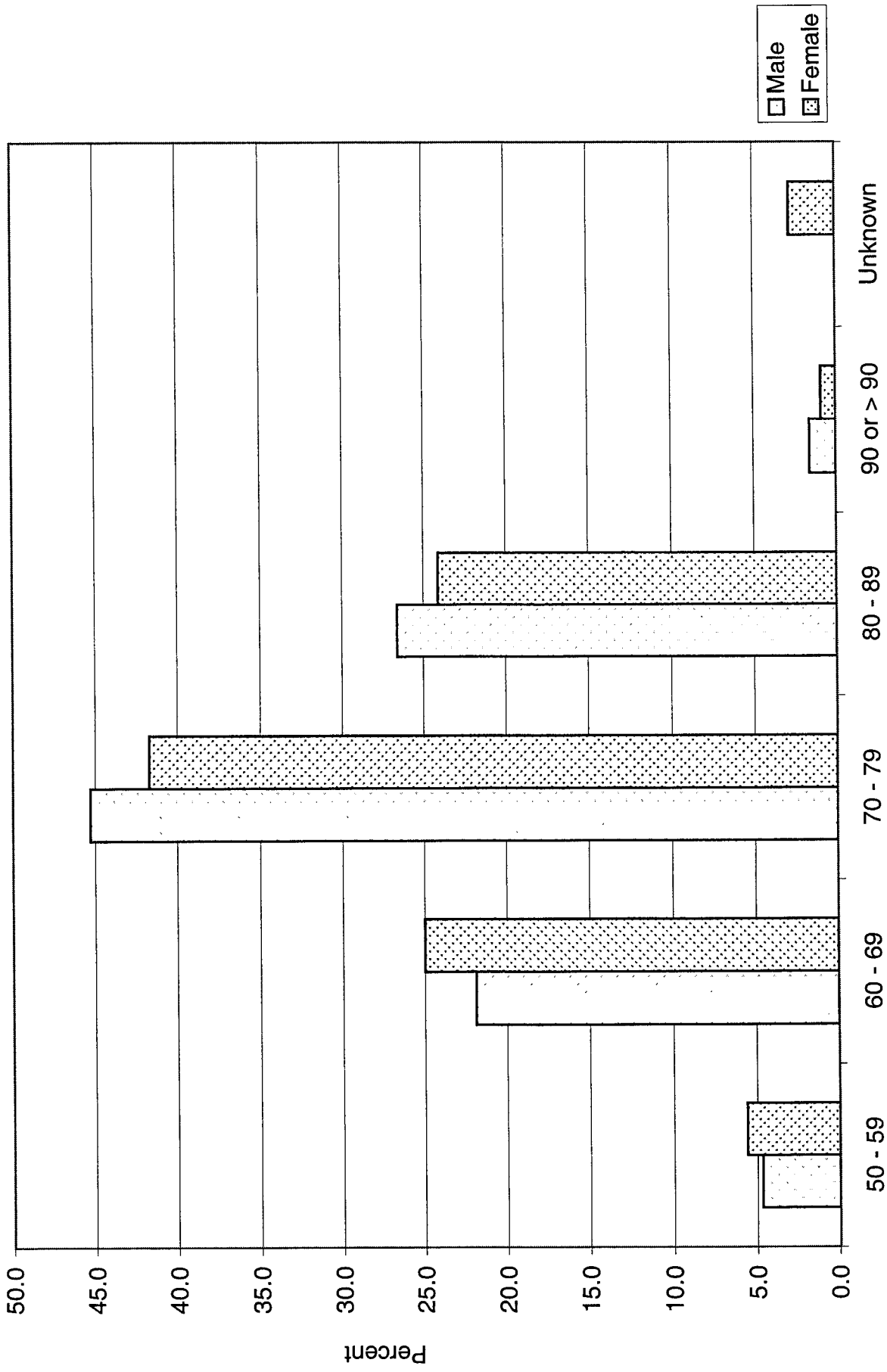

Fig 4.14 Age Distribution, by Gender.

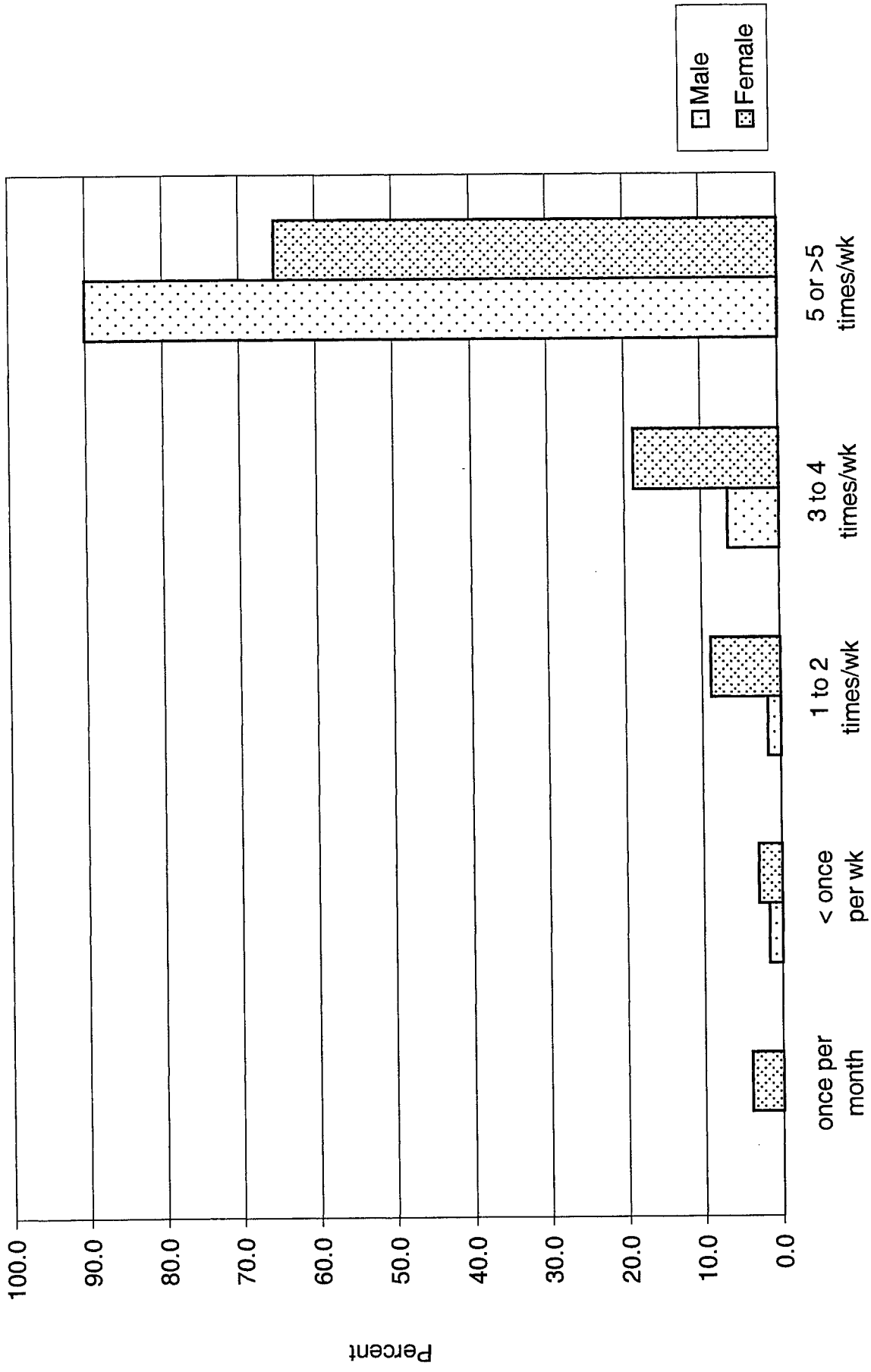

Fig 4.15 Driving Frequency by Gender.

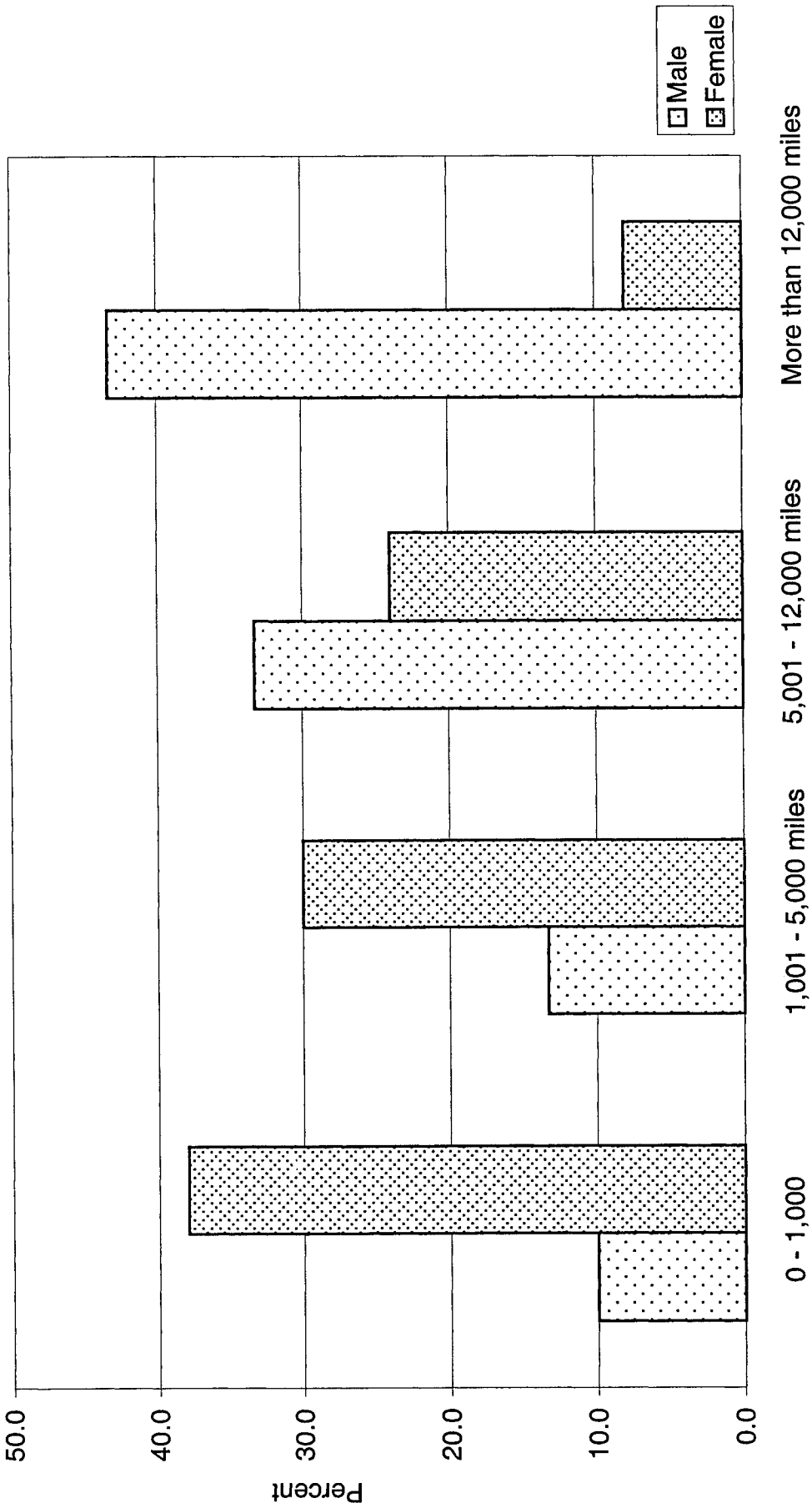

Fig 4.16 Annual Miles Driven, by Gender.

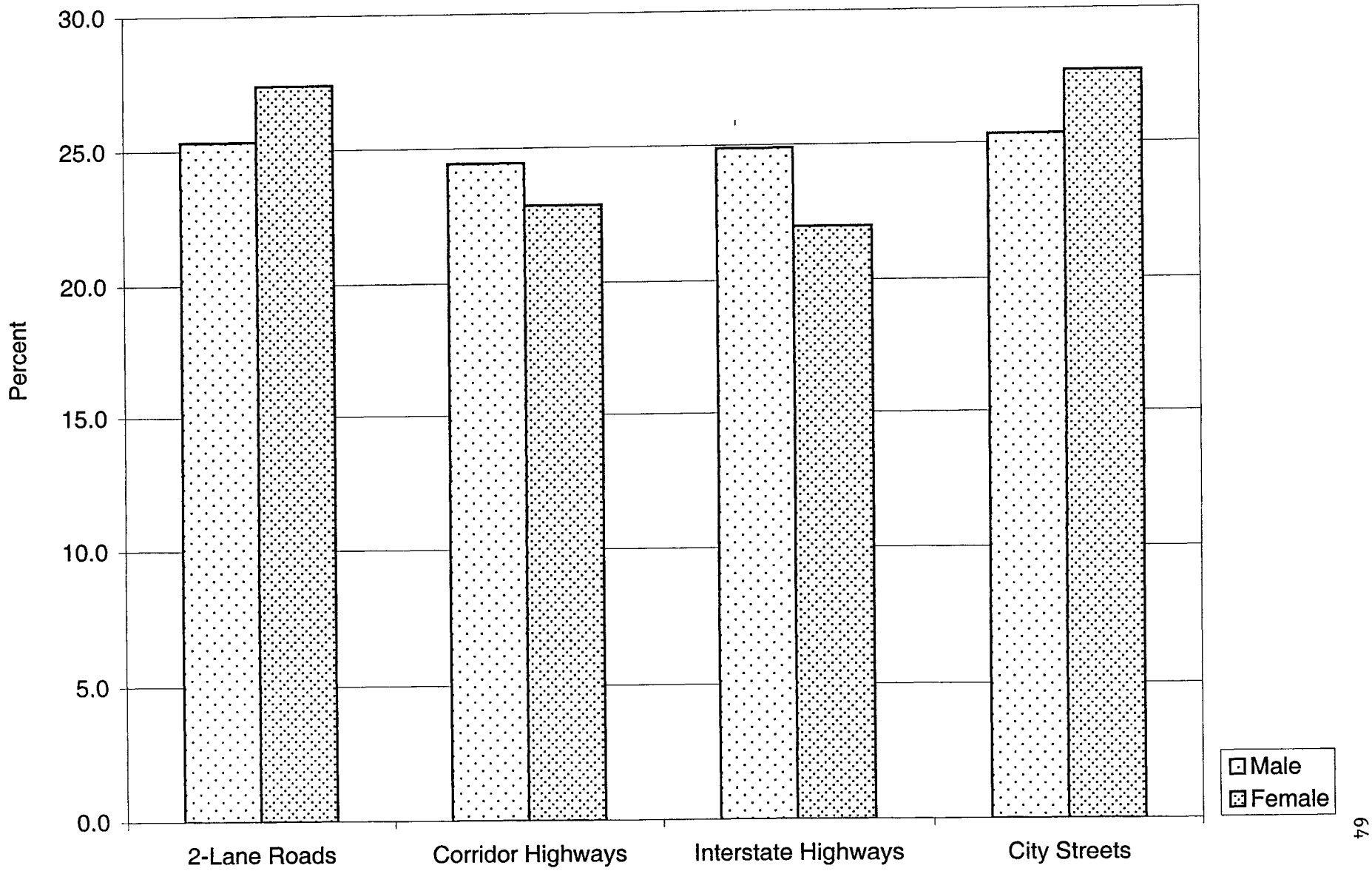

Fig 4.17 Overall Driving Experience, by Gender.

Figure 4.18 depicts the distribution of driving experience on these same types of roadways in the past twelve months. The distribution was very similar to that for overall driving experience.

Participants were asked if they have presently limited their driving and, if so, to indicate the main reason. As shown in Figure 4.19, of the 44 percent of respondents that indicated they limited their driving, over 70 percent of the male respondents noted that they had difficulties driving at night, while only 33.9 percent of the females noted the same difficulty. For males, bad weather and other reasons ranked second and third with about 17 percent and 11 percent, respectively. For females, bad weather or "other" reasons tied for second, each with 23.7 percent. It is interesting to note that no males indicated that they limited their driving due to traffic too fast or intersections confusing.

The participants were also asked about how often they drive on divided highways. Results are presented in Figure 4.20. Over one-quarter of the males drove on corridor highways one or more times per day compared with less than 10 percent of the females. Almost one-half of the male respondents drove on corridor highways several times a week compared to less than 30 percent of the females. Interestingly, almost one-third of the female respondents seldom or never drove on corridor highways.

Participants were asked about how often they drive on divided highways at night. Results are shown in Figure 4.21. The percentage of male drivers indicating seldom or never, which had been just over 5 percent for these highways generally, rose to about 32 percent at night. Whereas about one-half of the males had indicated they used corridor highways several times a week, less than one-third drove several times a week at night.

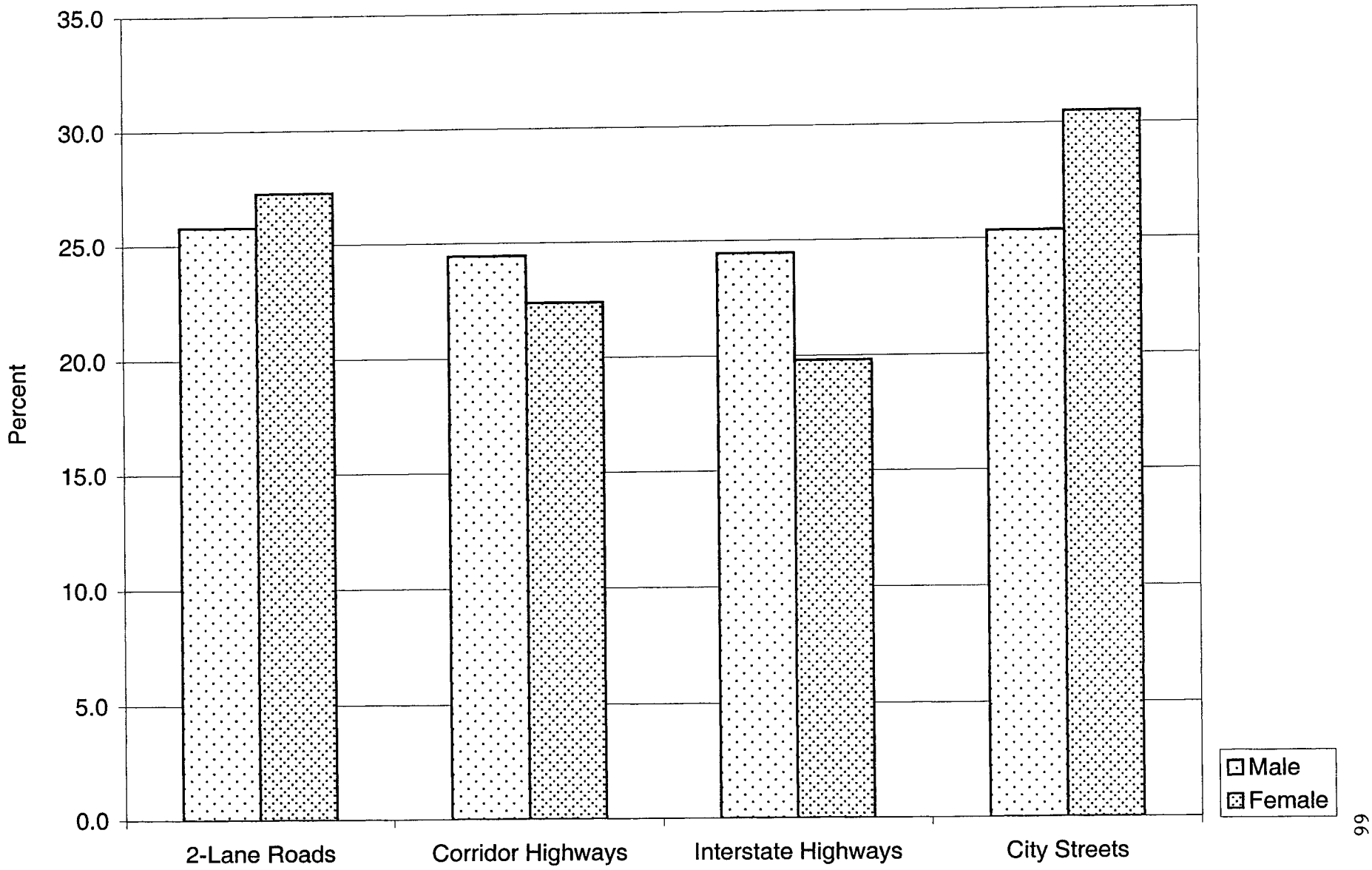

Fig 4.18 Driving Experience in Last Twelve Months, by Gender.

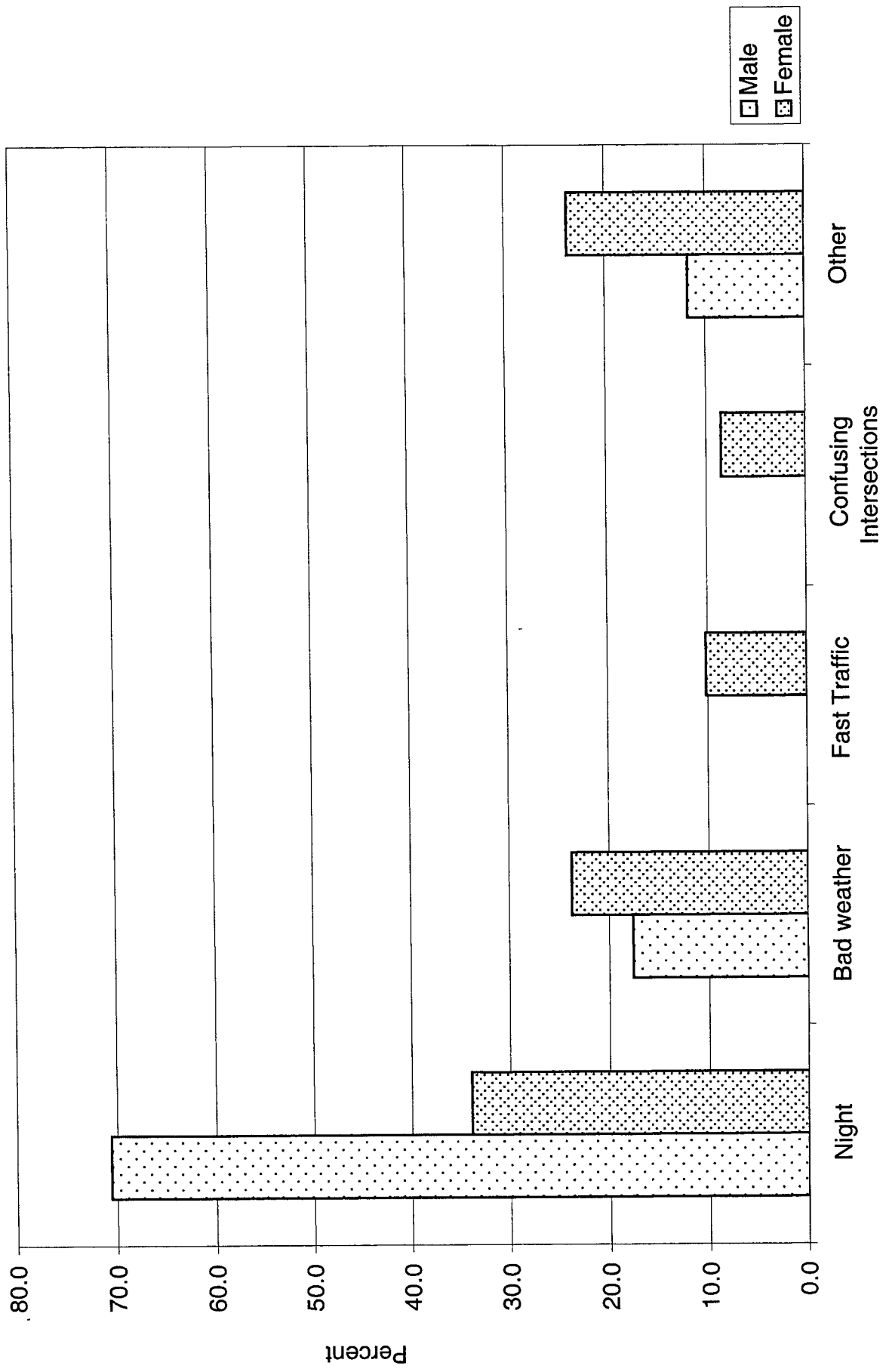

Fig 4.19 Reasons for Currently Self-Limiting Driving, by Gender.

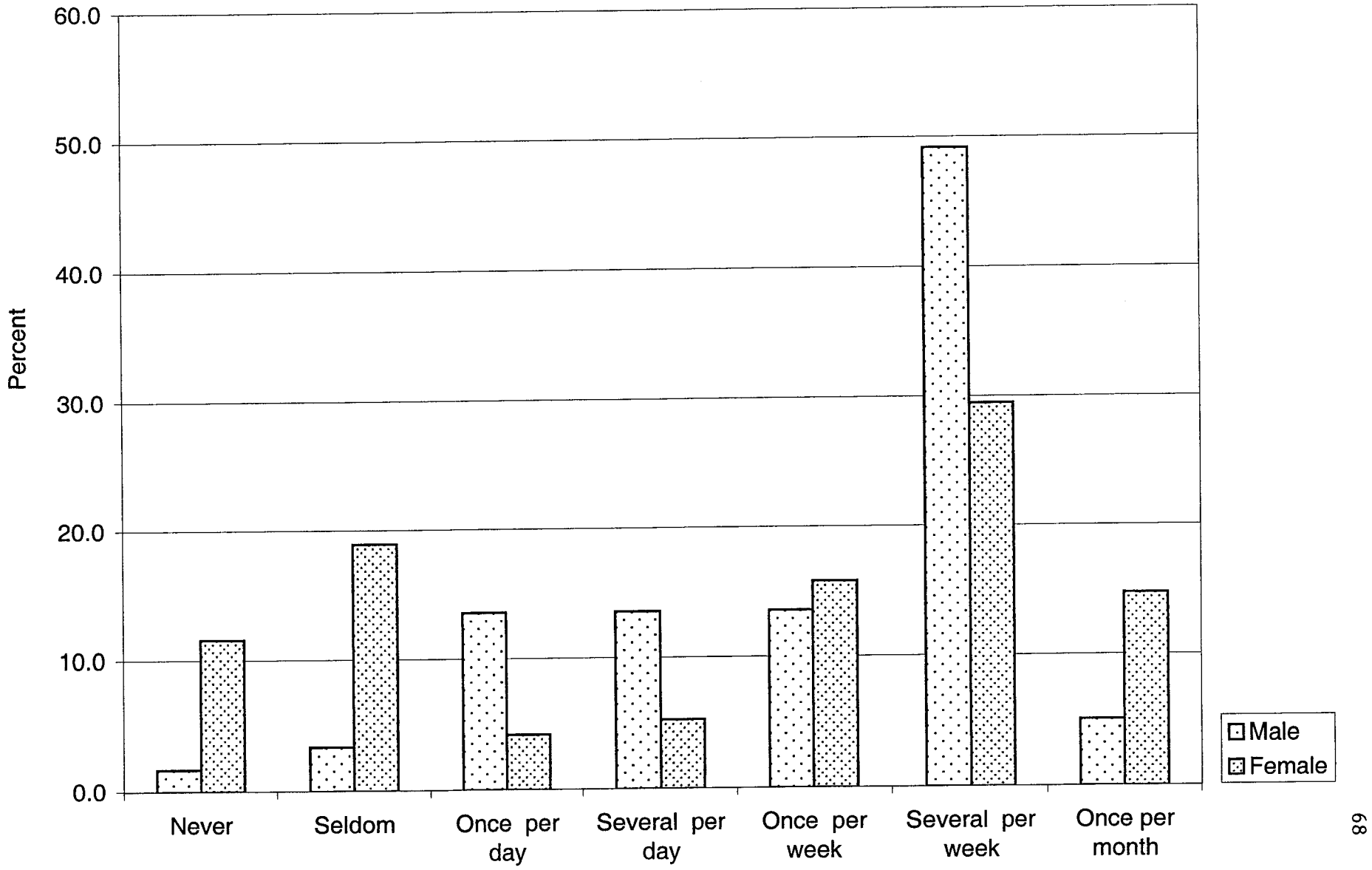

Fig 4.20 Driving Frequency on Divided Highways, by Gender.

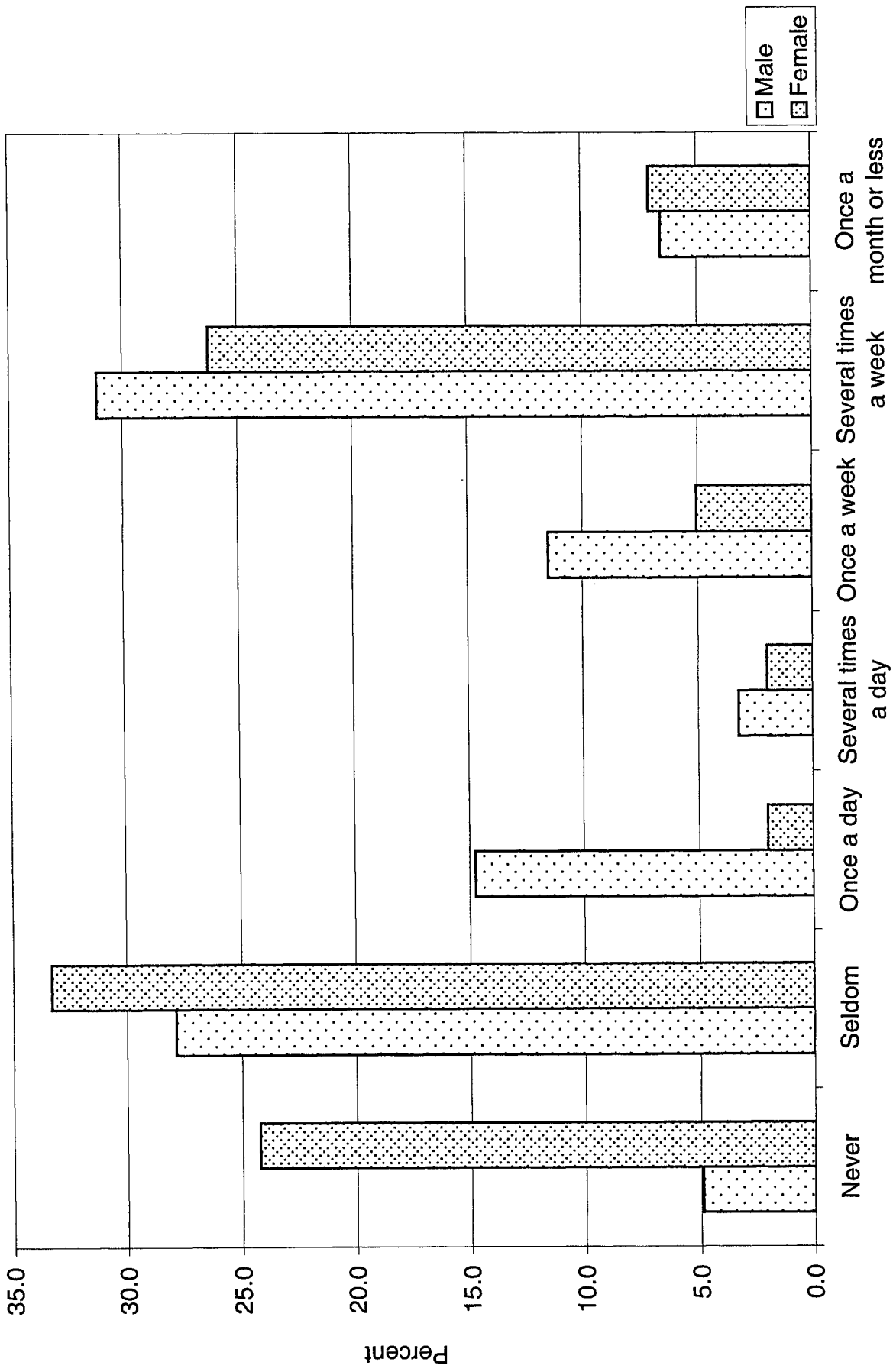

Fig 4.21 Driving Frequency on Divided Highways at Night, by Gender.

The percentage of females who seldom or never drove on divided highways increased from about one-third to one-half for the nighttime condition.

Respondents indicating they seldom or never drove at night were asked why they did not drive at night; results are presented in Figure 4.22. Headlight glare was the primary reason for female drivers, followed closely by personal safety. The most commonly cited reason for male drivers, on the other hand, was personal safety.

Table 4.5 presents the summary of responses by gender to the questions about perceived difficulty of turning maneuvers. Interestingly, females were essentially equally divided in perceiving the crossing maneuver and the left-turn onto the divided highway as most difficult. However, over three-fourths of the males rated the left-turn onto the divided highway as more difficult than the crossing maneuver. For the other two paired comparisons, there were no significant differences between male and female responses.

Table 4.5. Summary of Responses to Paired Comparisons, by Gender.

Question	Comparison	% Responding "More Difficult"	
		Male	Female
17	Crossing Divided Highway	22.4	49.4
	Making Left Turns onto Divided Highway	77.6	50.6
18	Making Left Turns onto Divided Highway	60.0	58.4
	Making Left Turns from Divided Highway	40.0	41.6
19	Crossing Divided Highway	43.4	48.6
	Making Left Turns from Divided Highway	56.6	51.4

Participants were asked to select from a list, the factor presenting the greatest difficulty when making a left turn onto a divided highway. Results are shown in Figure 4.23. Interestingly, more than one-half of the male respondents (54.0 percent) indicated

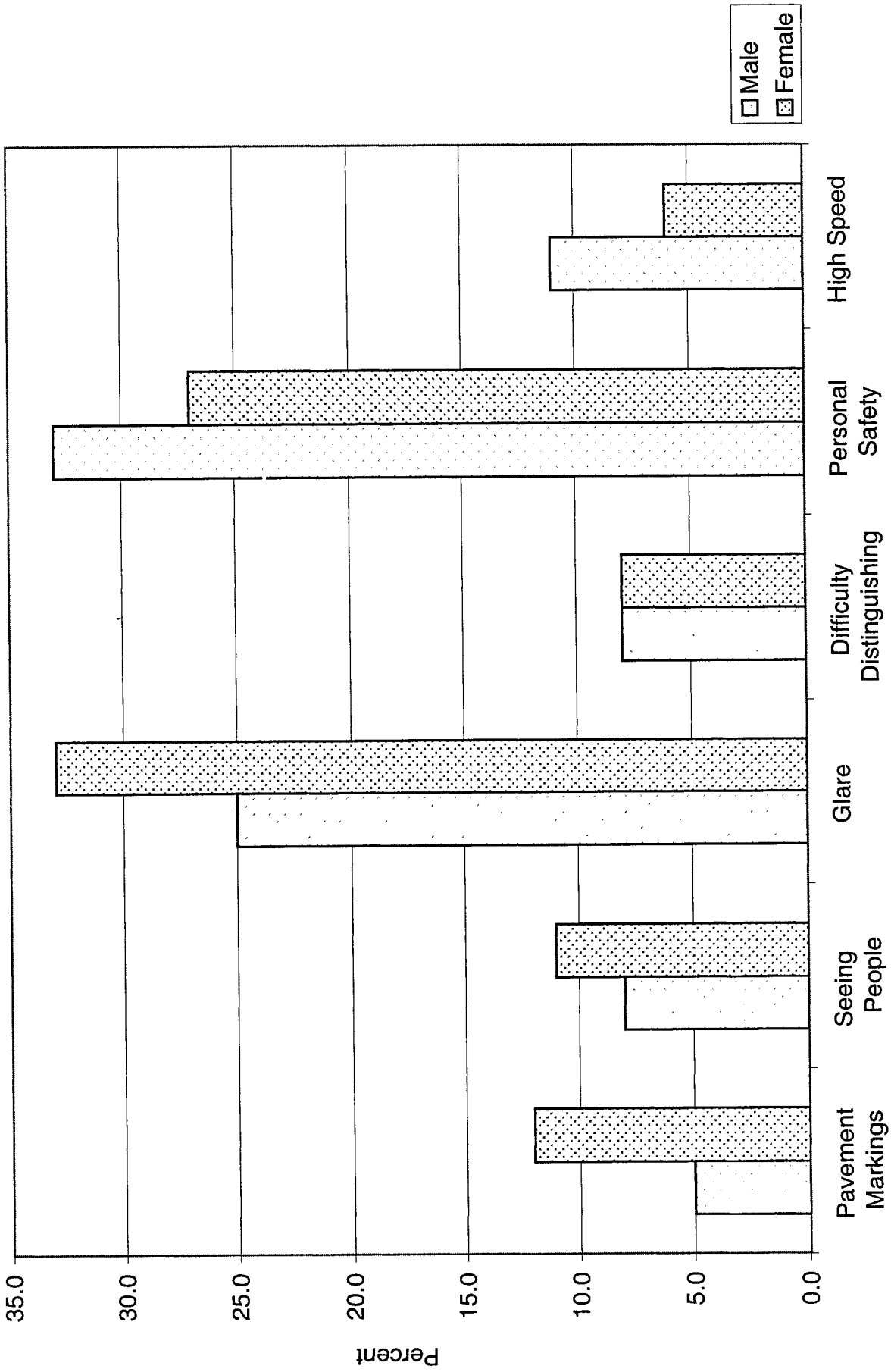

Fig 4.22 Reasons for Not Driving on Corridor Highways at Night, by Gender.

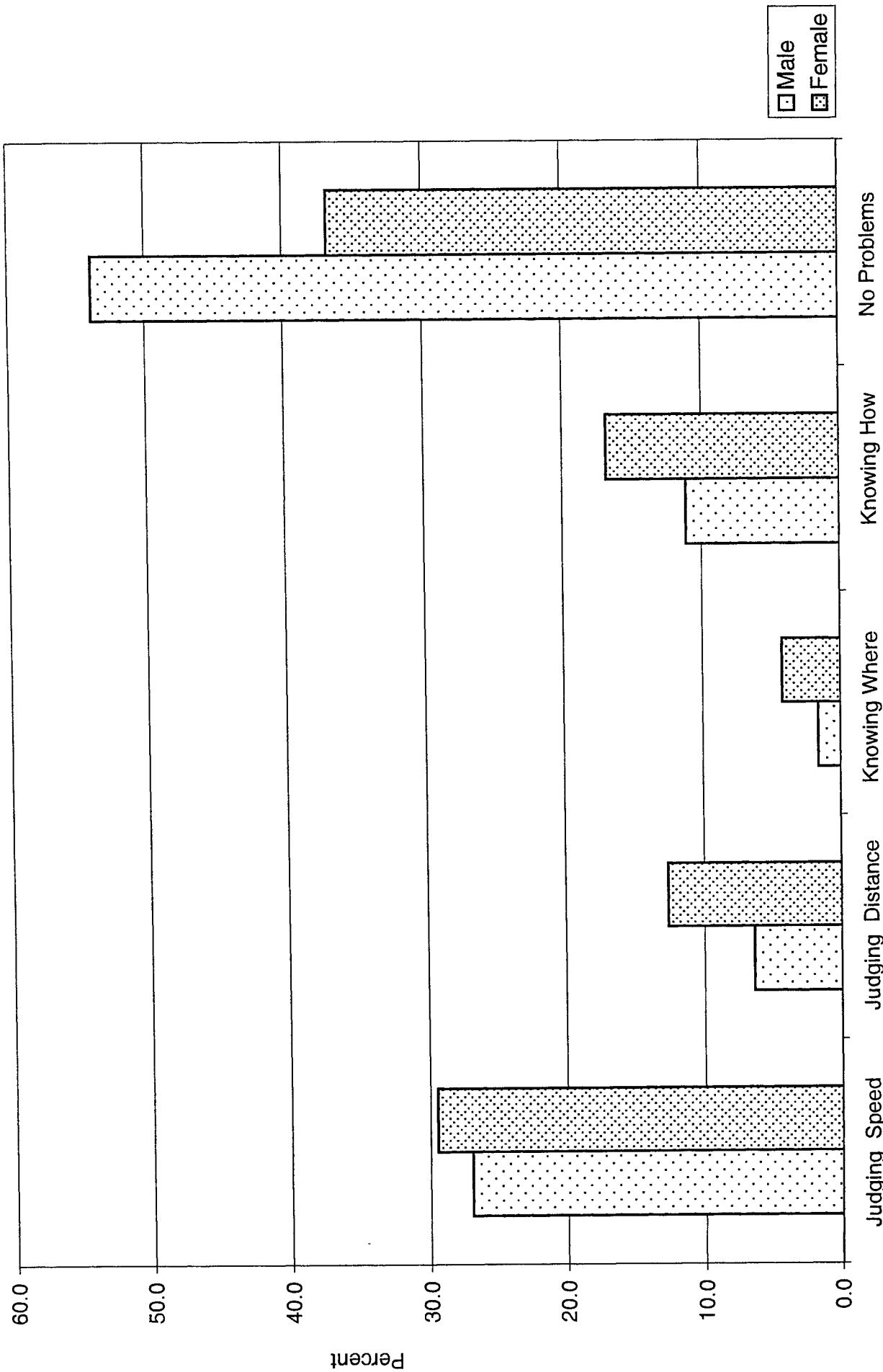

Fig 4.23 Greatest Difficulty in making Left Turn onto a Divided Highway, by Gender.

that they did not have problems at these intersections. However, only 36.8 percent of females did not have problems at these intersections. The relative distributions of difficulties was similar for males and females. For both sexes, the greatest difficulty when making a left turn onto a divided highway was judging the speed of oncoming vehicles followed by knowing how to travel through the middle of the intersection.

There was more variation between the sexes in response to the question about the factor presenting the greatest difficulty in trying to find a side road when traveling on a divided highway. Results are summarized in Figure 4.24. About thirty percent of the male respondents indicated that they did not have problems finding a side road, while only 15.7 percent of females indicated they did not have problems. The most frequently cited difficulty for females was "fast moving traffic on my rear bumper" while the most frequently cited difficulty for males was "road name sign is too small to read." For females, the third most frequently cited difficulty was "side road is difficult to see" while for males it was no right turning lane.

Figure 4.25 shows responses to the question about identifying problems encountered since the speed limit was increased from 55 to 65 mph on corridor highways. The distribution of responses, by gender, is very similar. The major difference was in the "do not have problems" category. Almost 21 percent of the males indicated that they did not have problems whereas less than 12 percent of the females indicated that they did not have problems.

Respondents were asked whether they had ever entered a divided highway going the wrong direction. A higher percentage of male respondents (17.5 percent) than female respondents (10.3 percent) indicated that they had done so.

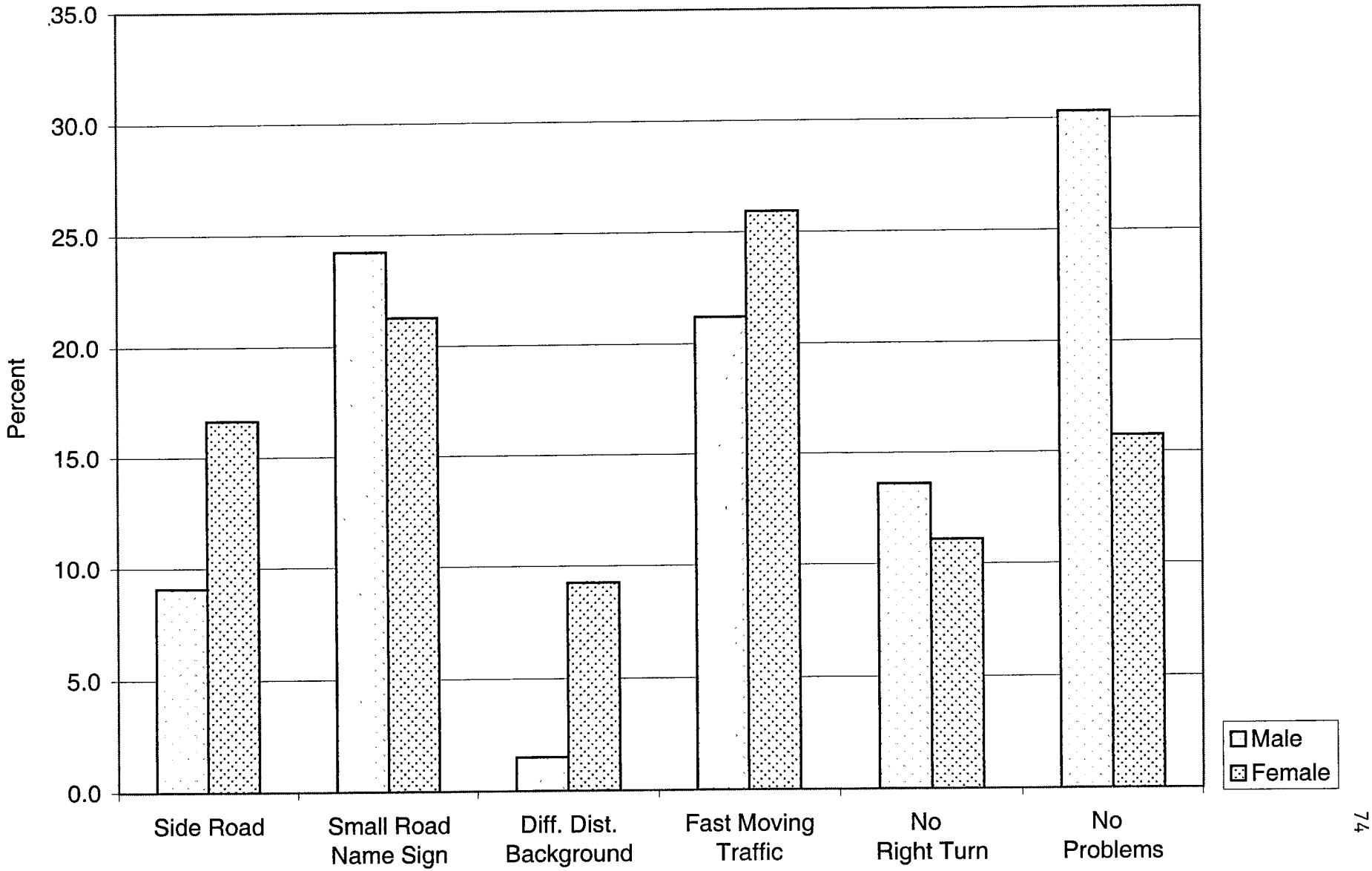

Fig 4.24 Diffculty in Trying to Find Side Road, by Gender.

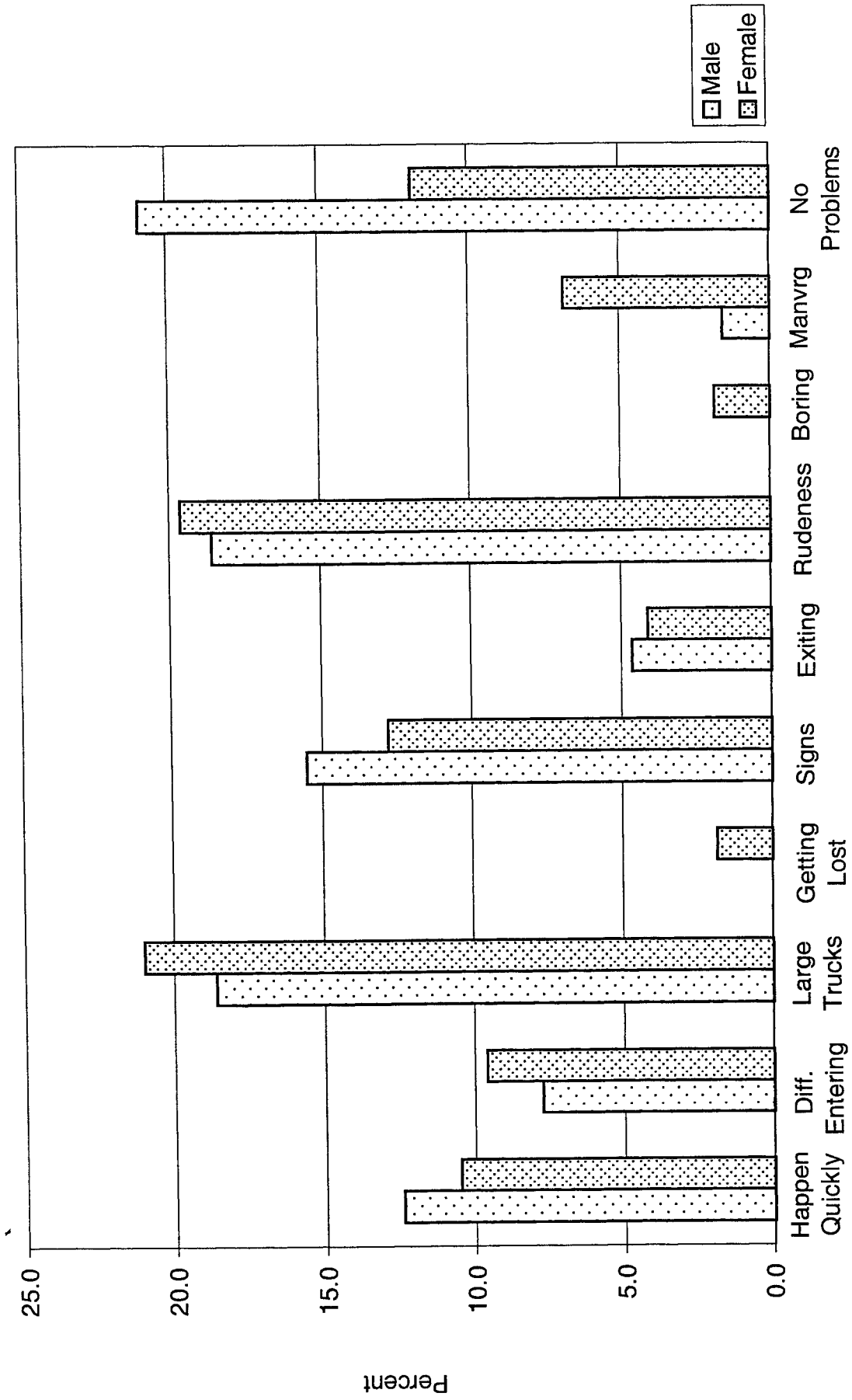

Fig 4.25 Problems Encountered After Speed Limit Increase, by Gender.

As noted in the previous section, in response to the photographic questions about pulling into the intersection, most drivers indicated they would not enter the intersection in either case. Results indicated no real differences between sexes relative to this question.

Figure 4.26 summarizes responses to the question where participants were asked to indicate the location at which they would stop before completing a left turn onto the divided highway. Over one-half of the females indicated that they would stop in the middle of the intersection, while only 43.8 percent of male respondents so indicated. One-fourth of the male respondents indicated that they would stop at location C while the second most frequent response for females was "none of these." Location A was the least cited response for both males and females.

Results by County and Corridor Highway

It was noted in the previous chapter that several counties had a small number of completed surveys. Thus, analysis on a county basis was of limited value. However, certain notable findings relative to demographics and driver behavior are discussed in this section.

As shown in Table 4.6, Wood County had the oldest participants. In contrast, Harrison and Braxton counties had the youngest participants, both with median ages under 70.

Participants in Wood, Ritchie and Nicholas counties had the longest residency times. Lewis County was notable in that its participants were relative newcomers compared to the rest of the counties in that the median residency time was only 10 years. The next shortest residency time was 40 years in Randolph County.

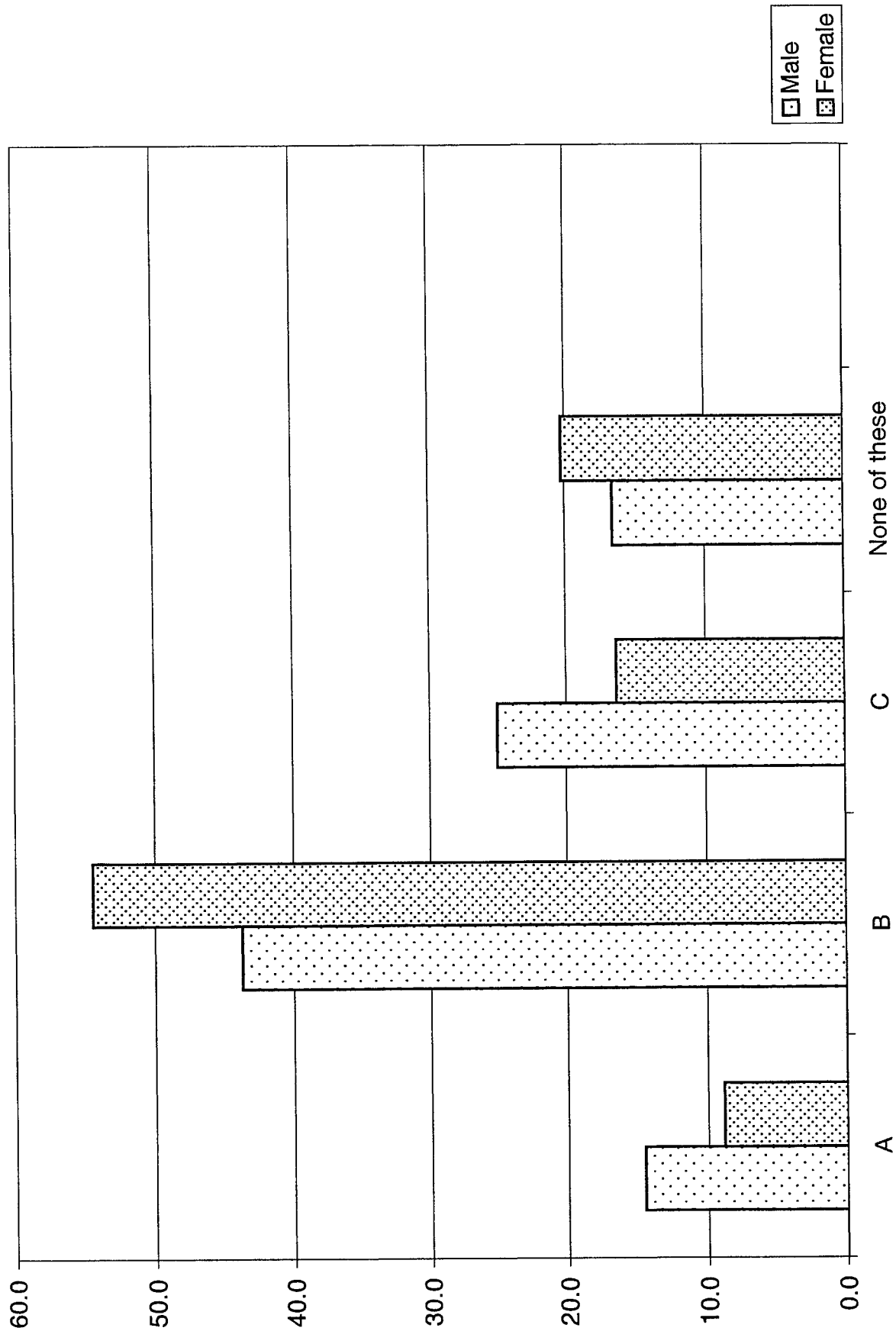

Fig 4.26 Stopping Locations at Median, by Gender.

Table 4.6. Median Age and Residency of Participants, by County.

County	Median Age of Respondent	Median Residency Time
Boone	76	59
Braxton	69	55
Doddridge	71	55
Fayette	74	22
Harrison	65	57
Kanawha	75	60
Lewis	71	10
Logan	75	42
Mercer	75	56
Nicholas	74	62
Raleigh	73	50
Randolph	72	40
Ritchie	76	69
Upshur	76	43
Wood	82	80
Overall	74	55

The education levels of the counties were evaluated by designating the category of highest grade completed with a score of 1 through 4, where 1 is primary through high school and 4 is a college graduate. The statewide weighted average calculated using this method was 2.5. Participants in Mercer County had the highest education level with a weighted average score of 3.4.

When asked about the frequency of driving on a divided highway with four or more lanes, a significant amount of participants (15.4 percent) from Nicholas County indicated that they never drove on these types of roadways compared to the overall average of 7.7 percent. The same was true for Upshur County for the "seldom" category.

The data were also analyzed by corridor highway. This was accomplished by grouping those counties through which a particular highway passed. The corridor highways and the associated counties are shown in Table 4.7. In the discussion which follows, Route 460 has not been included due to its small sample since it includes only one county (Mercer) which had a small sample size.

There was no significant difference in participant age between corridor highways. The median residency time for participants in counties contiguous to Routes 19 and 33 was noticeably shorter than the median residency time for Routes 50 and 119. Route 33 participants tended to drive less than the overall sample, particularly at night.

Some differences between corridors were noted for the paired comparison questions. For Question 17, participants in the Routes 19, 33 and 119 areas indicated that making a left turn onto a divided highway was more difficult than crossing a divided highway. However, for Route 50 respondents, these movements were perceived as similar in difficulty.

Table 4.7. Corridor Highways and Associated Counties.

Corridor Highway	County
Route 19	
	Braxton
	Fayette
	Nicholas
	Raleigh
Route 33	
	Lewis
	Randolph
	Upshur
Route 50	
	Doddridge
	Harrison
	Ritchie
	Wood
Route 119	
	Boone
	Kanawha
	Logan
	Mingo
Route 460	
	Mercer

Similarly, for Question 18, over three-quarters of Route 50 respondents indicated that making a left turn onto a divided highway was more difficult than making a left turn from a divided highway. Results for the other corridor highways showed more of a 50-50 split.

For Question 19, over one-half of Route 50 respondents indicated that crossing a divided highway was more difficult than making a left turn from a divided highway. For Route 119, respondents were equally divided on the question. However, for Routes 19 and 33, around two-thirds of respondents perceived making the left turn from a divided highway as more difficult.

The reasons for these differences are not immediately apparent. However, it should be noted that Route 50 is the oldest of the corridor highways studied; it has been open to traffic for at least 25 years. The other corridors were built more recently. Also note that respondents from this area had resided in their counties for longer than the overall sample.

CHAPTER 5

ENGINEERING AND EDUCATION IMPLICATIONS

Introduction

The preceding chapter discussed the results of the analysis of survey responses. The data provide a better understanding of the demographic and driving characteristics of West Virginia's older drivers who live near Appalachian corridor highways. While, for the most part, older drivers are able to negotiate these intersections safely, several problem areas and driver behavior issues were identified. Some of these are beyond the purview of engineers and safety educators. For example, large trucks and rudeness or dangerous actions of other drivers were the most commonly cited "dislikes" about corridor highways. However, there are few, if any, viable actions that engineers or educators can take to address these perceived problems. Other concerns raised are more amenable to engineering or education countermeasures. This section identifies some of the engineering and education implications arising from the survey results.

Engineering Implications

About one-half of the older driver respondents indicated that they had problems making turning or crossing maneuvers at the unsignalized at-grade intersections on corridor highways. Responses to other questions revealed a lack of understanding about how to travel through the middle of the intersection. The relatively high percentage (about 13 percent) of respondents who had gone the wrong way on a divided highway also suggests a problem since it is assumed that the entry in the wrong direction had to be made at an at-grade intersection.

One way to address the issue is through traffic engineering techniques. Enhanced delineation in the form of additional channelization (e.g., pavement markings and delineators) and/or additional indications of the directionality of a roadway (e.g., signs and painted arrows) or lanes of the roadway appear to be indicated based on the survey.

Survey results indicated that the third most frequent "dislike" of older drivers about corridor highways was signs that are difficult to see or confusing. The researchers do not know how to interpret these findings. The informational and guide signing on corridor highways is purposely more similar to that found on the Interstate System as opposed to the local street system. Thus, advance placement of the sign and letter height of the message are appropriate for the high speeds found on corridor highways, although certainly the same cannot always be said for street name signs on urban roadways. Since survey respondents suggest that the side road signing is generally adequate, attention to delineation of the intersection and to the side road in the immediate vicinity of the intersection, as discussed above, may help address this perceived problem.

The researchers are not suggesting that every unsignalized intersection on corridor highways receive such enhancements. Rather, review of accident records at high accident intersections should be made to determine if older drivers are actually over-represented in such accidents. If so, then some of the delineation and channelization improvements described herein should be considered.

Education Implications

Driver education material is another way to address the issue of lack of understanding about how to travel through the intersection. Review of the American Association of Retired Persons (AARP) "55 Alive Mature Driving" course workbook

(1994) indicates that while the workbook provides instructions on making left turns at intersections, the discussion is for the city street situation. The workbook also discusses using a series of right turns to avoid making a left turn at an intersection. Again, while this may be viable on urban streets, it is not a practical technique for older drivers on corridor highways. The topic of intersections with medians and how drivers should deal with them are not addressed in the AARP workbook. Thus, it is recommended that driver educational materials be developed, targeted for older drivers, which describes how to safely negotiate at-grade intersections on divided highways with medians. This material could be included in the AARP 55 Alive Mature Driving workbook and course materials. In addition, the material could be readily distributed as a handout or brochure at senior centers, AARP meetings, fairs and festivals, and similar venues. The information sheet could also be inserted in envelopes containing driver licensing or motor vehicle registration materials.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS AND IMPLEMENTATION

Introduction

The research described in this report represents a survey of older drivers living in the vicinity of West Virginia corridor highways to assess their driving behavior at unsignalized at-grade intersections on such roadways. Previous research has shown that generally older drivers demonstrate an increased accident involvement at at-grade intersections. However, there is no information available on older driver experiences or perceptions at the unsignalized at-grade intersections found on these divided high-speed highways. An assessment of driver understanding of these intersections was the primary objective of this study.

Several conclusions have been drawn and recommendations made as a result of the research effort. Conclusions are presented first, followed by recommendations and implementation of research results.

Conclusions

Respondents had lived in their counties for a considerable length of time and had been driving most of that time. Since the corridor system in West Virginia began to develop much more recently, clearly respondents had been driving for several decades before the construction of corridor highways.

Based on the demographic characteristics of the sample, it is believed that the gender and age distribution of participants are representative of the older driver population in West Virginia. However, due to the nature of the study (using a printed survey

distributed at senior centers), the sample is biased toward the healthier, better educated and more physically active and socially interactive seniors.

Only about five percent of respondents did not currently drive, even though all held valid licenses. No one indicated that they stopped driving due to recommendations or restrictions of a family member, physician, or government agency.

Consistent with national data, West Virginia older drivers tend to make frequent short trips. However, a significant proportion of the West Virginia sample drove more than 12,000 miles per year. Such annual travel tends to imply regular commuting and/or longer trips such as would be associated with vacations/touring. Males drove more frequently and more miles than females.

A significant percentage of older drivers in West Virginia self-limit their driving due to difficulties driving at night and bad weather. Fast traffic or confusing intersections were not a major concern to West Virginia older drivers.

Participants drove regularly on all functional classes of roads. Their current driving, in terms of types of roads used, did not differ from their overall driving history.

Two-thirds of the respondents drove on corridor highways at least once a week. Only 20 percent seldom or never used such highways, primarily because they did not need to. However, almost one-half of the respondents seldom or never drove on divided highways at night. Headlight glare and concern for personal safety were the primary reasons.

Almost one-half of the participants indicated that they did not have problems making turning or crossing movements at the unsignalized at-grade intersections on corridor highways. Making left turns onto the divided highway is perceived as the more

difficult turning movement. Crossing the divided highway was perceived as less difficult than making left turns. Route 50 respondents differed from the other corridors relative to the perceived difficulty of turning/crossing maneuvers.

Over one-fourth of respondents indicated that their greatest difficulty in making a left-turn onto a divided highway was judging the speed of oncoming vehicles. A significant number (15 percent) stated that their greatest difficulty was knowing how to travel through the middle of the intersection. Results of a pictorial question about how to travel through a hypothetical intersection confirmed this confusion.

Over 20 percent of respondents did not have problems finding the proper side road on a corridor highway. Difficulties noted included (in order) fast-moving traffic on my bumper and road name sign is too small to read.

Large trucks and rudeness or dangerous actions of other drivers were the most commonly cited "dislikes" about corridor highways. There are really no viable highway agency actions that can be taken to address these concerns. However, it should be noted that also ranking high was "signs that are difficult to see or confusing." These same three factors were noted in terms of problems encountered since the speed limit was increased to 65 miles per hour on corridor highways.

Surprisingly, 13.2 percent of respondents had entered a divided highway going in the wrong direction. This proportion seems high to the researchers and suggests that increased attention be paid to the channelization of the at-grade intersections themselves so that the directionality of roadways and lanes is clear.

Results for the photographic questions about pulling out from a side road across the divided highway given different views of oncoming traffic were felt not to be

representative of research findings in the literature or of older driver accident experience. This was attributed to the static nature of the photographs and to the amount of time available for participants to consider the situation.

Recommendations

About one-half of the respondents indicated that they had problems making turning or crossing maneuvers at the unsignalized at-grade intersections on corridor highways. Responses to other questions revealed a lack of understanding about how to travel through the middle of the intersection. The relatively high percentage of respondents who had gone the wrong way on a divided highway also suggests a problem since it is assumed that the entry in the wrong direction had to be made at an at-grade intersection.

Driver education materials is one way to address the issue of lack of understanding about how to travel through the intersection. Review of the workbook for the American Association of Retired Persons (AARP) "55 Alive Mature Driving" course workbook (1994) indicates that while the workbook provides instructions on making left turns at intersections, the discussion is for the city street situation. The workbook also discusses using a series of right turns to avoid making a left turn at an intersection. Again, while this may be viable for urban streets, it is not a practical technique for older drivers on corridor highways. Intersections with medians and how drivers should deal with them are not addressed in the workbook. Thus, it is recommended that driver educational material be developed, targeted for older drivers, which describes how to safely negotiate at-grade intersections on divided highways.

Another way to address the issue is through traffic engineering techniques. Enhanced delineation in the form of additional channelization and/or additional indications

of the directionality of a roadway or lanes of the roadway appear to be indicated based on the survey.

Survey results indicated that the third ranking dislike of older drivers about corridor highways was signs that are difficult to see or confusing. The researchers do not know how to interpret these findings. The informational and guide signing on corridor highways is more like that found on the Interstate System as opposed to the local street system. Thus, advance placement of the sign and letter height of the message are appropriate for the high speeds found on corridor highways, although certainly the same cannot always be said for street name signs on city streets. Since the side road signing is generally adequate, attention to delineation of the intersection and of the side road in the immediate vicinity of the intersection, as discussed above, may help address this perceived problem.

Responses to the static photograph questions were not as useful as originally anticipated. This is attributed to the static nature of the photographs. Both the literature and the survey results show that older driver judgment of speeds and distances is critical to the safe negotiation of at-grade intersections. Thus, it is recommended that experiments which include time, speed and distances be conducted to develop additional knowledge about older driver behavior at at-grade intersections on corridor highways. Laboratory experiments could be devised to study the effects of speed, vehicle type/size, and the phenomenon of looming.

Implementation

The results of this research are readily implementable. Work can begin immediately to develop a one or two page set of instructions on how to safely traverse an at-grade intersection on a divided highway. This material could be included in the AARP 55 Alive Mature Driving workbook and course materials. In addition, the material could be readily distributed as a handout or brochure at senior centers, AARP meetings, fairs and festivals, and similar venues. The information sheet could also be inserted in envelopes containing driver licensing or motor vehicle registration materials or simply available as a handout at the same stations.

Similarly, the traffic engineering improvements suggested are also immediately implementable. The researchers are not suggesting that every unsignalized intersection on corridor highways receive such enhancements. Rather, review of accident records at high accident intersections should be made to determine if older drivers are over-represented in such accidents at these at-grade unsignalized intersections. If so, then some of the delineation and channelization improvements described herein should be considered for the problem locations.

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APPENDIX A

PILOT FEEDBACK FORM

Pilot Feedback Form

- Did you have any difficulty understanding the *directions*?

  _____Yes
  _____No

- Did you have difficulty reading the *print*? (size, style)

  _____Yes
  _____No

- Were there *terms* used that were unfamiliar or confusing?

  _____Yes
  _____No

- Were there *questions* that you did not understand?

  _____Yes
  _____No

- Did you have difficulty understanding the *black and white photographs*?

  _____Yes
  _____No

- Did you have difficulty understanding the *diagrams*?

  _____Yes
  _____No

APPENDIX B

SURVEY INSTRUMENT

College of Engineering and Mineral Resources
West Virginia University
Department of Civil and Environmental Engineering

This survey is being distributed by the College of Engineering and Mineral Resources at West Virginia University as part of a research project to help engineers understand how people drive on divided highways. The information from this survey will be used to design better highways, improve signing, and to develop educational materials.

Your responses will be kept confidential. You do not have to answer all questions. Completion of this survey is voluntary. You will not be affected in any way if you refuse to complete the survey or if you complete only a partial survey.

This survey will take approximately 20 minutes to complete. Please fill in the blanks or mark answers as stated for each question. If you have any questions, just ask the survey helper. You may stop answering this survey at any time by simply returning the forms. Thank you for your time and cooperation.

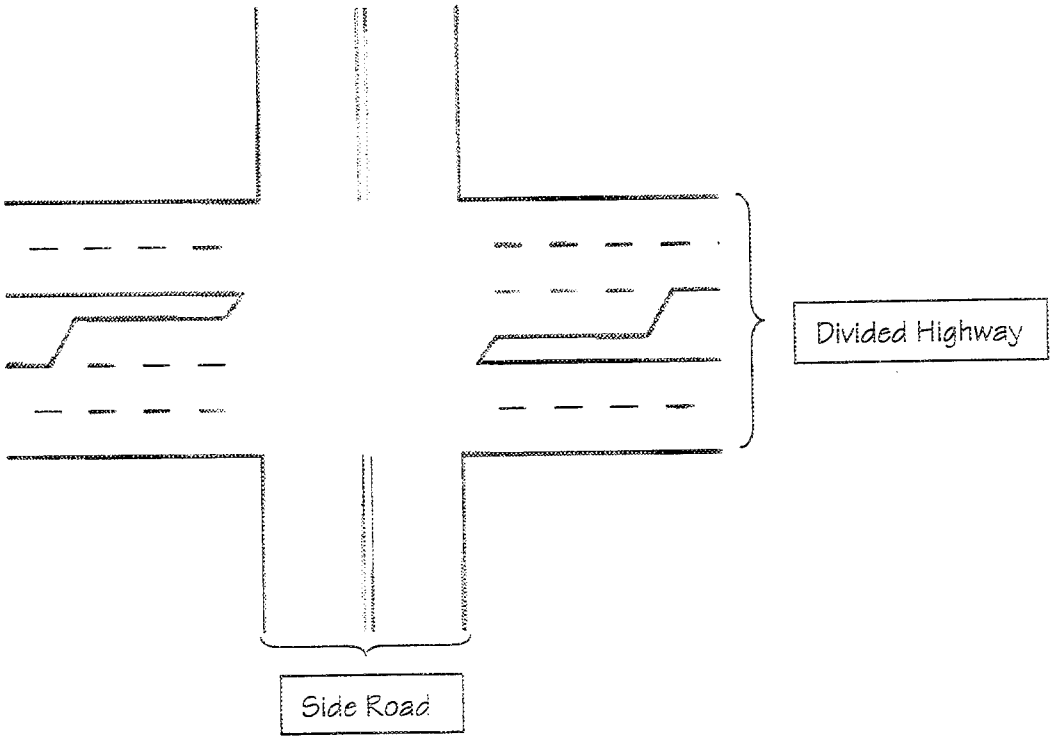
WEST VIRGINIA UNIVERSITY
Institution Review Board for the
Protection of Human Research Subjects

FEB 1 0 2000

APPROVED
X _____
EXPIRES 2-10-01
H.S. # 4123

Ronald W. Eck, P.E.
Professor of Civil Engineering
West Virginia University
P.O. Box 6103
Morgantown, WV 26506-6103
Phone: (304) 293-3031 ext. 2627

Note: Divided highways in this survey refer to Corridor Highways, that is, highways with four or more lanes, such as; Route 19, Route 50, Corridor G (Route 119), and Corridor H (Route 33). These are modern highways that have intersections with traffic lights or with STOP signs on the side roads. The photograph below shows a divided highway; the drawing shows an intersection of a divided highway and a side road.



1. How many years have you have lived in your county? _____Years

2. Age: _____

3. Sex:

   _____Male
   _____Female

4. Do you currently drive a vehicle?

   _____Yes, skip to question 6
   _____No, go to question 5

5. What motivated you to stop driving (check only one response)? After answering this question, return your survey to the helper. Thank you for your participation in our survey.

   _____Spouse or children suggested stop driving
   _____Physician suggested stop driving
   _____Restricted by government agency
   _____Intersections confusing
   _____Physical difficulties (i.e. turning your head, getting in and out of the vehicle, etc)
   _____Traffic too fast
   _____Other, explain_____
   _____
   _____

6. What is the highest grade in school you have completed (check only one response)?

   _____Primary through high school
   _____High school graduate
   _____Some college
   _____College graduate

7. How many years have you been driving? _____Years

8. How often do you drive (check only one response)?

_____Once a month or less
_____Less than once a week
_____1 - 2 times a week
_____3 - 4 times a week
_____5 or more times a week

9. Approximately how many miles have you driven in the last 12 months (check only one response)?

_____0 - 1,000 miles
_____1,001 - 5,000 miles
_____5,001 - 12,000 miles
_____ More than 12,000 miles

10. In your driving experience, have you driven at least once a week on the following roads (check all that apply)?

_____Two-lane rural roads
_____Rural four-lane divided (corridor) highways
_____Interstate highways
_____City streets

11. In the last twelve months, have you driven at least once a week on the following roads (check all that apply)?

_____Two-lane rural roads
_____Rural four-lane divided (corridor) highways
_____Interstate highways
_____City streets

12. If you have limited your driving presently, what is the *main reason* you did so (check only one response)? If not, skip to question 13.

_____Difficulties driving at night
_____Bad weather
_____Traffic too fast
_____Intersections confusing
_____Other, explain_____
_____
_____

13. How often do you drive on divided highways with four or more lanes (check only one response)?

_____Never
_____Seldom
_____Once a day
_____Several times a day
_____Once a week
_____Several times a week
_____Once a month or less

14. If you checked seldom or never in question 13, why do you not drive or have limited driving on these types of roadways (check only one response)?

_____I did not check seldom or never in question 13
_____Do not *need* to use this type of roadway
_____Do not *want* to use this type of roadway

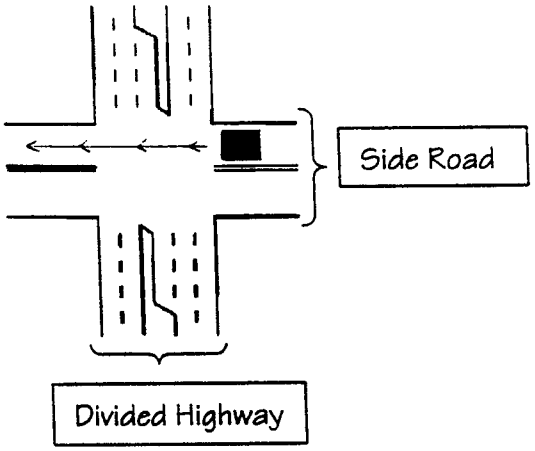
15. How often do you drive at night on divided highways with four or more lanes (check only one response)?

_____Never
_____Seldom
_____Once a day
_____Several times a day
_____Once a week
_____Several times a week
_____Once a month or less

16. If you checked seldom or never in question 15, why do you not drive or have limited driving on these types of roadways at night (check all that apply)?

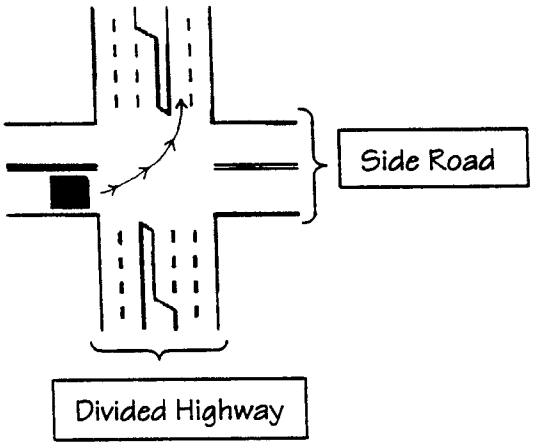
_____I did not check seldom or never in question 15
_____Difficulty seeing pavement markings
_____Difficulty seeing people or animals in roadway
_____Headlight glare
_____Difficulty distinguishing signs and/or cars from background scenes
_____Personal safety
_____Speed too fast

17. Which of the two situations below is *more difficult* for you at an intersection that does *not* have a traffic light (check only one response)?



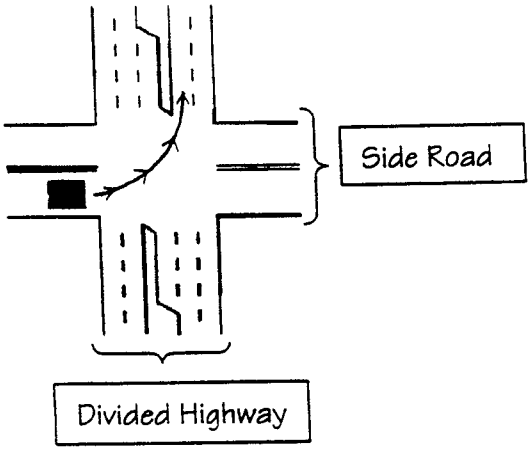
_____Crossing a divided highway

(OR)



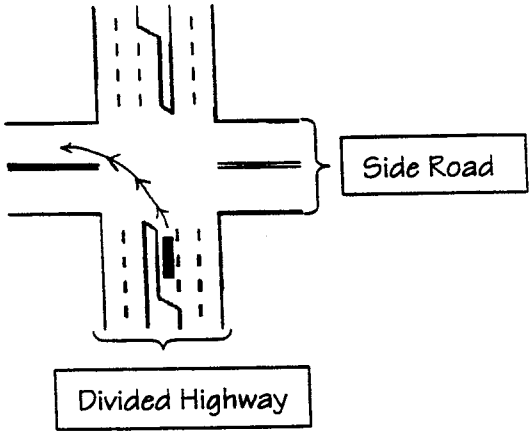
_____Making a left turn onto the divided highway

18. Which of the two situations below is *more difficult* for you at an intersection that does *not* have a traffic light (check only one response)?



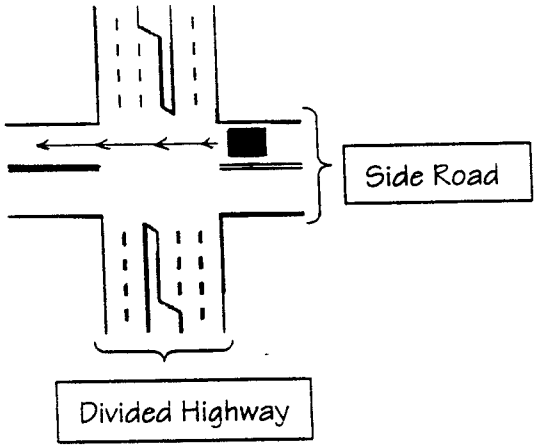
_____Making a left turn onto the divided highway

(OR)



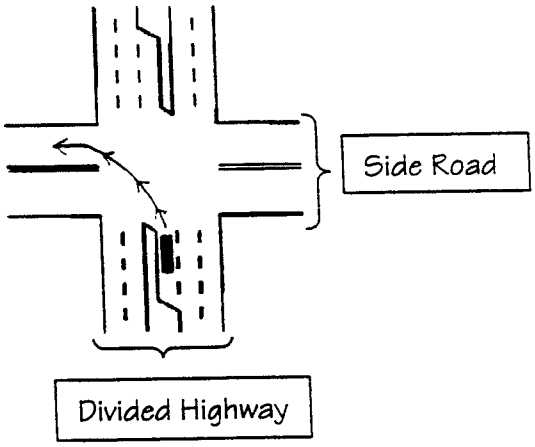
_____Making a left turn from the divided highway to a side road

19. Which of the two situations is *more difficult* for you at an intersection that does *not* have a traffic light (check only one response)?



_____Crossing a divided highway

(OR)



_____Making a left turn from the divided highway to a side road

20. What presents the *greatest* difficulty for you when making a left turn onto a divided highway that does *not* have a traffic light (check only one response)?

_____Judging the speed of oncoming vehicles
_____Judging the distance to oncoming vehicles
_____Knowing where to stop before entering the divided highway
_____Knowing how to travel through the middle of the intersection
_____Do not have problems at these intersections

21. What presents the *greatest* difficulty for you in trying to find a side road when traveling on a divided highway (check only one response)?

_____Side road is difficult to see due to guardrails, signs, etc.
_____Road name sign is too small to read
_____Difficult to separate from background (stores, signs, lights, etc.)
_____Fast moving traffic on my rear bumper
_____There is no right turning lane provided
_____Do not have problems finding proper side road

22. Indicate the *five factors* which you dislike the most about sections of divided highways that do not have traffic lights (check only *five* responses).

_____Things happen too quickly
_____Difficulty entering divided highway
_____Large trucks
_____Getting lost
_____Signs that are difficult to see or confusing
_____Difficulty exiting divided highway
_____Rudeness or dangerous actions of other drivers
_____Boring view, nothing to look at
_____Difficulty maneuvering in traffic

23. What problems have you encountered since the speed limit was increased from 55 mph to 65 mph on corridor highways (check *all* that apply)?

_____Things happen too quickly
_____Difficulty entering divided highway
_____Large trucks
_____Getting lost
_____Signs that are difficult to see or confusing
_____Difficulty exiting divided highway
_____Rudeness or dangerous actions of other drivers
_____Boring view, nothing to look at
_____Difficulty maneuvering in traffic
_____Do not have problems

24. Have you ever entered a divided highway going the wrong direction (check only one response)?

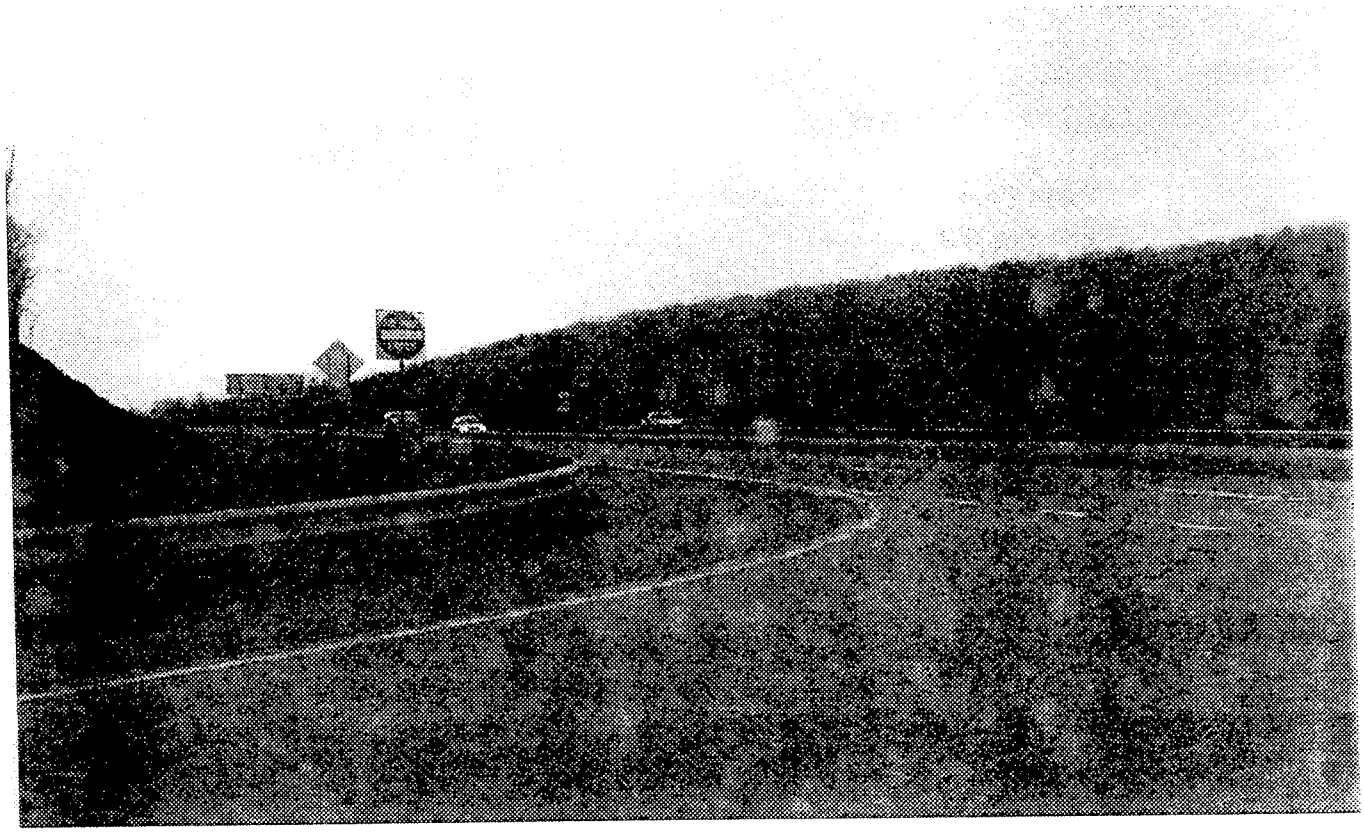
_____Yes
_____No

25. Have you had an accident on a divided highway within the last 10 years (check only one response)?

_____Yes
_____No

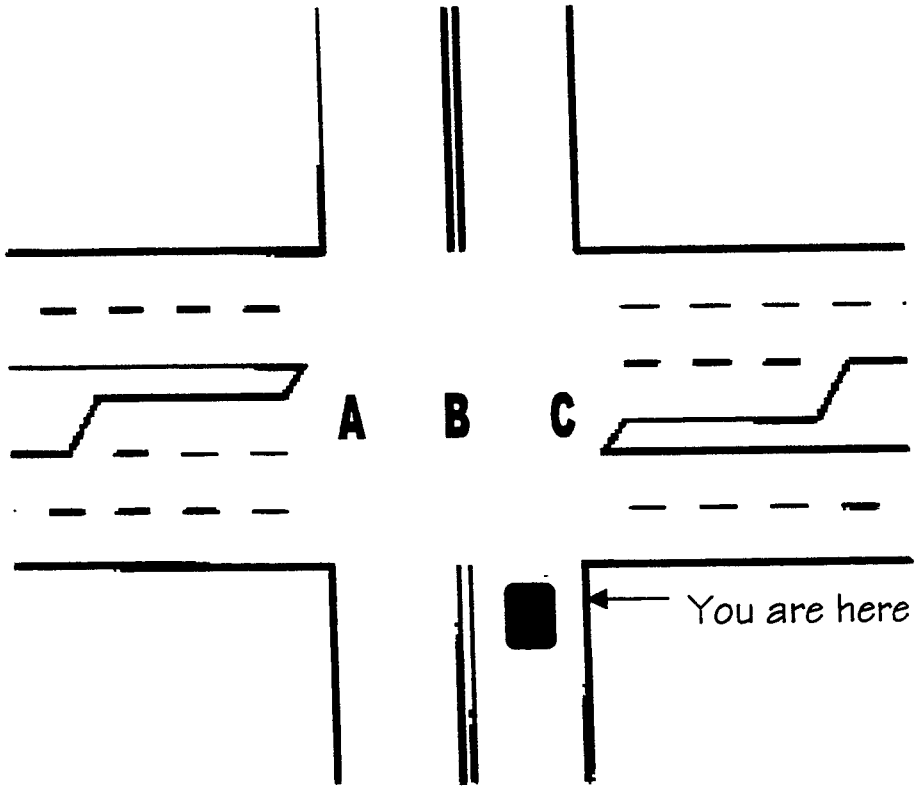
26. You are waiting to cross the divided highway. No traffic is approaching from the right, so you look to your left. Assuming the vehicle to the left is traveling at 65 miles per hour, would you pull out to cross the roadway (check only one response)?

_____Yes
_____No
_____Can't tell from the photo



27. You are waiting to cross the divided highway. There is no traffic approaching from the right, so you look to your left. Assuming the vehicles to your left are traveling at 65 miles per hour, would you pull out to cross the roadway under the conditions shown (check only one response)?

_____Yes
_____No
_____Can't tell from the photo



28. If you were going to stop in the middle of the intersection before completing a left turn onto the divided highway, where would you stop your car (check only one response)?

_____A
_____B
_____C
_____None of these locations