ROAD USER INTERACTIONS:

PATTERNS OF ROAD USE AND PERCEPTIONS OF DRIVING RISK

Samuel G. Charlton, Ph.D.
Jean E. Newman, Ph.D.

Transport Engineering Research New Zealand Ltd.
and University of Waikato

Rebecca E. Luther
Brett D. Alley
and
Peter H. Baas
Transport Engineering Research New Zealand Ltd.

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TERNZ Ltd
PO Box 97846
South Auckland Mail Centre
New Zealand
www.ternz.co.nz

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EXECUTIVE SUMMARY

The goal of the Road User Interactions research programme is a better understanding of the human factors of our road transport system: road user demographics, risk perceptions of road users, and the driving attitudes and reactions of various road user groups.

Our analysis of the 1989 and 1999 New Zealand Household Travel Surveys distinguished several fundamental road user differences and identified consistent demographic trends over the past 10 years. The driver characteristics of gender, age, and area of residence (urban, secondary urban, and rural) are the demographic factors which most clearly differentiate distinct New Zealand road user groups in terms of their amount of driving. Men drive nearly twice as far as women, but women make an equivalent number of trips per day. Men are more likely than other drivers to be driving early in the morning and late at night, whereas women's travel peaks are later in the morning and earlier in the afternoon. Work-related driving forms the largest component of daily trips, followed by social/recreational, shopping, and transportation of passengers. Women take many more trips in these last two categories and their length indicate that women's trips are more often associated with urban and suburban trips close to home than men's trips.

Young drivers (aged 15 to 19) show less of a gender differentiation in their driving. Over the past 10 years, the amount of driving by young women has increased significantly, and now exceeds the driving by young men. Young drivers' trips are most often associated with work and social activities and are typically later in the day and night than other road users.

The amount of driving decreases substantially after the age of 65, and older drivers tend to distribute their driving so that it occurs in off-peak daytime hours, late morning and early afternoon. Older drivers' trips are predominantly social/recreational and shopping trips, their work-related travel dropping to less than 2% of their trips.

Analysis of the patterns of road use suggests that members of the various road user groups are most likely to encounter each other on the roads during the mid-afternoon (14.00 to 16.00). Although these hours do not comprise the peak driving times for any of the road user groups, they do represent the time at which their respective driving hours overlap to the greatest extent. Interestingly, it is these hours of the day which are also associated with the greatest crash risk for drivers of all road user groups. Inspection of crash data show that young

drivers' and older drivers' crashes at these times have some characteristics in common; both groups have a disproportionate number of crossing, turning, and manoeuvring crashes at intersections in the mid-afternoon. Young drivers' crashes which occur outside these hours are more typically loss of control and cornering crashes. Middle-aged drivers have a much higher proportion of overtaking, head on and rear end crashes than either young or older drivers.

The second half of this report explored the patterns of risk perception and driving behaviour of a representative sample of road users in Hamilton, Auckland, Gisborne, New Plymouth, and Palmerston North from March through December of 2001. Our sample of 327 drivers appeared to be a very good approximation of the New Zealand driving population described in the first half of this report. The scenarios employed in the risk assessment paradigm showed a good range of risk ratings. Overall, situations involving trucks and motorcycles were rated as significantly riskier than other vehicles. Motorway scenarios were rated as being the riskiest and urban scenes the least risky. There were significant differences in the risk ratings of various road user groups. Rural drivers and women drivers rated all of the driving scenarios as having greater risk than did the other participants, and they rated the high risk scenarios as being much riskier. Men indicated the greatest willingness to accept the risk in the driving situations and rated their own driving skill as higher. Finally, of all the age groups, older drivers rated the scenarios as having the highest risk, and young drivers generally rated lower risk situations as much lower than other drivers.

General patterns of driving behaviour in terms of driving errors, lapses, and violations were collected using the Manchester Driving Behaviour Questionnaire (DBQ)[1]. Young men in our sample reported high levels of violations and aggressive violations. The male drivers' rates of violations and aggressive violations were significantly higher than the women drivers' and the number of both decreased significantly with age. Women reported the highest rate of driving lapses, while young drivers reported the highest number of errors. Interestingly, the error scores correlated with the risk ratings such that drivers with high error scores had the highest risk perceptions, were least willing to accept the risk in a situation, rated their own driving skill lowest, and were most likely to see other drivers as posing a serious problem.

Given the differences in the perceptions and attitudes of young and older drivers, why do they share a propensity for mid-afternoon crashes at intersections? One potential clue to this

puzzle lies in how these perceptual and attitudinal differences are manifested in the driving styles of the two groups. Perhaps by virtue of their greater experience on the road, older drivers have a heightened perception of risk as compared to young drivers. This is accompanied, however, by older drivers' greater difficulty perceiving, interpreting, and judging the movements and intentions of other drivers (in part due to some degradation in perceptual abilities with age). When driving on inner city roads the elderly are much more likely than other drivers to drive through red lights at controlled intersections and to fail to follow give way rules at intersections. In contrast, young drivers perceive inner city driving as less hazardous than older drivers and typically drive at higher speeds, make more overtaking manoeuvres, accept smaller gaps between vehicles when turning at intersections, and a display a generally more dynamic driving style (rapid acceleration and deceleration, sharp braking, etc.). When these two different perceptual and behavioural styles share the same road (during the mid-afternoon), it is not at all surprising that older and young drivers have the majority of midafternoon crashes at intersections.

[1] The DBQ categorises driver behaviour along four complementary dimensions: driving errors, lapses, violations and aggressive violations.

ROAD USER INTERACTIONS:

PATTERNS OF ROAD USE AND PERCEPTIONS OF DRIVING RISK

The goal of the Road User Interactions research programme is a better understanding of the human factors of our road transport system: road user demographics, risk perceptions of road users, and the driving attitudes and reactions of various road user groups. The information on road user groups, patterns of road use, and driving interactions is intended to assist Government and industry decision making, facilitate improvements in road design and heavy vehicle driver selection and training, and lead ultimately to improved social and economic sustainability of the transport industry. This report documents the progress and findings obtained for Objective 1 of the research effort.

BACKGROUND

Almost without exception, road transport affects the daily lives of everyone in New Zealand in one way or another. The road transport system provides, for example: the major method of distributing all goods produced, consumed, imported and exported; mobility for the elderly; access to leisure activities (it can be a leisure activity of its own accord), and access to places of work and education. In the urban environment, the road transport system occupies a significant proportion of the land area. Some aspects of the social costs of road transport are readily apparent; road transport is the major cause of death of people under the age of thirty-five. Overall, nearly 3000 people died on New Zealand roads in the past 5 years. Yet the road transport system's effects are not confined to the roads themselves, they impinge upon dwellings, public spaces, commercial premises, and even the global environment.

Fundamental to reducing the negative impact of road transport on our society is the need to better understand the human factors aspect of the system. Much of this fundamental knowledge is presently not available to planners, Government decision-makers, and the road transport industry. Even basic facts such as, who the road users are in terms of their demographics (age, gender, experience, health, etc.), their driving characteristics (private, commercial, and professional), and the nature of their use of the road system (when, where, and how long they drive) are not known. Similarly, the mixes of various road users and vehicle types and the driving interactions they have on our roads are similarly unknown. Additionally, road users' and communities' perceptions of risk and attitudes towards road transport and road

safety that arise from these interactions is important information that at this stage is unknown. Finally, in order to assess and plan for the future impact of changes in our population of road users and increased traffic on our roads, the current nature of road user interactions must be established as a baseline for extrapolation.

In order to achieve the goal of providing information on road user demographics, interactions, and attitudes to appropriate end-users, the research programme will build on existing data, both overseas and local, and employ methodologies that have a demonstrated record of success. For example, in the area of road user demographics, previous overseas research has shown that people often have incorrect stereotypes of other road users. Griffin, Rodriguez and Lantz (1993) reported that U.S. truck driver demographics do not substantiate the stereotype most people have of them: 91% of drivers were male, had an average age of 38, and were better educated than the average US citizen. A survey in Western Australia (Arnold et. al., 1996) found that truck drivers there were almost exclusively male, 69% were aged 30-50, and had an average of 15.8 years of experience. The Western Australia data also revealed that 50% of the truck drivers worked more than 14 hours in a day, one third drove 40-60 hours per week. While it is suspected that New Zealand truck driver demographics and patterns of road use may be different to those in the US and Western Australia, there are no local data on which to make comparisons. If the overseas findings are any guide, however, it would not be surprising if the characteristics of New Zealand truck drivers were very different to the impressions of the general public. Further, while the larger population of all New Zealand road users is generally very diverse, it is expected that various road user groups (e.g., rural vs. urban, private vs. commercial vs. professional, age and gender groups, etc.) will have distinctive demographic characteristics and patterns of road use.

In addition to differences in demography and patterns of road use, various New Zealand road user groups were also anticipated to have distinct differences in their interactions with, and perceptions of other road users. For example, overseas research (Trankle, Glau, & Metker, 1990; Lerner & Rabinovich, 1997) has shown that young male drivers tend to underestimate the risk inherent in various driving situations and overestimate their own driving skill and degree of control, while at the other extreme, older female drivers overestimate driving risk and underestimate their degree of control. Further, the risk acceptance of some road user groups (e.g., young males) appears to be significantly related to risk taking behaviours while driving, such as speed choice, and thus to an increased probability of crash involvement (Matthews & Moran, 1986; Harré, Field, & Kirkwood, 1996; Horswill &

McKenna, 1999). These perceptions of driving risk and the driving skill of themselves, and other road user groups affect the nature of interactions between driver groups (Lerner & Rabinovich, 1997; Matthews & Moran, 1986). Differences in the perceptions and interactions of road user groups and their implications for driver behaviour can be obtained by presenting drivers with various driving scenes and situations and eliciting estimates of relative driving risk, degree of control, and the skill and safety characteristics of other drivers (Lerner & Rabinovich, 1996; Horswill & McKenna, 1999). Further, presentation of dynamic representations of various driving scenarios, either with video or driving simulators, can capture ecologically valid measures of driving responses for those situations (Charlton, Mueller, & Baas, 1999; Horswill & McKenna, 1999; Wachtel, 1993). These perceptions and driving responses of road user groups can then be combined with the demographic and road use information to portray the types of interactions occurring between drivers on New Zealand roads now and, based on trends in road user demographics and road use, in the future.

To achieve the outcome of reducing the social costs and improving the long-term sustainability of the transport system, the goals of the research were threefold: 1) development of detailed information on road user demographics and patterns of road use, 2) identification of drivers' perceptions of risk and typical driving responses in various road situations, and 3) characterisation of road user interactions through analysis of the characteristics and attitudes of drivers sharing the road at any given time.

PATTERNS OF ROAD USE

Our characterisation of New Zealand driver demographics was undertaken through analysis of data collected for the 1989/90 and 1999/00 New Zealand Household Travel Surveys (NZHTS). These surveys were undertaken by the Land Transport Division of the Ministry of Transport and subsequently by the Land Transport Safety Authority of New Zealand. We chose to use these surveys as a starting point for the research on road user interactions in order to provide information about who is on the road, when, and the purpose(s) of their trip.

The 1989/90 survey contained data from 3102 households and the 1999/00 survey contained 5367 households. The surveys sampled all of the major urban areas in New Zealand, and collected information on: demographic characteristics such as age, sex, ethnicity, occupation and number of occupants, type and age of vehicle(s), type of licence, accident history, and number of kilometres driven (both in the last 12 months, and in their "life so far"). Respondents over the age of five were also asked to complete detailed questions about all of their travel on the two designated days, including the mode of transport, information about where they went and any stops along the way, the purpose of their trip, whether they were the driver or a passenger, how many other people were in the vehicle, the route, what speed zone(s) they had travelled through, where they had parked, and for drivers, information about alcohol consumption during the two target days. The details of these surveys and the sampling methods they employed are contained in two reports: *New Zealand Household Travel Survey July 1989-June 1990* (MoT, 1992), and *New Zealand Travel Survey Report* (LTSA, 2001). The data sets from these two surveys were made available to us by the Land Transport Safety Authority of New Zealand for use in the present research.

For purposes of comparison, we have also (where appropriate) included data from the Great Britain National Travel Survey (DETR, 2001) and the National Personal Travel Survey from the United States (DOT, 1999a). Similar to the NZHTS, these surveys are based on travel diaries from a representative sample of households.

Amount of Driving

New Zealanders have increased their total amount of kilometres driven by car by 35% in the 10 years since 1990 (to 273,200,000 km per year). The total number of trips taken by drivers also increased by 22% during that period; while the average distance driven per trip

also increased 10% (to 8.8 km per trip). Interestingly, the amount of passenger kilometres increased by only 14% (to 164,600,000 km), and the average trip distance for passengers actually decreased by 1% (to 10.2 km) in the past ten years. These trends are more or less equivalent to travel trends observed in Great Britain from the mid-1980s to 1997/99 where the number of trips taken by drivers increased by 30%, the number of trips made by passengers increased by 17%, and the average trip distance increased by 11% (to 8.6 miles or 13.8 kilometres) (DETR, 2001). The overall distance travelled by car in Great Britain increased by 41% from the mid-1980s to 1997/99.

Averaged across all age, income, ethnic groups and regions of the country the annual distance reported by drivers was 14,794 kilometres per driver in 1999 as compared to an average of 13,786 kilometres in 1989. Thus, the reported annual average has risen between 1989 and 1999, but the amount of increase was not uniform across all segments of road users.

Gender, age, and regional differences.

For both 1989 and 1999, men in New Zealand drove almost twice as many kilometres by car in the year prior to the survey than women. In the 1989 survey men reported driving an annual average of 17,746 kilometres, whereas women reported driving an average of 9,409 kilometres (a difference of 8337 kilometres). The relative difference is almost as large for 1999: men reported driving 18,655 kilometres whereas women reported 10,967 kilometres (a difference of 7,598). The gap between women and men's driving distances became smaller by 739 kilometres per year. Of the two driver groups, women's driving showed the greater relative increase between 1989 and 1999 increasing by 16.5% whereas men increased their driving by only 4.6%.

The amount of driving by young women (aged 15 to 19 years) in particular substantially increased in the past 10 years, from a national annual total of 2.5 million kilometres in 1989/90 to 4.4 million kilometres in 1997/98; an increase of 76%. In comparison, young male drivers (15 to 19 years) increased their driving 19%, from an annual total of 4.8 million kilometres in 1989/90 to 5.7 million kilometres in 1997/90. The number of driver trips shows the same trend; a 75% increase for young women (39.4 million annual trips in 1989/90 and 68.7 million trips in 1997/98) and an increase of 7% for young men (70.5 million annual trips in 1989/90 and 75.6 million trips in 1997/98).

A view of the relationship between age and amount of driving is shown in Figure 1. As can be seen in the figure, the distances driven increase sharply from the teens to early twenties

(no doubt coinciding with the beginning of employment) and then level off until late middle age where they take a sharp turn downward (again, probably corresponding to the end of working life and the concomitant decrease in income). It is striking to note that men report driving a greater number of kilometres than women at all ages; however they also showed a steeper decline in kilometres driven at the older ages, possibly because they started from a higher number of kilometres driven, whereas women were already driving relatively few kilometres per year. These age differences are statistically reliable regardless of the survey year: 1989, $F(13, 5086) = 19.46$, $p < .0001$, 1999, $F(13,9340) = 41.17$, $p < .0001$. In both 1989 and 1999, the effects of age on distance driven were greater for men than for women and is evident in the small but significant interactions between gender and age group in both the 1989 $F(13,5086) = 2.79$, $p < .001$ and 1999 analyses, $F(13,9340) = 4.17$, $p < .0001$. Men showed the greatest decrease in driving after 55-59 years of age in the 1989 study, and after 60-64 in the 1999 study. Women also showed a decrease in the amount of driving at older ages, with the greatest decrease occurring after 65-69 years of age in the 1989 study and, like men, after 60-64 in the 1999 study.

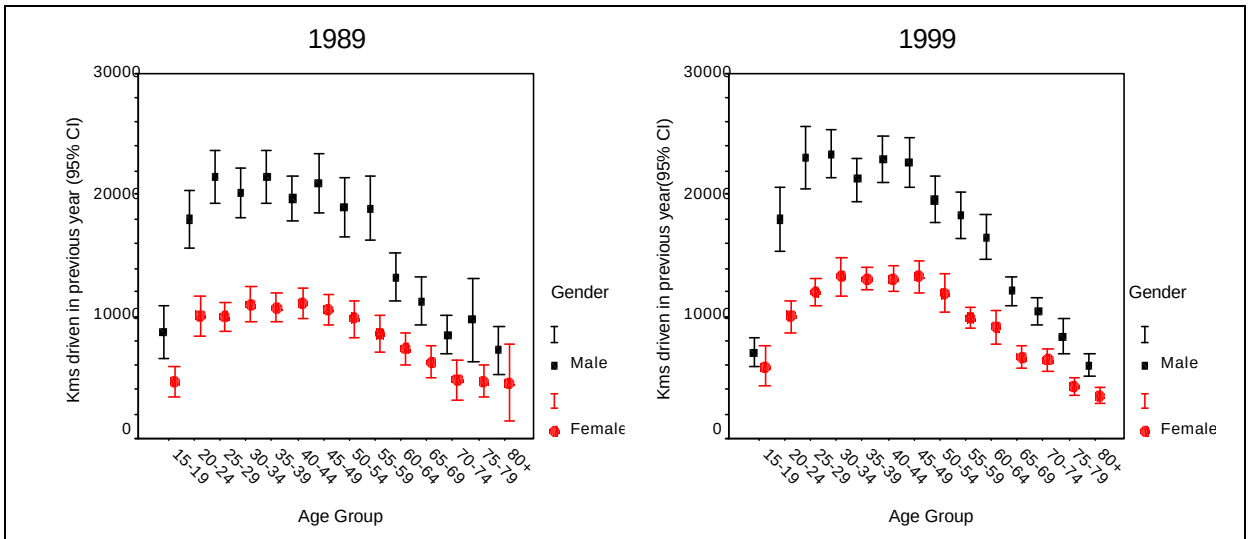

Figure 1. Age, gender, and kilometres driven per year.

The type of area or district also makes a significant difference in the number of kilometres driven. For example, a comparison of the number of kilometres driven by area (main urban[2], secondary urban, and rural) in 1999 reveals that area has a significant effect on the number of kilometres driven ($F(2,9362) = 11.48$, $p < .0001$) such that those in rural areas

[2] Main urban areas include cities with over 60,000 residents (i.e., greater Auckland, Christchurch, Wellington, Hamilton, Dunedin, and New Plymouth), secondary urban areas included cities with a population of 10,000 or greater, with the remainder classified as rural (based on 1996 census data).

drive more kilometres per year (an average of 16109 kms) than those in main urban (14224 kms) and secondary urban (13914 kms) areas[3]. Post-hoc pairwise comparisons (Least Significant Difference test) indicated that the total kms driven by rural drivers were significantly greater than those of either main urban ($p < .0001$) or secondary urban drivers ($p < .002$). In contrast, the total kms driven in main urban and secondary urban areas were not significantly different from one another ($p = .606$).

Interestingly, there are some geographical regions of the country where the amount of driving is noticeably higher; the regions with the greatest number of kilometres per year were the Waikato, Auckland and Wellington regions (in that order). The regions in which individuals reported driving the fewest number of kilometres were the Gisborne, Nelson and Southland regions (again, in order). Post hoc comparisons supported these conclusions, in that distances driven in Waikato, Auckland, and Wellington were not significantly different from each other, but differed from all other regions. Similarly, Gisborne, Southland, and Nelson did not differ from each other but were significantly lower than Waikato, Auckland, Wellington, Bay of Plenty, Manawatu, Taranaki, and Otago. While there is not a statistically significant interaction between gender and geographical region, it is interesting to note that women in the Waikato drove more than women in any other region, including Auckland and Wellington, and the difference between Otago women and men was much greater than for other regions.

Another perspective on the amount driven by various segments of the New Zealand population is provided by looking at the number of daily trips made by car drivers, and the average distance and duration of those trips. These data are shown in Figures 2, 3, and 4. As Figure 2 shows, young female drivers take somewhat more trips per day than young male drivers, whereas the older male drivers take many more trips than their female counterparts. Also apparent in the figure is the relationship between area and number of trips, with drivers in rural areas making the fewest trips per day and drivers in the main urban areas making the greatest number of daily trips.

Figure 3 shows that in terms of the average distance per trip, male and female drivers living in rural areas drive much further than drivers in main urban and secondary urban areas. Male drivers' trips are longer than those of female drivers in all areas, with the exception of rural drivers where the trips taken by young female drivers are slightly longer on average than those of young males.

[3] This analysis was limited to the 1999/00 survey as these data were not available in the 1989/90 data set.

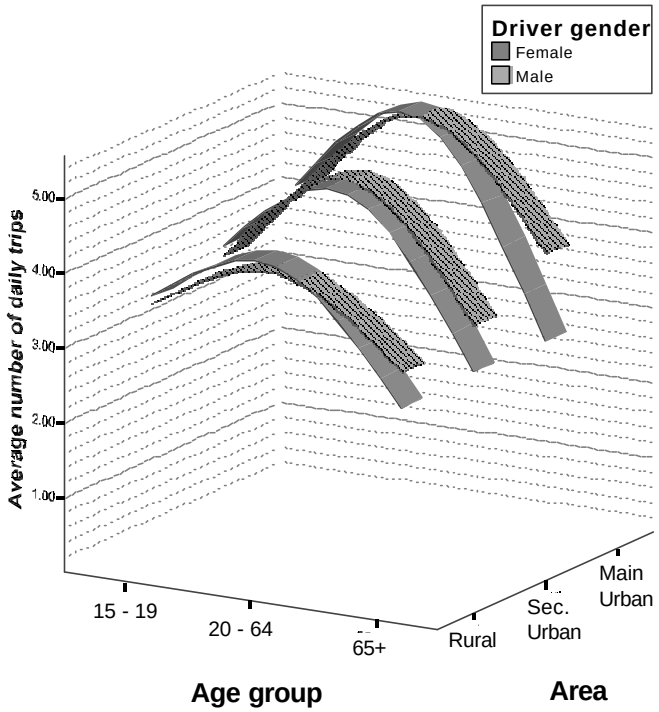

Figure 2. Age, gender, area, and average number of daily trips.

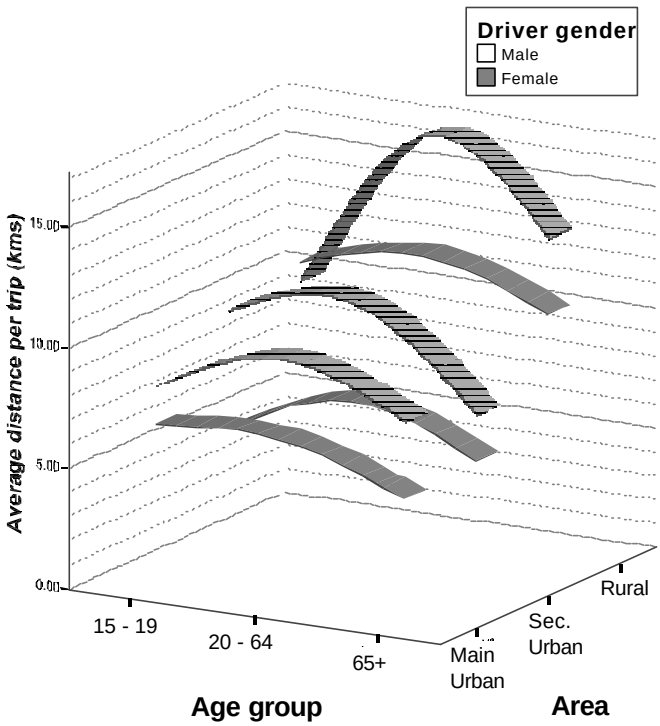

Figure 3. Age, gender, area, and average distance per trip.

Finally, Figure 4 shows the average trip duration for men and women drivers. As can be seen in the figure, men's car trips generally take longer than women's trips, regardless of the area, with the difference being greatest for drivers between the ages of 20 and 64. The greatest disparity in the duration of men's and women's trips can be seen in the secondary urban area, where young and middle aged women reported the shortest average trip durations in the nationwide sample. Also of note is that young drivers in the main urban areas drive longer per trip than young drivers elsewhere and that the young female drivers' trips in those areas take longer than those of their male counterparts.

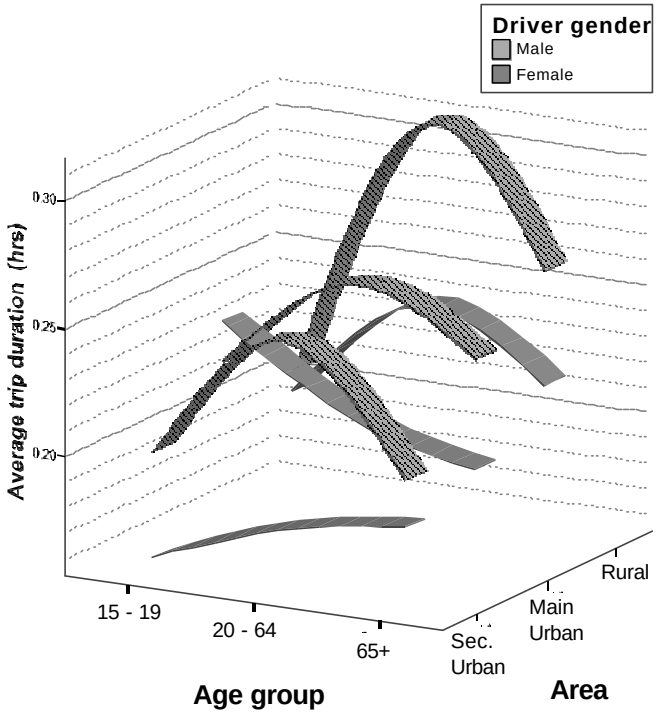

Figure 4. Age, gender, area, and average trip duration.

Income, occupation, and ethnicity.

Other demographic factors of interest with regard to the amount of driving include the income, occupation, and ethnicity of the drivers. An analysis of the relationship between income and the reported kilometres driven per year indicates that those on higher incomes drive a significantly greater number of kilometres, $F_{(9,4857)} = 64.22$, $p < .0001$ (1989) and $F_{(10, 8756)} = 45.43$, $p < .0001$ (1999). As shown in Figure 5, the influence of income is quite striking and holds for both men and women, although the relationship is more obviously linear for men, and men at all income levels drove more then women in both 1989 and 1999. It is

interesting to speculate on the reason for the income effect; it could be due merely to the fact that a higher income permits one to purchase more petrol and keep the car in running order, or that a greater income implies more availability of leisure time, some of which can then be spent driving to destinations such as holiday homes, sporting events, restaurants and movies.

The influence of income level as a possible explanation of the gender gap in kilometres driven was also explored. That is, because women generally are more likely to come from households with lower incomes (e.g., single parent families), the relative unaffordability of petrol may therefore limit the amount of women's driving. There is a statistically significant interaction between gender and income for both the 1989 data $F(9,4857)= 3.12$, $p<.001$, and the 1999 data, $F(10,8756) = 4.218$, $p<.0001$, such that while both women and men reported driving an increasing number of kilometres with reported income, men's driving increased at a greater rate with higher income. Yet the relationship of income to the amount of driving does not account for the gender difference in driving. An analysis of covariance, determining whether there is still a significant effect of gender when the effects of income are statistically accounted for, on both the 1989 and 1999 data still displayed a highly significant effect of gender, 1989: $F(1,4874) = 170.83$, $p < .0001$; 1999: $F(1,8775) = 206.32$, $p < .0001$.

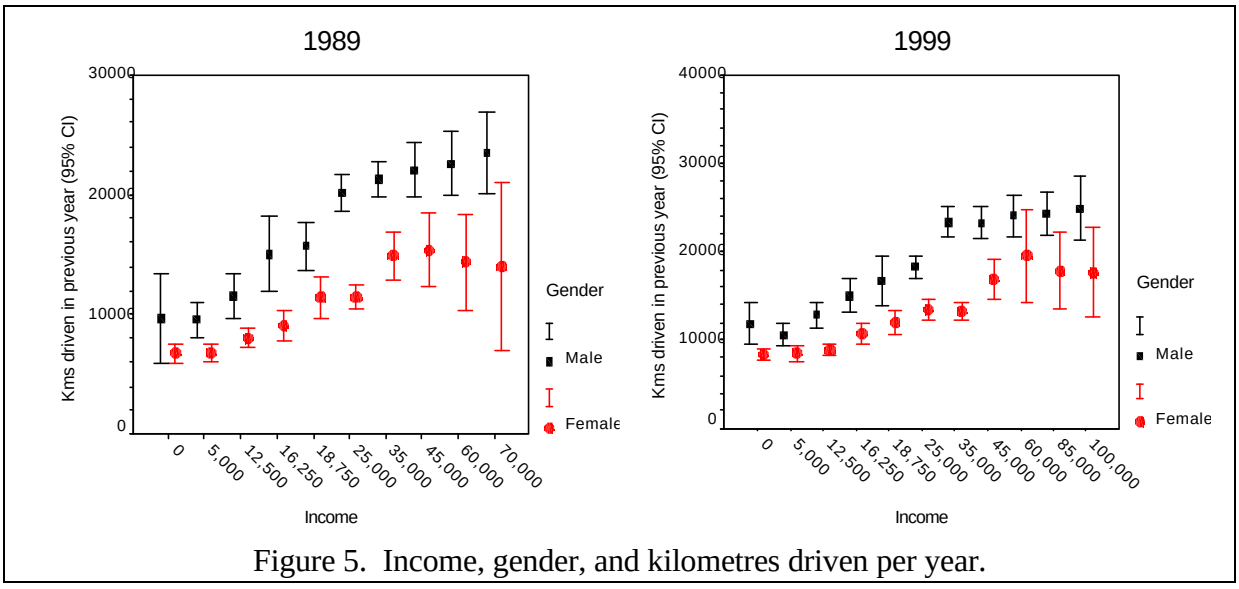

Figure 5. Income, gender, and kilometres driven per year.

An inspection of the distribution of income across different age groups indicated that younger and older drivers have lower incomes than middle-aged drivers. Similar to the argument raised for income and gender, it could be argued that the youngest and oldest drivers may drive fewer kilometres simply because they cannot afford to drive any more. Thus, a further analysis of the impact of age on the number of kilometres driven with income as a covariate was computed. Results showed that even when income was held constant, driver's

age still had a significant effect on the number of kilometres driven $F(13,4848) = 9.34$, $p<.0001$) (1989) and $F(13, 8764) = 16.36$, $p < .0001$ (1999).

Figure 6 shows the relationship between driver occupation and the reported number of kilometres driven per year. Statistical analysis of the 1989 data showed that occupation had a significant effect on the number of kilometres driven $F(6,3448) = 18.880$, $p<.0001$). The occupations that reported driving the greatest amount of kilometres per year in 1989 were sales and administration/managerial. Analysis of the 1999 data also show a significant effect of occupation on reported kilometres driven, $F (6,3448) = 18.88$, $p < .0001$. In 1999, machine operators, technicians, and administrators/managers drove the greatest number of kilometres. Interestingly the rate of driving for workers employed in sales decreased relative to its 1989 rate. It should be noted that the 1999 survey used the revised New Zealand Standard Classification of Occupations (Statistics NZ, 1995) and thus may have changed the categorisation of some jobs. Still, the patterns are rather similar overall, in that the top and bottom ends of the scale are almost identical across the decade: agricultural workers still drive relatively little, and administrators/managers drive the most.

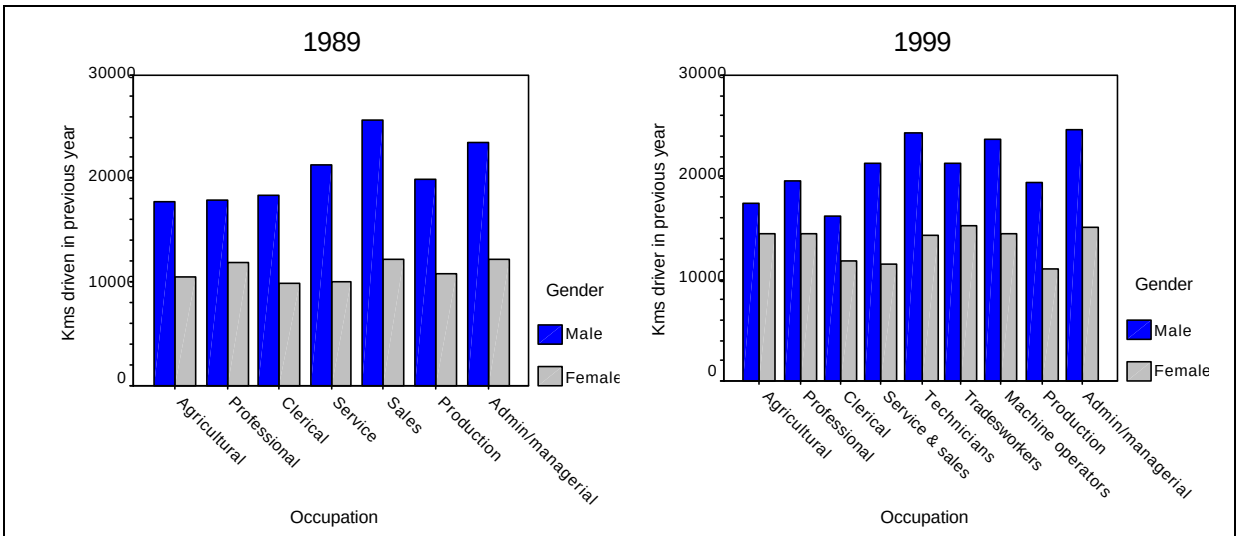

Figure 6. Occupation, gender, and kilometres driven per year.

Another finding apparent in the analysis of driver occupation is its relationship to the gender differences reported earlier. In other words, the data clearly show that men drive more than women even when they are in the same occupation. An analysis of co-variance was performed with kilometres driven in the car in the last year as the dependent variable, gender and occupation as independent variables, and income as a covariate (because of the close relationship between income and occupation). In both 1989 and 1999 there was a significant gender by occupation interaction, $F(6, 3303) = 3.197$, $p < .004$ (1989) and $F (8,5689) = 2.588$, p

< .008 (1999). The pattern for both the 1989 and 1999 interactions was such that men's distance travelled per year varied by occupation but women reported travelling the same distance, regardless of occupation. Again, in both 1989 and 1999 there are significant main effects of both gender ($F(1,3303) = 91.244$, $p < .0001$, 1989) and $F(1,5699) = 88.012$, $p < .000$, 1999) and occupation ($F(6,3303) = 6.079$ $p < .0001$, 1989) and $F(8,5689) = 3.499$, $p < .0001$, 1999) even when the effects of income are controlled. The results of this analysis strengthen the earlier finding that men drive more than women because they are men, not because of their occupation.

An analysis of the kilometres driven by members of different occupations in the three areas did reveal a small significant interaction between area and occupation: $F(16,6046) = 1.798$, $p < .026$. Those employed as professionals or technicians and associate professionals tended to drive fewer kilometres per year than other occupations if they resided in a main urban area. By comparison, clerks, trades workers, and plant and machine operators and assemblers tend to drive more kilometres per year than other occupations if they resided in a rural area. There was no interaction of gender with either of the variables of area or occupation alone or in combination.

Finally, our analyses showed no significant effect of ethnicity on kilometres driven for either survey, $F(3,5089) = .232$, $p > .05$ (1989), and $F(5,6348) = 1.07$, $p > .05$ (1999). Similarly, no significant interactions of ethnicity with gender, income, experience, or occupation were found in either data set. Thus it can be concluded that ethnicity has little effect on the number of kilometres driven per year.

Summary.

In using these data to predict who is most likely to be on the road, driver gender is clearly the most powerful variable. Men reported driving almost twice as much as women, in both 1989 and 1999. Driver age is also an important predictor, with individuals between 25 and 55 more likely to be on the road than either young (15-19) or older (60 and above) individuals. Having a higher income also makes it more likely that one will be on the road than someone who earns a small amount. Rural drivers also drive more (presumably because they have more distance to cover) but geographic region also influences the driving amount, with Waikato, Auckland and Wellington regions leading the way with kilometres driven in the previous year. Figure 7 shows rankings of some of the noteworthy road user groups according

to their annual amount of driving (distance) and their average number of trips taken each day. Although drivers in rural areas drive further, drivers in urban areas drive more frequently. A gender difference in road use is not apparent, however, when considering the frequency of road use (average number of trips), with young women drivers in particular making many more trips than young male drivers (and even more trips than their parents in rural areas).

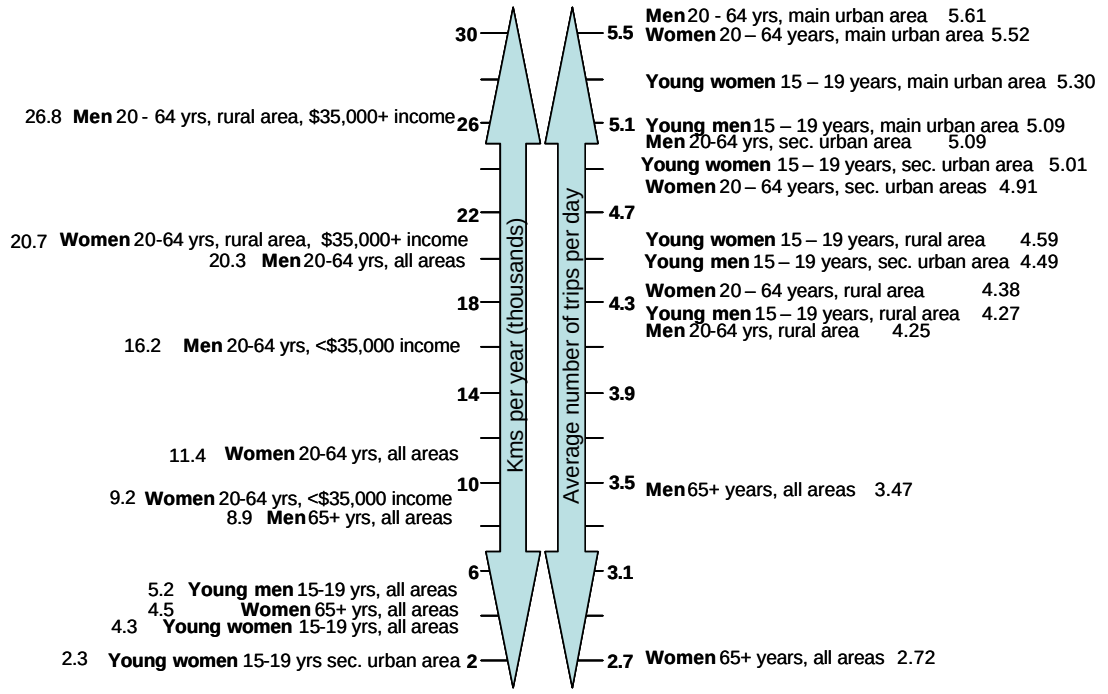

Figure 7. Ranking of road users by annual amount and number of trips in 1999.

These differences in road user groups are similar to those seen overseas. For example, men in the United States and Great Britain drive cars approximately 40% further than women, but take the same (or only slightly more, 2%) daily trips on average. Also similar to the New Zealand findings, residents of rural areas of the Great Britain drive further than residents of urban areas, and people living in Great Britain and United States households with high income report the highest use of cars.

Explicitly comparing driving amounts in New Zealand with the United States and the Great Britain, drivers here tend to take shorter, but slightly more frequent trips than drivers in the United States and Great Britain. The average distance per trip in New Zealand is 8.8 km, as compared to 14.5 km in the United States (9.0 miles) and 13.7 km (8.5 miles) per trip in the Great Britain. New Zealand drivers made an average of 4.38 daily trips (4.63 trips per weekday, 3.76 per weekend day) in 1998, as compared to 4.30 trips per day by United States

drivers in 1995 (comparable daily trip data is not available for Great Britain drivers). In 1995, men in the United States drove an average 28,200 km (17,500 miles) per year and women averaged 17,700 km (11,000 miles). In 1998 in New Zealand men reported 18,700 km driven per year whereas women reported driving 11,000 annual km.

Examining the historical trends in road use here and overseas, it is apparent that there is substantial consistency in the patterns of driving by various road user groups across the past decade. Of all the road user groups, women, and young women in particular, have shown the greatest increases in their amount of driving. Women's mobility increased more rapidly than that of men. In the United States in 1969, women drove fewer than 50% as many miles as men but by 1990 in the United States and New Zealand women drove 58% and 53% as far as men respectively; in 1995 women in the United States were driving 63% as far as men and by 1998 women in New Zealand were driving 59% as far as men. Overall, however, the number of drivers on the roads has increased, and those drivers are driving further and more frequently. Projecting these trends into the future, we anticipate a continued increase in the number of vehicle miles on our roads and a growing parity between men's and women's driving distances.

Driving Times and Destinations.

One of the purposes of assessing the demographics trends in road use is to establish how and when different road user groups interact. In order to further the identification of such occasions, an examination of road use patterns such as time of day and trip destination is required. Figure 8 shows the distribution of New Zealand drivers' trips by time of day and day of week. As can be seen in the figure, weekday trips (Monday through Friday) show some clearly differentiated peak travel times, particularly during the hours of 7.00 – 8.00, 15.00 – 18.00, and to a much lesser extent 10.00 – 12.00. In contrast, travel on weekend days show the peak travel time to be during the hours of 9.00 – 13.00.

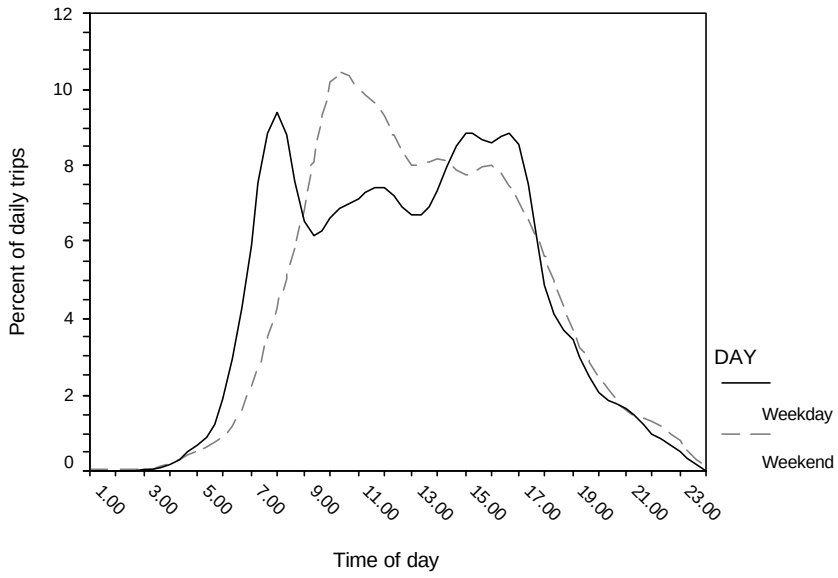

Figure 8. Distribution of daily trips by day of the week and time of day (departure time).

For purposes of comparison, Figure 9 shows the distribution of trips by drivers in Great Britain in 1997/99 by time of day and day of week. As can be seen by comparing Figures 8 and 9, the distribution of trips by New Zealand drivers is nearly identical with that observed for drivers in Great Britain.

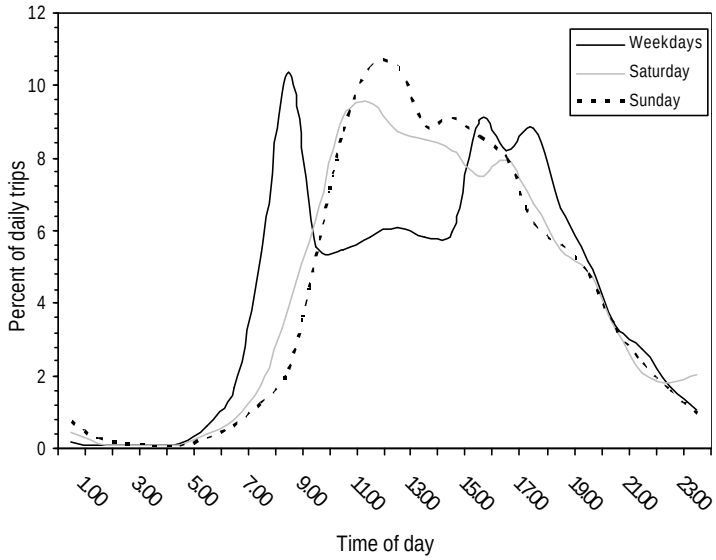

Figure 9. The distribution of trips by drivers in Great Britain in 1997/99 by time of day and day of week.

Figure 10 compares the timing of men's and women's trips throughout the day. In general terms, men's weekday trips begin and peak somewhat earlier in the morning and later in the afternoon than women's trips. In contrast, women's peak travel times on week days are

even more clearly differentiated than men's trips, and occur later in the morning and earlier in the afternoon. Weekend trips for men and women drivers are essentially equivalent, with men showing a higher proportion of early morning trips than women.

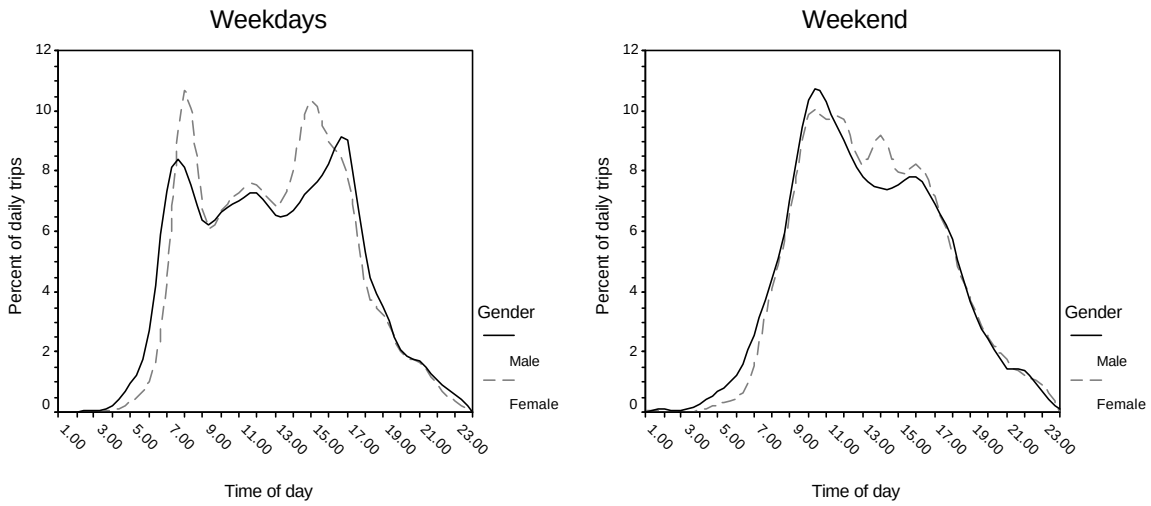

Figure 10. Men's and women's daily trips by day of the week and time of day (departure time).

Figure 11 shows the distribution of trips throughout the day for drivers of different ages. As can be seen, older drivers' trips are more concentrated, 84.5% of their trips occur between the hours of 9.00 and 16.00. Weekday trips by older drivers tend to occur between the peak trip times for other drivers. On the weekend, older drivers' trips begin earlier in the day than the general population, but otherwise conform to the same pattern found for older drivers on weekdays. In contrast, young drivers' trips occur later and are more distributed throughout the day, particularly on weekend days.

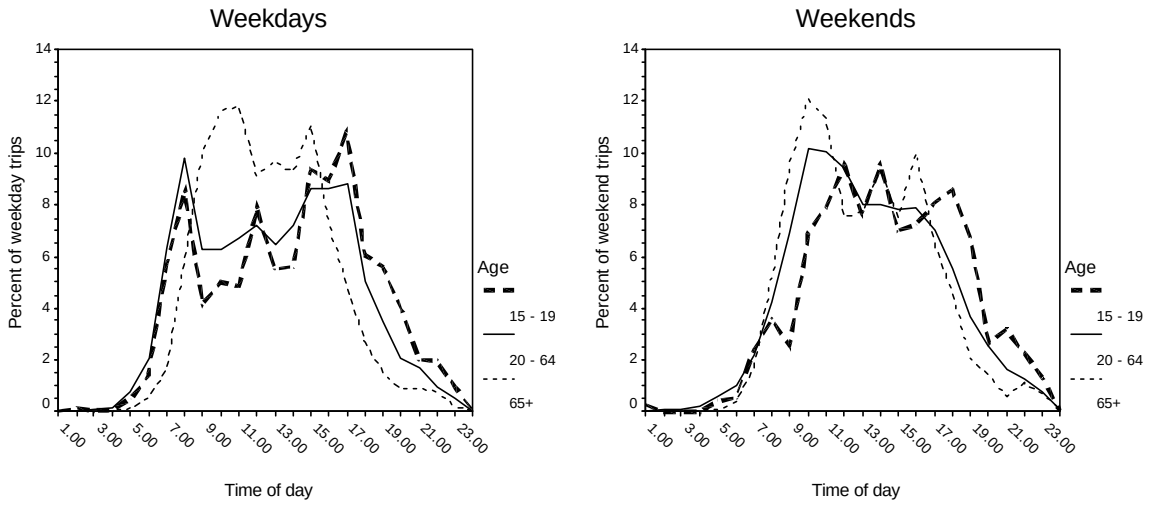

Figure 11. Distribution of trips by time of day and relative number of daily trips for drivers of different ages.

It should be remembered, however, that on the whole, young drivers and older drivers make substantially fewer trips per day than drivers between the ages of 20 and 64. Further, at any given time of the day there are substantially more drivers aged 20 to 64 on the road, as compared to these young and older drivers. Both of these phenomena are shown in Figure 12.

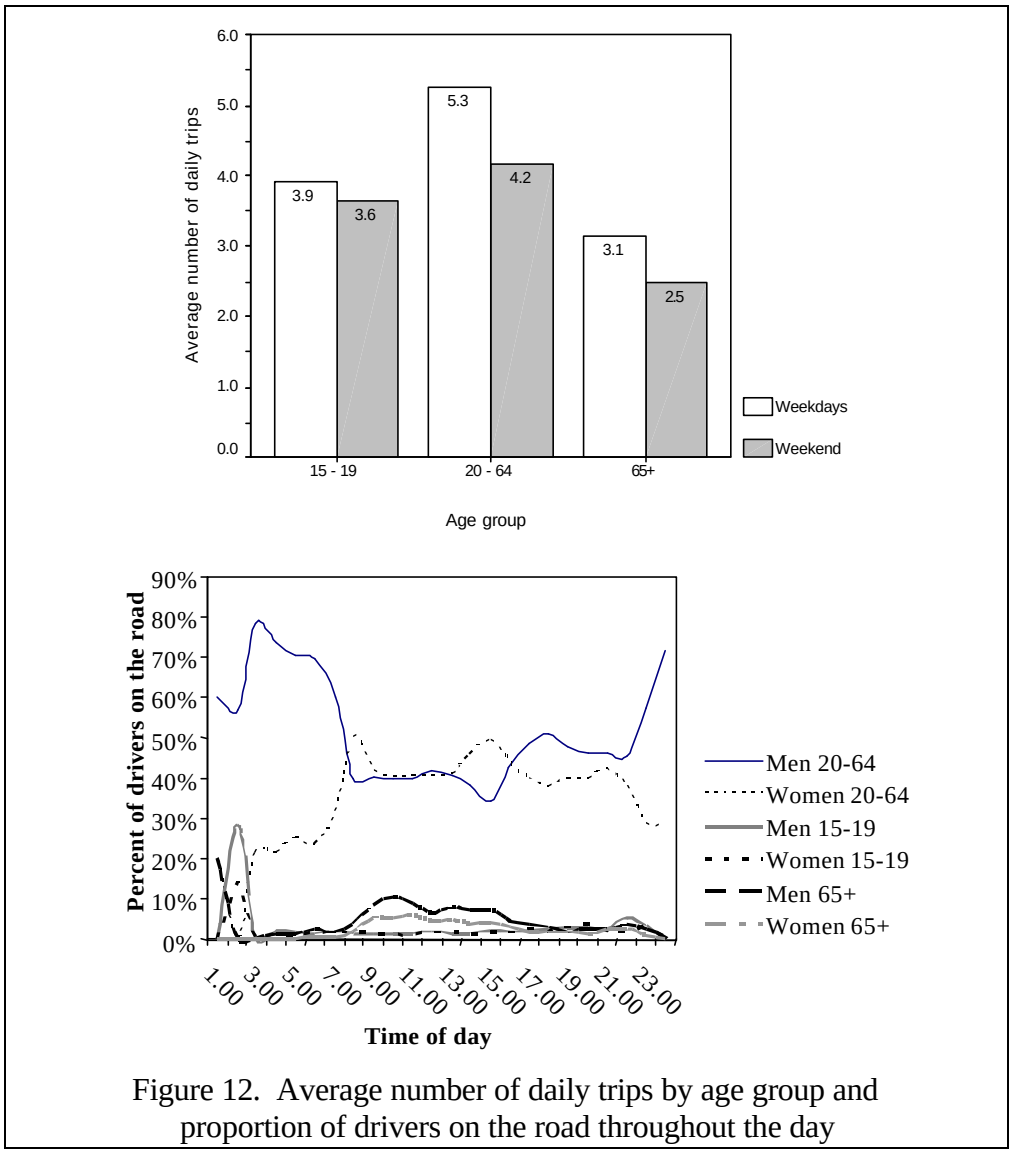

Figure 12. Average number of daily trips by age group and proportion of drivers on the road throughout the day

Figure 13 shows the distribution of trips throughout the day for different areas. As can be seen in the figure, the timing of trips is relatively uniform throughout the country. Weekday trips in every area show the characteristic morning and afternoon travel peaks, and weekends are characterised by later, more concentrated timing of trips, regardless of whether they are taken by urban, secondary urban, or rural drivers. Once again, it bears noting that rural drivers do take relatively fewer trips, on weekdays and weekends, as is shown in the bottom panel of the figure.

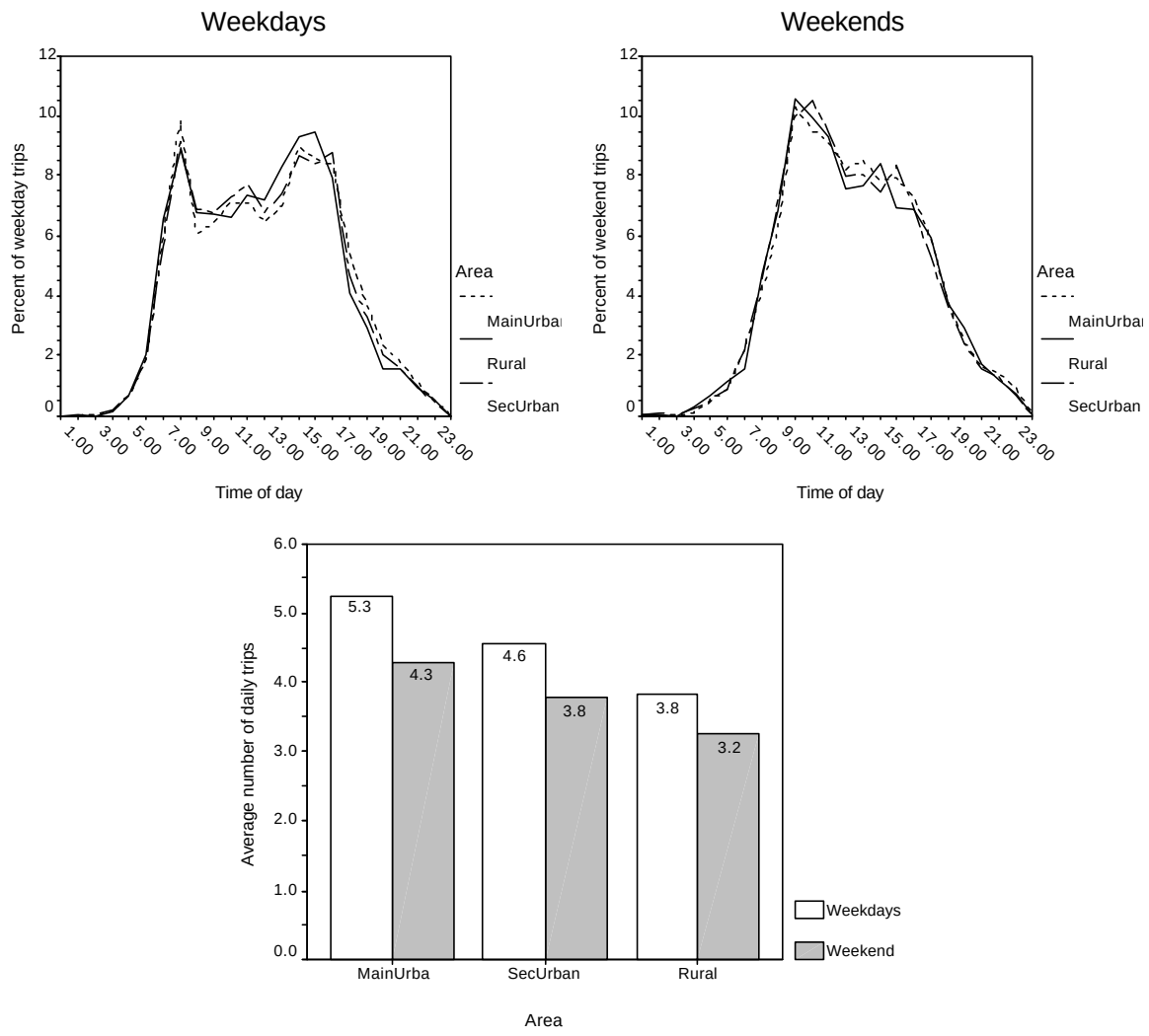

Figure 13. Distribution of trips by time of day and relative number of daily trips for drivers in different areas.

Another aspect of travel patterns across various road user groups can be explored by comparing the purpose of the daily trips. As described earlier, men and women drivers take approximately the same number of trips each day, although the reasons for those trips are somewhat different. As can be seen in Figure 14, women drivers make a higher proportion of shopping trips and twice as many trips to transport passengers whereas a higher proportion of men's trips are related to their work. Men and women drivers have approximately the same proportion of social/recreational trips and trips returning to their homes.

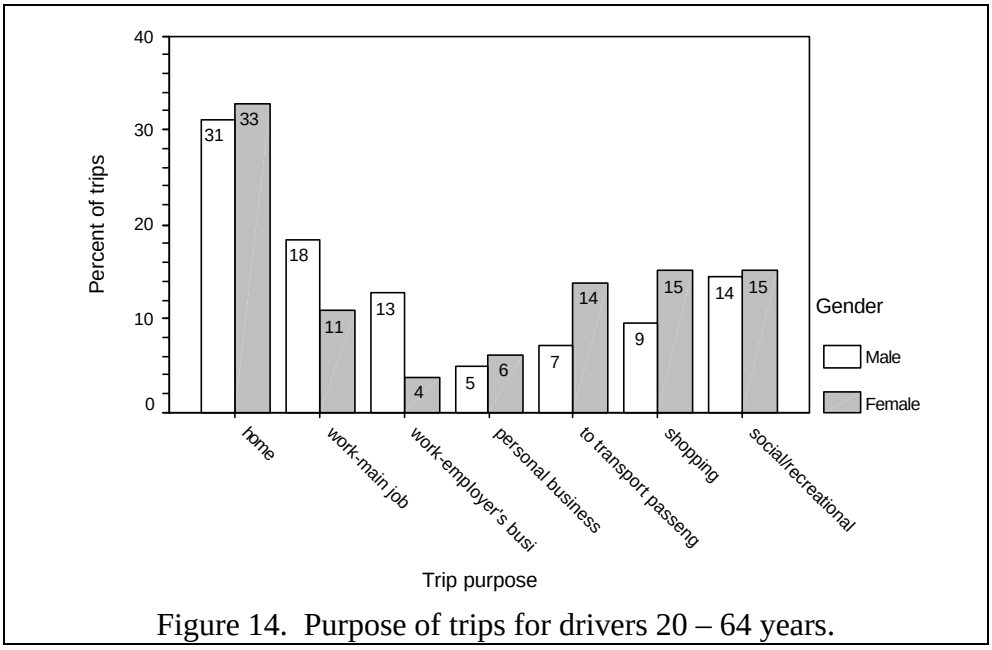

Figure 14. Purpose of trips for drivers 20 – 64 years.

Men's trips, regardless of their purpose, typically take longer than women's trips. As can be seen in Figure 15, the gender disparity in these trip durations is greatest for drivers in secondary rural areas, where women's work trips are an average of 22 – 50% shorter than men's trips. In contrast, men's and women's trips to go shopping tend to be of about the same duration, regardless of whether they live in urban, secondary urban, or rural areas. The figure also shows that whereas social/recreational trips take the longest for men, the longest duration trips for women are the ones they take to work.

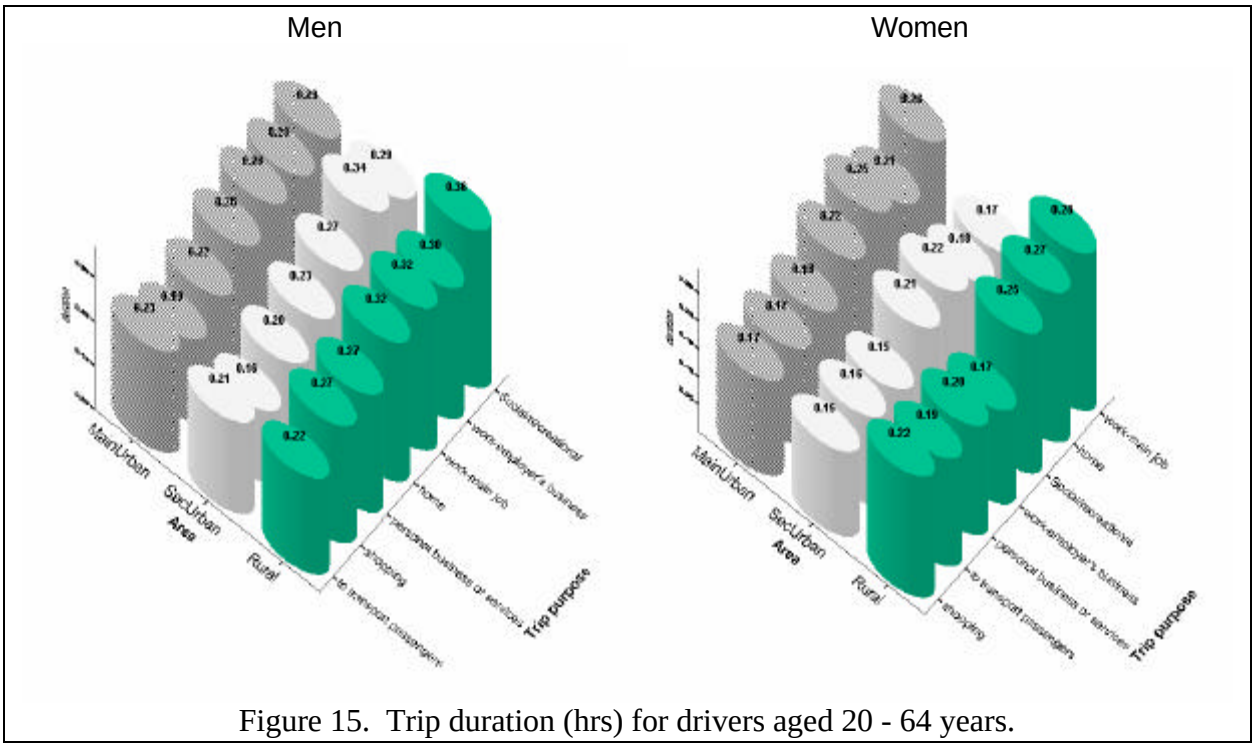

Figure 15. Trip duration (hrs) for drivers aged 20 - 64 years.

Interestingly, in terms of trip purpose, driver age has even a greater effect than gender. Figure 16 shows these differences for both weekdays and weekends. Young drivers (15-19 years) and older drivers (65+) both show a much higher proportion of social/recreational trips, particularly during weekdays. Similarly, older drivers have a substantially higher percentage of shopping trips than any other drivers and the lowest proportion of work trips, with this difference again being most prominent on weekdays. Not surprisingly, young drivers show the highest proportion of education-related trips (on weekdays) and the fewest trips for shopping.

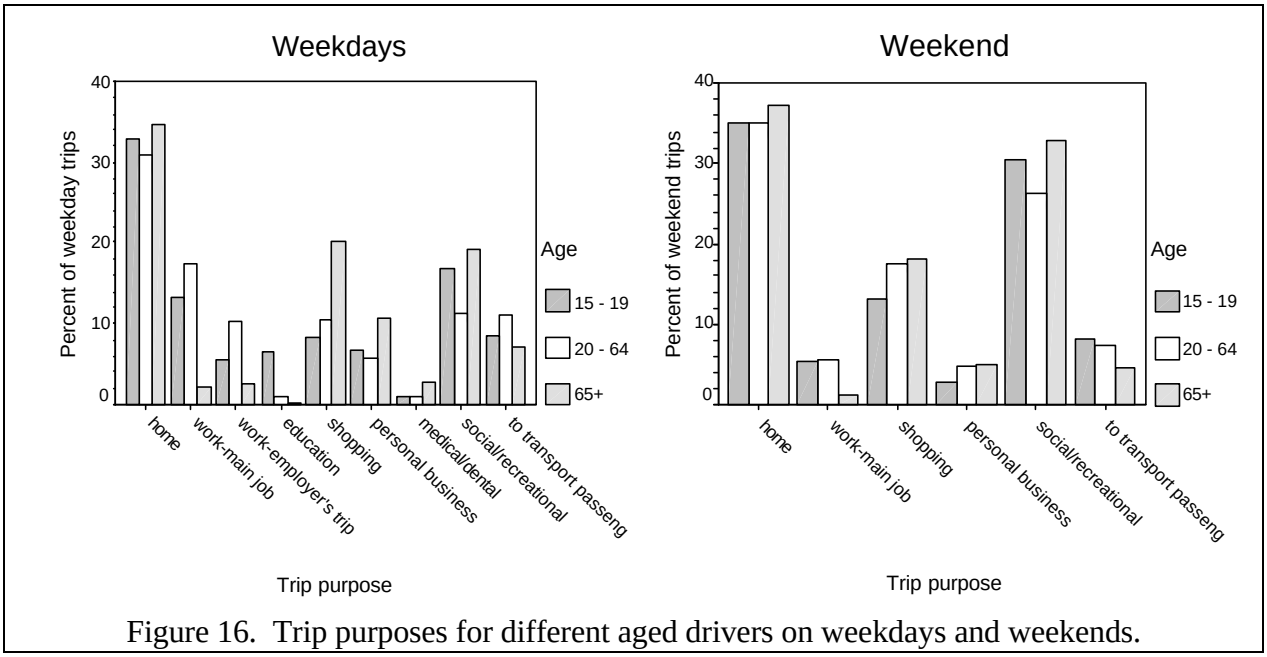

Figure 16. Trip purposes for different aged drivers on weekdays and weekends.

Figure 17 shows the trip purposes and trip durations for young drivers. Trips for educational purposes take the longest for young drivers living in urban and rural areas, and although they represent only about 4-5% of these drivers' trips, they are among the longest duration trips reported by any age group for any purpose. Trips taken for social/recreational purposes constitute a substantial proportion of young drivers' driving, but their duration is approximately equivalent to the social/recreational trips taken by drivers aged 20-64. Work-related trips for young drivers are less frequent and much shorter (10-45% depending on the area) than the work-related trips of drivers aged 20-64.

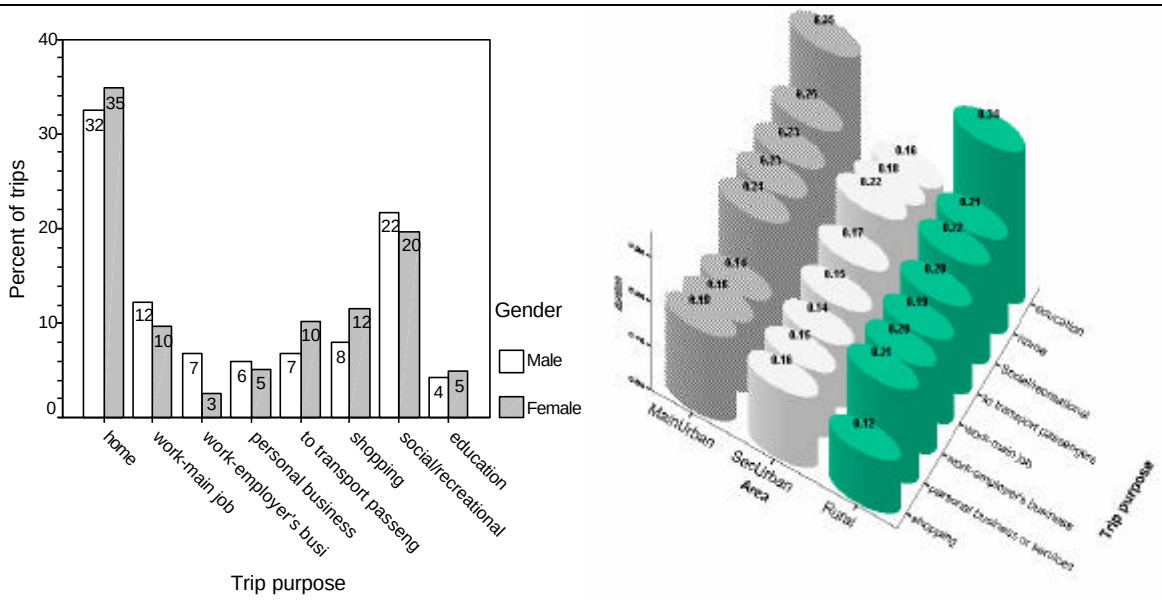

Figure 17. Purpose of trips and trip durations for young drivers (15 - 19 years).

Figure 18 shows the trip purposes and trip durations for older drivers. Trips for social/recreational purposes constitute a substantial proportion of older drivers' driving, and their duration is somewhat greater than the social/recreational trips taken by other drivers. Trips taken for shopping are also a significant component of older drivers' trips, but their duration is approximately equivalent to the duration of other drivers' shopping trips.

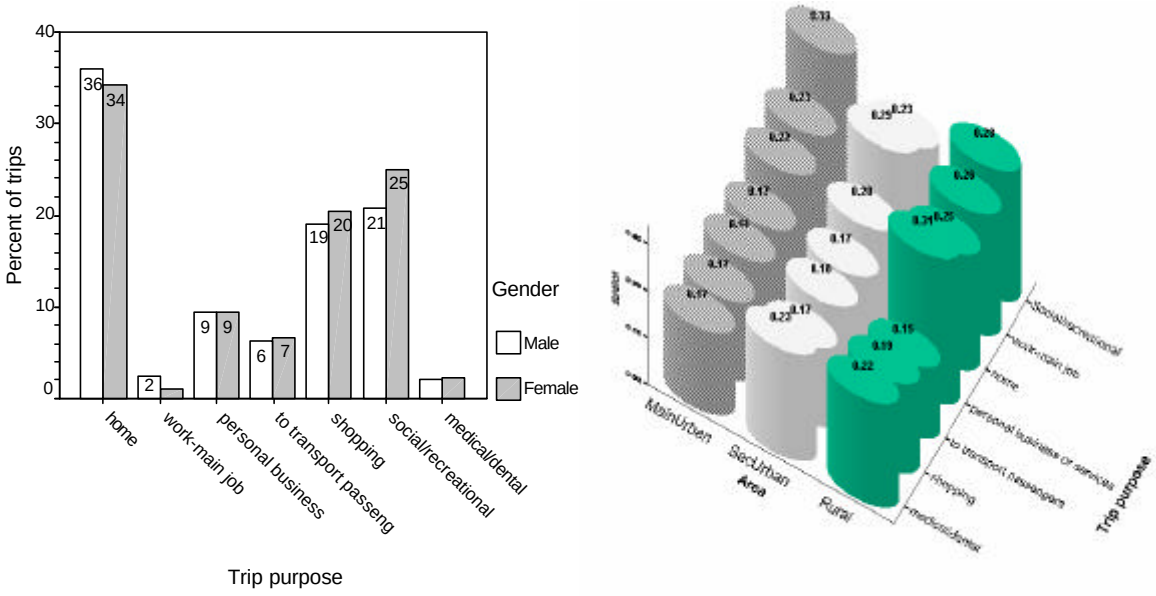

Figure 18. Purpose of trips and trip durations for older drivers (65 + years).

Conflicts & crashes

In the context of the preceding patterns of road use, another analysis of interest is the potential for conflicts between different road user groups and any crashes occurring at these conflict points. Recalling the peak travel time data (Figure 11) one of these potential conflict points occurs on weekday afternoons between the hours of 14.00 and 16.00, the time at which there is the greatest overlap in trips made by young, middle-aged, and older drivers. Although the proportion of drivers under the age of 20 and over the age of 64 on the road during these hours (3.9% and 10.1% respectively) is relatively small, one might expect the differences in the driving styles and capabilities of these road user groups to set the stage for potential conflicts. Figure 19 shows the distribution of multiple-vehicle injury crashes throughout the day for these groups[4], and as can be seen, there is indeed a peak in crash rates for all age groups between the hours of 14.00 and 16.00. Although it was not possible to specify the interaction of differing driver ages for all the parties involved in these crashes, it is telling that the peak crash rates are offset from peak travel times in the direction predicted by the potential for conflicts between different road user groups (older drivers crashes happen later than their peak travel time, and younger drivers crashes occur earlier than their peak travel times). Indeed, the location of these crashes suggest that the these drivers are sharing the same sort of roads during these hours; 64.6% of the young drivers' crashes were on 50 kph roads as compared to 59.8 for the middle aged drivers and 63.9% for the older drivers.

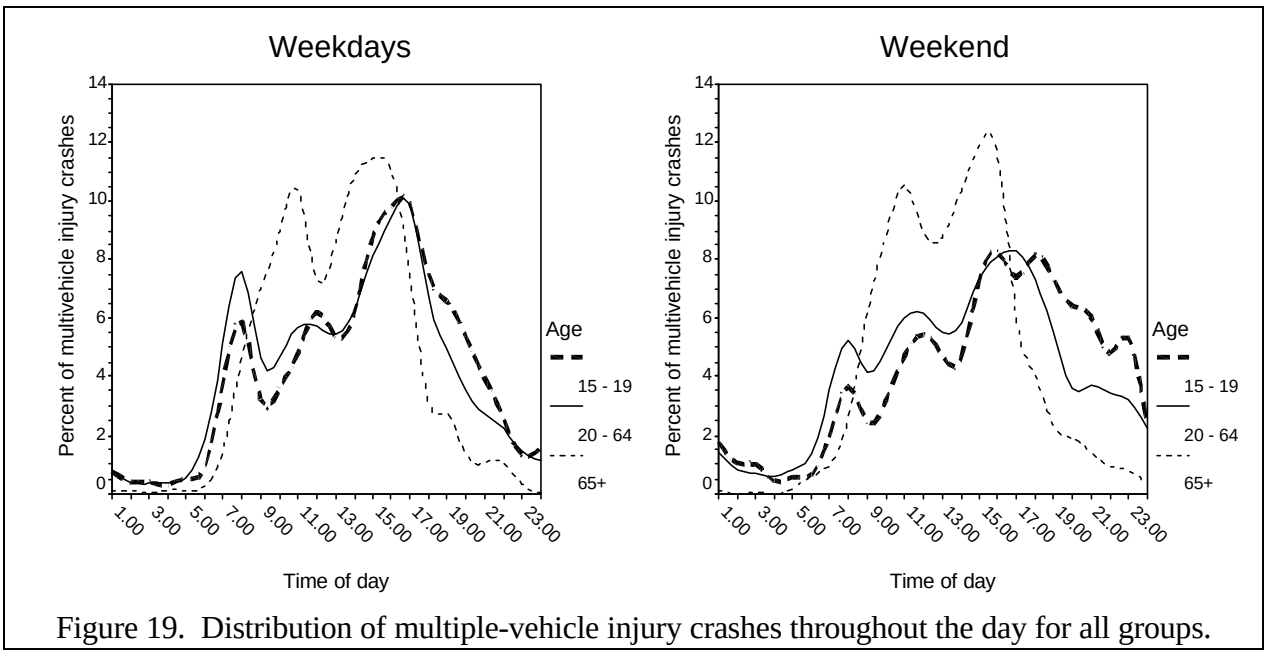

Figure 19. Distribution of multiple-vehicle injury crashes throughout the day for all groups.

[4] The crash data are from the LTSA National Crash data base for the years 1992 to 1997.

There are, however, differences between the groups in the types of crashes occurring during these times. Figure 20 shows the distribution of the most frequently recorded vehicle movement codes for the crashes of each of these groups on weekdays between 14.00 and 16.00. Older drivers had a disproportionately high number of crossing, turning, and manoeuvring crashes (codes H, J, L, & M). Young drivers had higher rates of collisions with turning vehicles (code G), and like the older drivers, higher rates of crossing and manoeuvring crashes (codes J & M). Older drivers (and to a lesser degree, younger drivers) did have fewer overtaking, head on, and rear end crashes (codes A, B, & F) as compared to drivers between the ages of 20 and 64.

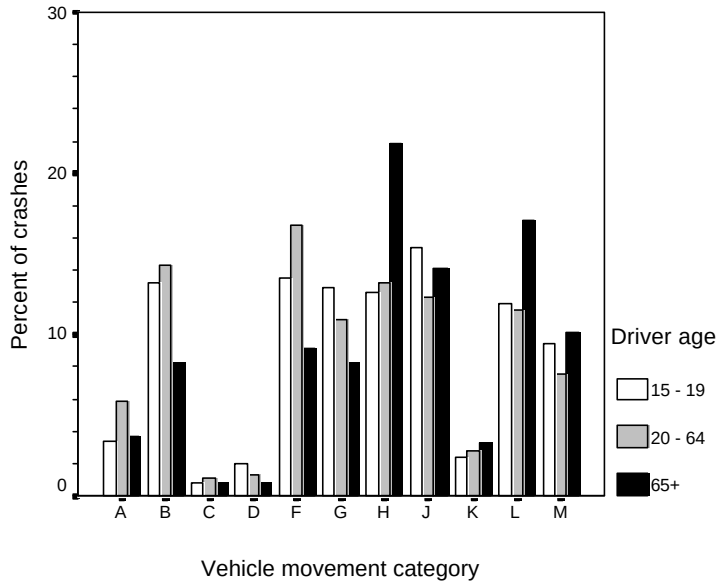

Figure 20. Most common vehicle movement categories recorded for multiple-vehicle crashes weekdays between the hours of 14.00 and 16.00.

Vehicle movement codes as follows: A= overtaking & land change, B = head on, C = lost control (straight roads), D = cornering, F = rear end, G = turning (vs. same direction), H = crossing (no turns), J = crossing (vehicle turning), K = merging, L = right turn against, M = manoeuvring (parking, U turn, etc.)

This pattern of different crash types across the driver age groups is not unique to week days or the afternoon hours. Figure 21 shows the most common multiple-vehicle crash types recorded across all hours and all days of the week. Here again, older drivers had a disproportionately high number of crossing, turning, and manoeuvring crashes (codes H, J, L, & M) while the young drivers showed a high proportion of crashes involving collisions with turning vehicles (code G), and like the older drivers, higher rates of crossing and manoeuvring crashes (codes J, L & M). So, although rates of injury crashes peak at times when different

driver age groups are simultaneously on the road, the crash mechanisms for these groups do not change appreciably from other times of the day as a result. Further, the vehicle movement categories for multi-vehicle crashes are quite similar for the youngest and oldest drivers with a predominance of crashes involving crossing, turning, and manoeuvring and fewer overtaking, head on and rear end crashes. It must be noted, however, that a substantially different pattern is revealed when single vehicle crashes are included. As can be seen in Figure 22, the number of lost control and cornering crashes (codes C & D) is increased significantly, but disproportionately so for young drivers.

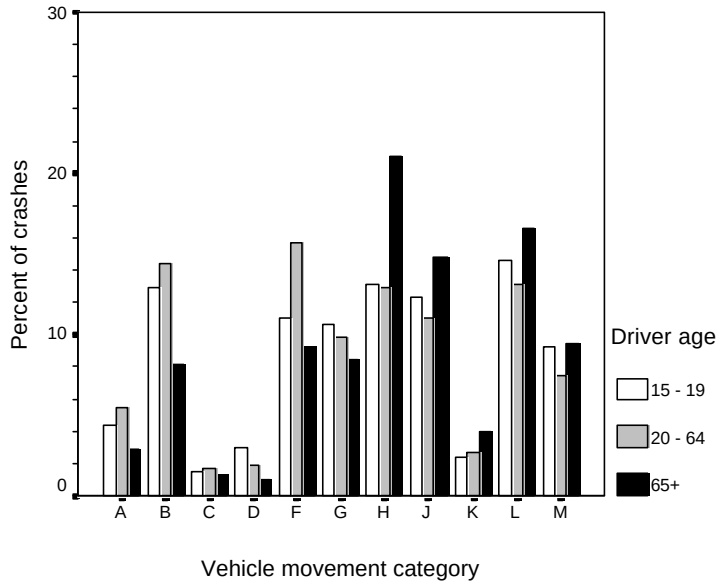

Figure 21. Most common vehicle movement categories recorded for all multiple-vehicle crashes.

Vehicle movement codes as follows: A= overtaking & land change, B = head on, C = lost control (straight roads), D = cornering, F = rear end, G = turning (vs. same direction), H = crossing (no turns), J = crossing (vehicle turning), K = merging, L = right turn against, M = manoeuvring (parking, U turn, etc.)

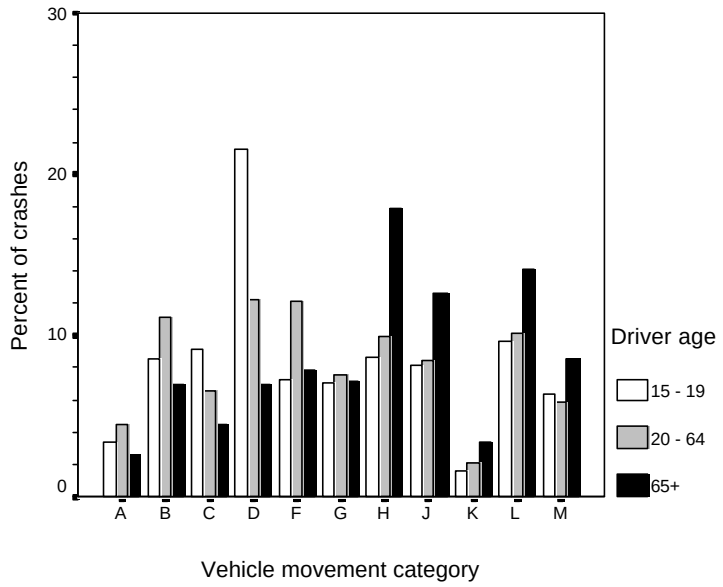

Figure 22. Most common vehicle movement categories recorded for all crashes.

Vehicle movement codes as follows: A= overtaking & land change, B = head on, C = lost control (straight roads), D = cornering, F = rear end, G = turning (vs. same direction), H = crossing (no turns), J = crossing (vehicle turning), K = merging, L = right turn against, M = manoeuvring (parking, U turn, etc.)

Considering these data in the context of crash statistics worldwide some notable trends become apparent. Crashes involving older drivers are more likely to involve multiple vehicles and more serious injuries (DLTR, 2001). Further, where fatal crashes involving two or more vehicles occur at intersections, the median age of the driver deemed responsible is 52 years old (DLTR, 2001). This is in comparison to a median age of 24 for crashes where only a single vehicle was involved. In the US, 40% of traffic fatalities and 60% of injuries to drivers on the 64+ age group occur at intersections, most of them during daylight hours (Hauer, 1988). In the UK, 63.1% of older drivers' fatalities occur at intersections, a much higher percentage than any other age group. Similarly, in Finland older drivers' fatal crashes typically occur during daylight hours, at intersections, and at low speeds (Hakamies-Blomqvist, 1988).

The percentage of fatal crashes is lower for the 65+ age group than for young drivers in all of these countries except Finland (19.3% versus 25.3%, 17.5% versus 24%, 21.3% versus 22.8%, and 22.3% versus 18.3% for NZ, US, UK and Finland respectively). Yet these two age groups are involved in more than 40% of fatal crashes. What is it that these groups have in common, and what makes them different? On rural roads, elderly drivers display a very smooth and uniform driving style with fewer accelerations and braking actions than young and

middle aged drivers (Schlag, 1993). When driving on inner city roads, however, the elderly are much more likely than other drivers to ignore red lights at controlled intersections (although less likely to drive through on amber lights), fail to follow give way rules at intersections, and failed to reduce speed at road-level railway crossings (Schlag, 1993). In contrast, young drivers in these situations display generally higher speeds, more overtaking manoeuvres, acceptance of smaller gaps between vehicles when turning at intersections, and a more dynamic driving style (rapid acceleration and deceleration, sharp braking, etc.). Although older drivers bring a wealth of advantages to the driving task in terms of experience and knowledge, they generally have greater difficulty perceiving, interpreting, and judging the movements and intentions of other drivers (Schmidt, 1987). When the behaviour of those other drivers is prone to rapid changes and higher velocities, as it is with young drivers, conflicts and crashes are perhaps a predictable result.

Conclusions – Road User Groups.

Characterising the road using population of New Zealand, the driver characteristics of gender, age, and area of residence (urban, secondary, urban, and rural) are the demographic factors which most clearly differentiate distinct road user groups in terms of their amount of driving. Men drive nearly twice as far as women, but women make an equivalent number of trips per day. Men are more likely than other drivers to be driving early in the morning and late at night, whereas women's travel peaks are later in the morning and earlier in the afternoon. Work-related driving forms the largest component of daily trips, followed by social/recreational, shopping, and transportation of passengers. Women take many more trips in these last two categories and their length indicate that women's trips are more often associated with urban and suburban trips close to home than men's trips.

Young drivers (aged 15 to 19) show less of a gender differentiation in their driving, and over the past 10 years, the amount of driving by young women has increased significantly, and in the case of young urban women now exceeds the driving by young men. Young drivers' trips are most often associated with work and social activities and are typically later in the day and night than other road users. The amount of driving decreases substantially after the age of 65, and older drivers tend to distribute their driving so that it occurs in off-peak daytime hours, late morning and early afternoon. Older drivers' trips are predominantly social/recreational and shopping trips, their work-related travel dropping to less than 2% of their trips.

ROAD USER INTERACTIONS

Analysis of the patterns of road use suggests that members of the various road user groups are most likely to interact on the roads during the mid-afternoon (14.00 to 16.00). Although these hours do not comprise the peak driving times for any of the road user groups, they do represent the time at which their respective driving hours overlap to the greatest extent. Interestingly, it is these hours of the day which are also associated with the greatest crash risk for drivers of all road user groups. Inspection of New Zealand crash data show that young drivers' and older drivers' crashes at these times have some characteristics in common; both groups have a disproportionate number of crossing, turning, and manoeuvring crashes. Young drivers' crashes which occur outside these hours are more typically loss of control and cornering crashes. This same pattern has been noted in crash statistics worldwide; older and younger drivers are vastly over-represented in fatality crashes and the types of crashes are remarkably similar at times of the day when these two groups are both on the road. Although it is an inference that a substantial number of the mid-afternoon crashes involve drivers of one age group colliding with those of another, it is not unreasonable to assume that it is the mismatch in driving styles and capabilities of these two groups (low speed, hesitant, and slower perceptions and reactions of older drivers versus high speed, hurried, and unpredictable driving of young drivers) that ultimately leads to the high rate of conflict and crashes. At later times of the day, the median age of drivers is younger and crashes more typically involve high speeds, cornering, and single vehicles. During these later hours there are very few older drivers on the road and thus fewer potential conflicts between young and old drivers (and many fewer crashes). While it is true that the lower number of multi-vehicle crashes occurring in the evening is in part due to a lower number of vehicles on the road during these hours, the contribution of the different driving styles of young and old to the disproportionate number of crashes occurring during the midafternoon should not be underestimated.

PERCEPTIONS OF RISK

The goal of this portion of the research programme is to identify and characterise the different patterns of risk perception, attitudes, and driving interactions of various New Zealand road user groups. The degree to which some portions of the road using public characterise the risk inherent in various driving situations is of interest inasmuch as it may affect their driving patterns and attitudes towards other road users. Following on from the preceding discussion of conflicts and crashes involving young and older drivers, one distinct area of difference between these road user groups is in their perceptions of driving risk and the difficulty of particular manoeuvres. Previous research (Trankle, Glau, & Metker, 1990; Groeger & Chapman, 1996; Lerner & Rabinovich, 1997) has shown that young male drivers tend to underestimate the risk inherent in various driving situations and overestimate their own driving skill and degree of control, while at the other extreme, older female drivers overestimate driving risk and underestimate their degree of control. Further, the risk acceptance of some road user groups (e.g., young males) appears to be significantly related to risk taking behaviours while driving, such as speed choice, and thus to an increased probability of crash involvement (Matthews & Moran, 1986; Harré, Field, & Kirkwood, 1996; Horswill & McKenna, 1999). These perceptions of driving risk and the driving skill of themselves, and other road user groups affect the nature of driver interactions between driver groups (Lerner & Rabinovich, 1997; Matthews & Moran, 1986).

For the New Zealand context, these patterns of risk perception and risk acceptance across driver age and gender are unknown. Additionally, the risk perceptions across other demographic and road use variables have yet to be identified. For example, how do drivers from rural areas perceive the risk inherent in urban motorway driving as compared to urban drivers? How do drivers rate the relative risk of approaching an intersection occupied by a large articulated truck as compared to a sedan? Most importantly, how do the risk perceptions of various New Zealand road user groups correlate to the number and type of crashes experienced by these drivers?

This portion of the report describes an experiment exploring the patterns of risk perception and the driving habits and attitudes of a sample of New Zealand drivers. Risk perception was assessed by asking the participants to rate the relative risk inherent in a series of photographs of several common driving situations, their willingness to accept that risk, their

own driving skill, and the relative skill of the other drivers depicted in the situation. Driving habits and attitudes were assessed by means of targeted questions on road use and responses to the Manchester Driver Behaviour Questionnaire (DBQ). The DBQ categorises driver behaviour in terms of errors, lapses, and violations and has been found to be a good predictor of crash involvement (Reason, et. al., 1990; Parker, Reason, Manstead & Stradling 1995; Stradling & Meadows, 2000). The impetus for the development of the DBQ was a closer examination of the role of human error in causing crashes. Norman (1981), Rasmussen (1982), Reason (1990) and others have argued that human error can be dichotomised into three distinct categories: lapses or slips (inadvertent or inappropriate occurrences of highly practiced behaviours), errors or mistakes (errors of omission or commission resulting from a lack of knowledge or information) and violations (intentional actions in violation of rules or established practice). The DBQ attempts to capture a driver's propensity to commit various types of aberrant behaviours while on the road and classify them as lapses, errors, and violations. Comparison of drivers' DBQ answers to their crash histories as well as analysis of accident statistics has shown that the violations score on the DBQ, particularly items classified as aggressive violations, is a good predictor of accident involvement (Parker et al, 1995, Rothengatter, 1997). This experiment will investigate the relationship between drivers' DBQ ratings and their perceptions of risk. These data will also be contrasted with the patterns of road use, conflicts, and crash findings described earlier in this report.

Method

Participants

An initial group of 32 participants were used to refine the questionnaire structure and administration protocol and was comprised of 18 women and 14 men ranging in age from 18 to 80. The pilot participants were recruited from university courses and notices posted in local papers in Hamilton and Tauranga. The participants were given a $5 gift voucher in recognition for their participation.

Another 327 participants were recruited to participate in the main experiment primarily through schools, sports clubs, Senior Citizens Associations and church groups in Auckland, Hamilton, Tauranga, Gisborne, New Plymouth, and Palmerston North. Some participants were recruited by placing notices in local papers but this form of recruitment was not found to be very effective. The participants ranged in age from 15 to 78 (mean age 41.63, std. dev. of

15.35) and all possessed an unrestricted driver licence. The sample consisted of 158 men and 154 women (15 participants did not indicate their gender on the questionnaire). Thirty-five percent of the participants resided in a main urban area at the time of the survey, 41% resided in a secondary urban area, and 24% resided in a rural area[5]. The groups that organised sessions were given a donation in recognition for their participation.

Materials

The primary experimental materials consisted of photographs of driving situations adapted from driving situations described in the Ministry of Transport's Advanced Assessment and Training Manual (1992), Lerner and Rabinovich's (1996) training program for improving young drivers' risk perception, and the NRMA (1999) young driver education programme. The scenarios were comprised of 8 different urban, rural, and motorway driving situations as shown in Table 1.

Each driving situation photograph was digitally edited to contain one of several vehicle types (e.g., motorcycle, compact car (coupe), sedan, van or ute, or large rigid truck). The resulting set of 34 photographs were independently reviewed by two professional driving instructors and subsequently modified according to their comments. The driving scenes from each situation type are shown in Appendix A. The final photographs were compiled into a CD ROM-based questionnaire that asked participants to rate four aspects of each photograph: 1) the degree of driving risk in the situation, 2) their willingness to accept the risk in that situation, 3) their degree of control over their own vehicle in that situation, and 4) the driving skills of the other driver(s) depicted in the situations. These four questions were adapted from Lerner and Rabinovich's (1997) study of risk perception in young male drivers. Each question was rated on a 100-point scale by the participants. The specific wording of the questions, and the anchor points for the rating scales are shown in Table 2.

[5] Main urban areas included cities with over 60,000 residents (i.e., Auckland, Hamilton, and New Plymouth), secondary urban areas included cities with a population of 10,000 or greater, (i.e., Tauranga, Gisborne, and Palmerston North), with participants living outside those cities identifying themselves as rural.

Table 1. Driving scenario.		
Urban	Rural	Motorway
Urban Turn *Oncoming traffic turning in front of driver*	Rural Pass *Oncoming traffic with potential pass in front of driver*	Motorway Pass *Being overtaken in traffic (mirror view)*
Urban Overtaking *Overtaking vehicles at street-side parking*	Rural Overtaking *Overtaking a parked vehicle*	Motorway merge *Traffic merging from left*
Urban "T" *Approaching a vehicle at a T intersection*	Rural "T" *Approaching a vehicle at a T intersection*	

Table 2. Driving risk questions.	
How great a degree of risk do you feel there is in this situation?	
No risk (1)	Extremely high risk (100)
How willing are you, as a driver, to accept the risk in this situation?	
The risk is completely acceptable (1)	The risk is completely unacceptable (100)
How good are your vehicle control skills for dealing with this situation?	
My actions can avoid any potential problem (1)	My actions will have no effect on whether there is a collision (100)
How would you rate the other driver(s) in this situation?	
Certain to contribute to a serious situation (1)	Unlikely to contribute to a serious problem (100)

In addition to the ratings of the driving scenes, a series of questions about driver demographics (e.g., age, gender, occupation, income) and driving patterns (e.g., type of vehicle, typical purposes of car trips, typical times of day for trips) were also presented to the participants. The end of the questionnaire consisted of the 28-item Manchester Driver Behaviour Questionnaire (DBQ) (Reason, et. al., 1990; Parker, Reason, Manstead, & Stradling 1995). The DBQ categorises driver behaviour along four complementary dimensions: driving errors, lapses, violations, and aggressive violations. A copy of the 28-item version of the DBQ is shown at Appendix B.

Procedure

The participants in the pilot study were asked to answer the demographic questions and then were each shown a series of 8-9 of the driving situation photographs selected at random from the overall set of 34 photographs. The photographs were presented on a 21 in computer screen located on the desk in front of them. The results from this pilot investigation were used to refine the questionnaire structure and administration protocol.

The main body of experimental participants were surveyed in groups ranging from 5 to 40. The participants were asked to complete the demographic questions in a questionnaire booklet provided to each participant. Following completion of the demographic questions, the participants were shown an example driving scene and allowed to practice answering the four rating questions. The driving scenes were projected on a screen in front of the group of participants and were presented at a rate of approximately 30 sec per scene with 5 sec interval between scenes. The presentation order was counterbalanced across experimental sessions. The participants rated the driving scenes individually in their questionnaire booklets and if desired by the group, a short rest break was allowed at the half-way point. Following the rating of the driving scenes, the participants were asked to complete the 28 DBQ items. Experimental sessions took between 45 min and 1 hr to complete, including instructions and questions and discussion at the end of the session.

Results

As mentioned earlier, demographic data collected from the participants included their occupation, average annual income, type of vehicle, amount of driving per week, typical times of day for trips, and typical purposes of car trips. The result for one of these questions, amount of driving per week, is shown in Figure 23. As can be seen in the figure, the results for the sample of 327 participants is consistent with the data reported previously from the national household travel survey; rural males aged 20-64 report driving the most with young and older drivers in secondary urban areas driving the fewest kms. As with the national survey, there was a significant positive correlation between reported income and the amount of driving, with higher earners driving more; $r = .183$, $p < .01$.

Figure 24 shows the distribution of driving throughout the day for men and women participants, and as with the national survey data, there are two clearly defined peaks between the hours of 6.00 to 10.00 and 14.00 to 18.00. Figure 25 shows the pattern of driving throughout the day for the three age groups, and it can be seen that young drivers have a greater proportion of their driving later in the day, whereas the older drivers tend to allocate their driving to off-peak hours (later in the morning and in the early evening). Finally, the purpose of drivers' trips is shown in Figure 26, and once again travel to work is the most frequent destination for both men and women, with men travelling more as part of their job and women making more trips for shopping and to transport children. It is apparent from these travel data

that the driving behaviour of our sample of 327 drivers appears to be equivalent to the driving patterns reported in the national survey.

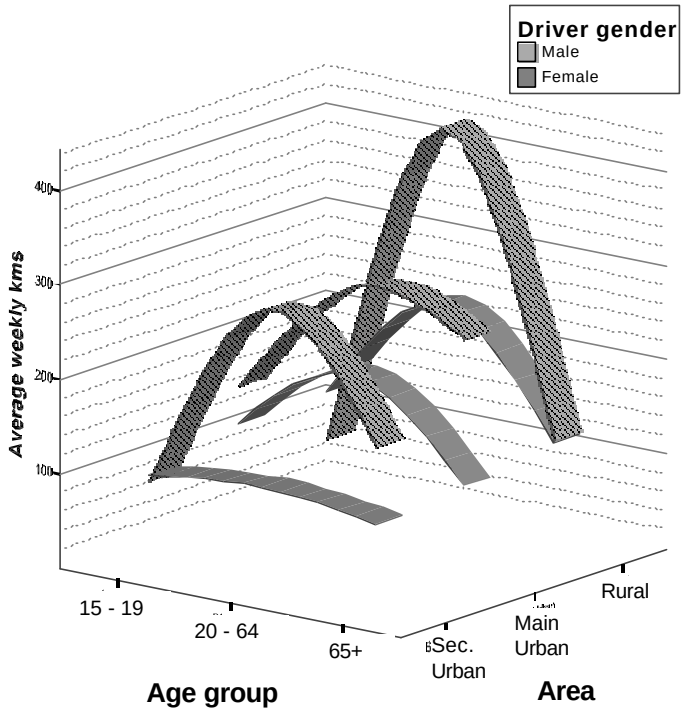

Figure 23. Age, gender, area, and average kms driven per week.

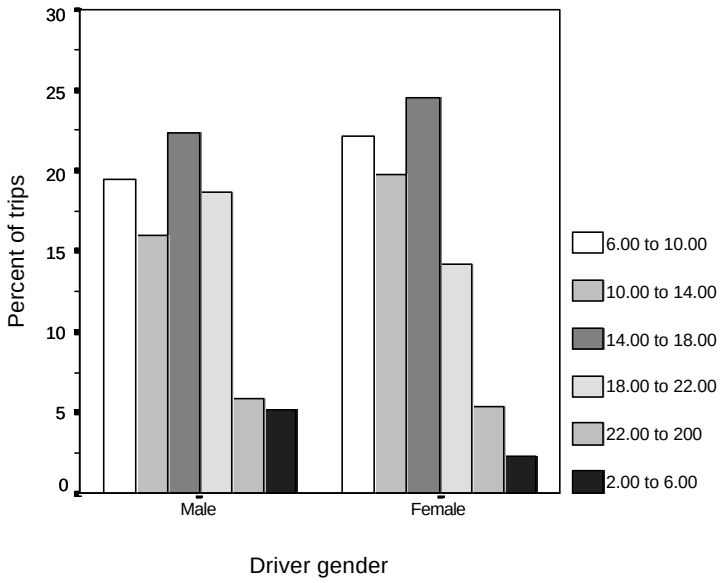

Figure 24. Distribution of driving hours throughout the day by men and women.

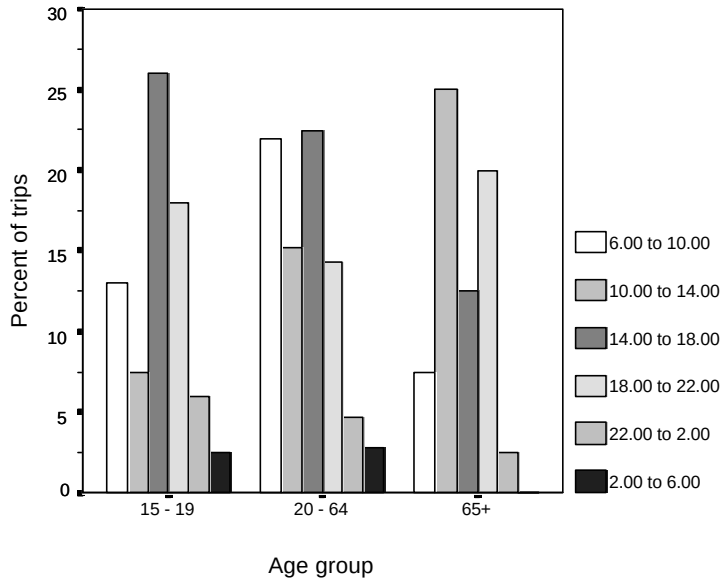

Figure 25. Distribution of driving hours throughout the day for different age groups.

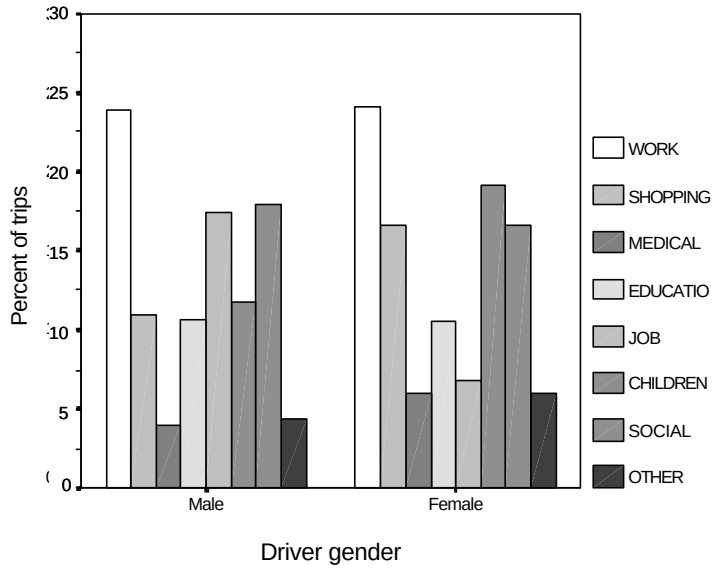

Figure 26. Purpose of trips for men and women drivers.

Overall perceptions of risk.

Figure 27 shows the participants' ratings of driving risk for the eight driving scenario types (i.e., urban turn, rural overtaking, motorway merge, etc.). As can be seen in the figure, the participants regarded some of the scenarios as intrinsically more hazardous than others. A repeated-measures analysis of variance indicated that the differences between scenario types was statistically reliable, $\underline{F}$ (7, 318) = 71.18, $\underline{p} < .01$. The "urban overtaking" scenario, where the driver is passing a row of parked cars (one of which has begun reversing), was rated as

having the highest risk. The "rural pass" in which there is oncoming traffic with a potential passing manoeuvre involved was also rated as having a high degree of risk by the participants. In contrast, the risk ratings for the "urban turn" and "urban T" driving scenarios were significantly lower than the ratings for the other scenarios.

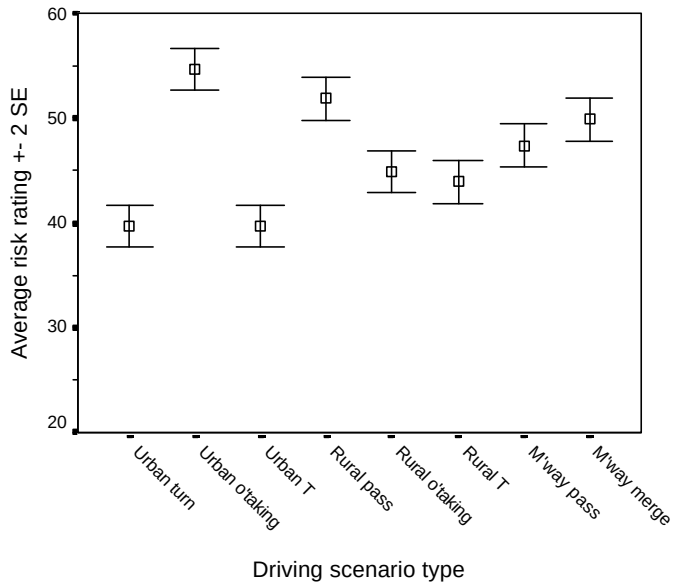

Figure 27. Risk ratings for the 8 scenario types.

Figure 28 shows the risk ratings for 5 vehicle types used in the driving scenarios. A repeated-measures analysis of variance indicated that the differences between vehicle types were statistically reliable, $\underline{F}$ (4, 320) = 55.13, $\underline{p} < .01$. Driving scenes containing motorcycles and trucks were typically rated as being more risky than scenes containing other vehicles. Similarly, when asked to rate the other drivers depicted in the scenes (in terms of whether their behaviour would lead to a serious problem), there was a significant difference for vehicle type, $F (4, 320) = 7.456$, $p < .01$, with scenes containing trucks and motorcycles being rated as most likely to lead to a serious problem, and scenes with the two-door cars being rated as least likely to lead to a serious problem. It should be noted that trucks were the most consistently associated with high risk ratings as only two of the 34 driving scenes contained motorcycles (rural pass and urban turn). Thus regardless of participant age, gender, or area of residence, driving situations containing trucks and motorcycles were viewed as possessing a greater degree of risk and the drivers of those vehicles were seen as having the potential to cause a serious problem.

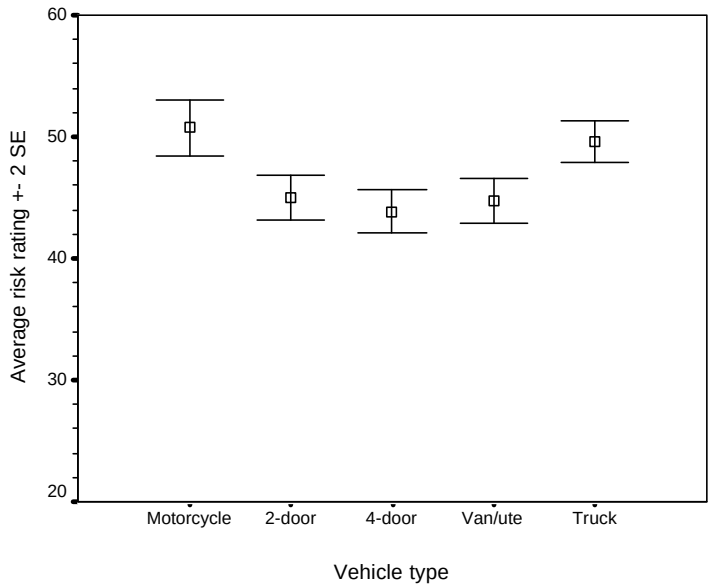

Figure 28. Risk ratings for 5 vehicle types.

Of the 34 driving scenes presented to the participants, the urban overtaking scenario featuring the truck was rated as the riskiest, followed by the rural pass scene containing the motorcycle and the motorway merge containing the truck. The two scenes with the lowest ratings of risk were the urban turn and the urban T scenes, both containing a two-door car. Table 3 shows the average risk ratings for the 34 driving scenes in descending order.

Table 3. Average risk ratings for the 34 driving scenes.

Driving scene	Mean risk rating	Driving scene	Mean risk rating
urban overtaking truck	63.94	m'way pass 2 door	44.88
rural pass motorcycle	59.69	rural overtaking truck	43.68
m'way merge truck	57.65	rural T 2 door	43.62
m'way pass truck	55.58	rural T 4 door	43.41
urban overtaking van	53.97	rural T ute	43.29
rural pass van	51.92	m'way pass 4 door	43.00
rural pass 4 door	51.87	urban T 4 door	42.27
urban overtaking 4 door	50.29	urban turn truck	42.22
urban overtaking 2 door	50.13	m'way merge 4 door	42.01
rural overtaking 2 door	50.02	urban turn motorcycle	41.85
m'way merge 2 door	49.91	urban T truck	40.83
m'way merge van	49.91	urban turn van	39.82
rural pass 2 door	49.26	urban T van	39.14
rural pass truck	47.10	rural overtaking 4 door	39.12
rural overtaking van	46.48	urban turn 4 door	39.03
m'way pass van	46.17	urban T 2 door	36.82
rural T truck	45.02	urban turn 2 door	35.97

Risk perception and road user groups.

Figure 29 shows the ratings of risk for the urban, rural and motorway scenarios from participants living in urban, secondary urban, and rural areas. Overall, participants rated the urban scenarios as least risky, followed by the rural scenarios, with motorway scenarios receiving the highest risk ratings. A repeated measures multivariate analysis of variance indicated that while there was a main effect of scenario location, ($F(2, 646) = 26.24$, $p < .01$) but no statistically reliable difference between the ratings of the three residential road user groups. Thus, the perception of the motorway scenarios as having the greatest risk overall, and the urban scenarios as having the least risk, did not differ as a function of where the participants lived.

Examining the risk ratings for the highest and lowest rated driving scenes (ratings of urban overtaking truck and urban turn two-door), there was a difference between the residential areas (a significant area by scene interaction, $\underline{F}(2, 320) = 3.99$, $\underline{p} < .01$) such that the rural residents rated both scenarios as riskier than the other participants, the main urban residents rated the urban overtaking truck scene as less risky than the other participants and secondary urban residents rated the rural turn two-door scene as less risky than main urban and rural residents. This interaction is shown in Figure 30.

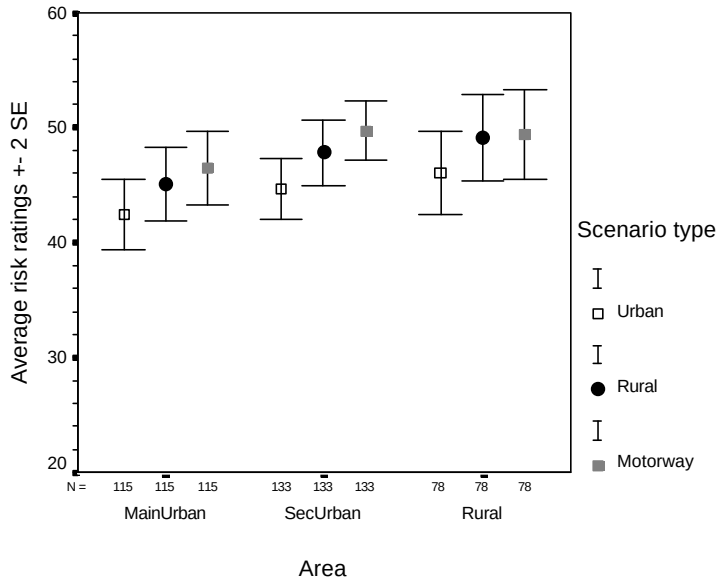

Figure 29. Ratings of risk by road users living in urban, secondary urban, and rural areas.

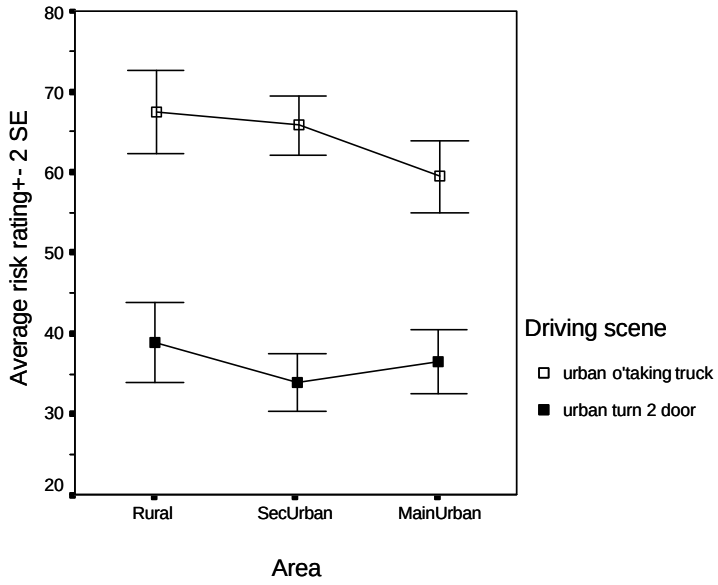

Figure 30. Ratings of risk for high risk scene (urban overtaking truck) and low risk scene (urban turn 2 door) by road users living in urban, secondary urban, and rural areas.

Turning to gender and age differences in risk ratings, perhaps the most noteworthy gender difference was a significant interaction with type of vehicle ($F(4,301) = 2.39$, $p < .05$). Women participants generally rated the scenarios the same as or slightly riskier than men, but women rated the motorcycle scenarios as being much riskier. There was also a significant interaction between gender and age for the participants' overall ratings of other drivers (the degree to which their driving is likely to cause a serious problem). The male participants tended to rate other drivers as worse (more likely to cause a problem) as they get older, whereas women rate them as better ($F(2, 306) = 3.80$, $p < .05$), as shown in Figure 31.

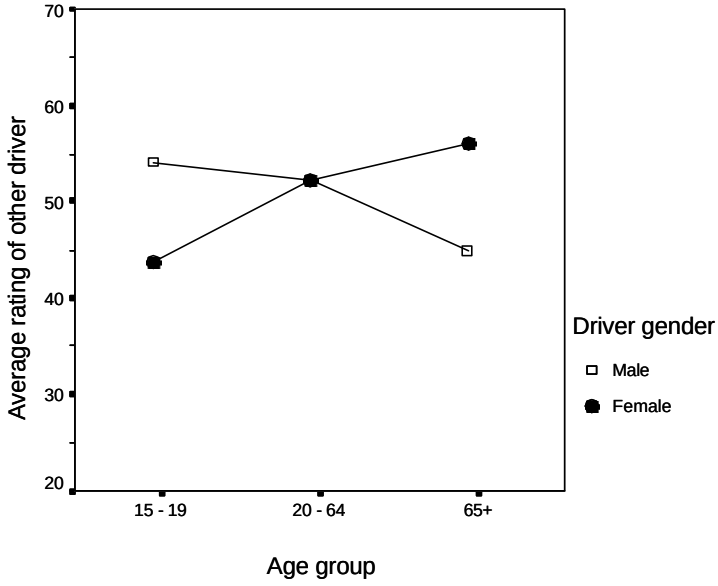

Figure 31. Ratings of other drivers by men and women drivers across the three age groups.

There were several noteworthy age differences in the participants' risk ratings. A multivariate analysis of variance indicated a significant age difference across the various scenario types (an age by scenario type interaction, $F(14,600) = 2.18$, $p < .01$). As can be seen in Figure 32, the source of this interaction lies in the finding that young drivers tended to rate the rural pass and motorway merge scenarios as much less risky than other drivers, while older drivers tended to rate the rural overtaking, rural T, and motorway pass as less risky than other drivers.

Considering only the highest and lowest rated risk driving scenes, there was also a significant age effect for the high risk scene (urban overtaking truck) such that older drivers rated it as riskier than other drivers; $F(2, 304) = 105.11$, $p < .01$ (as shown in Figure 33). For the low risk scene (urban turn 2-door) ratings of risk increased linearly with the age of the driver; $F(2, 304) = 23.77$, $p < .05$. Interestingly, participants' ratings of risk acceptance and their own driving skill showed a significant gender effect (but no age effect) for the high risk scenario such that men were more willing to accept the risk than women, $F(1, 304) = 4.72$, $p < .05$, and rated their skill as being better able to cope with the situation, $F(1, 302) = 7.52$, $p < .05$.

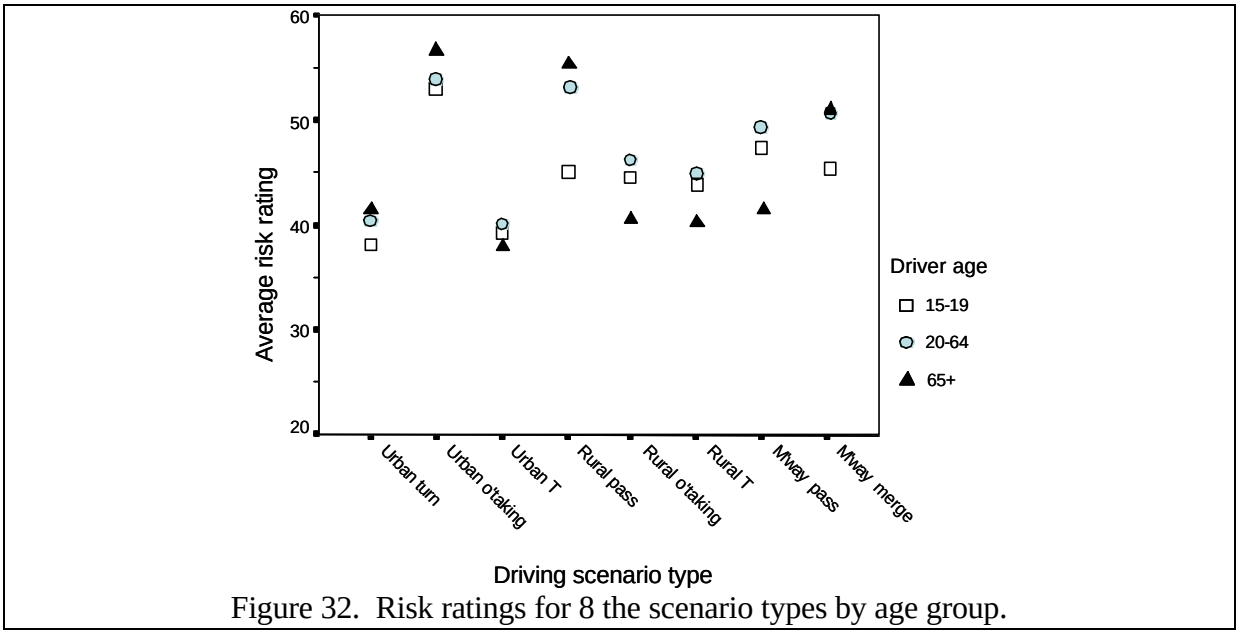

Figure 32. Risk ratings for 8 the scenario types by age group.

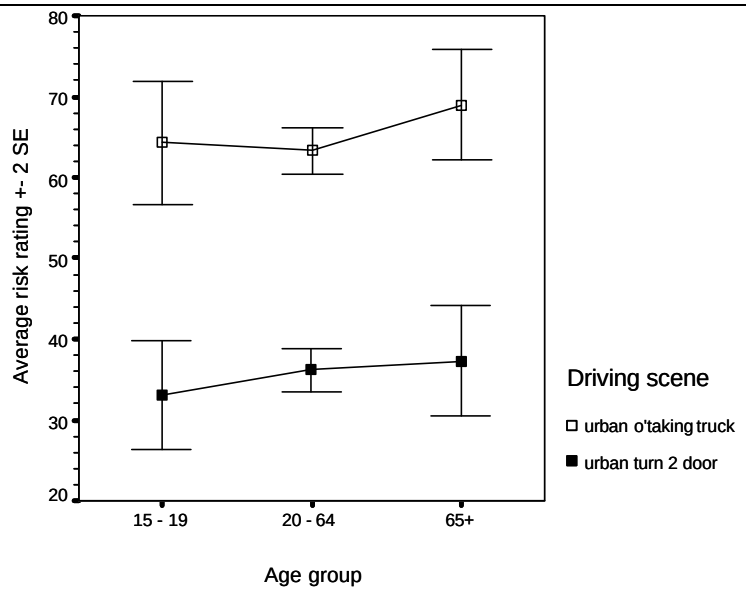

Figure 33. Risk ratings for the high risk scene (urban overtaking truck) and low risk scene (urban turn 2 door) by age group.

DBQ ratings

The participants' responses to the DBQ indicated some significant differences in the driving habits of the participants. An analysis of variance indicated significant age and gender differences for violations ($F(2, 304) = 17.11$, $p < .01$ and $F(1, 304) = 19.47$, $p<.01$, respectively), and aggressive violations ($F(2, 304) = 16.31$, $p < .01$ and $F(1, 304) = 10.18$, $p<.01$,). The results for violations and aggressive violations are shown in Figures 34 and 35 with young males being much more likely to violate the traffic rules and display aggressive acts towards other drivers. There is also a gradual decrease in these tendencies with driver age, although young women did not display the high levels of violations reported by young men. In addition to the relationship of the violation and aggressive violation scores to age and gender, there were also significant positive correlations between these scores and the amount of weekly driving reported; $r = .173$ and $r = .144$, $p <.01$ for violations and aggressive violations respectively. Finally, rural residents reported the highest rates of violations, although this difference was only marginally significant; $F(2, 321) = 2.62$, $p < .07$.

There was a significant gender effect for the DBQ lapse scores, such that women reported more frequently trying to start in the wrong gear, getting into the wrong lane approaching a roundabout, etc.; $F(1, 308) = 6.16$, $p < .01$. There was also a marginally significant age difference in the DBQ error scores, with young drivers reporting more errors than older drivers; $F(2, 322) = 2.59$, $p < .07$.

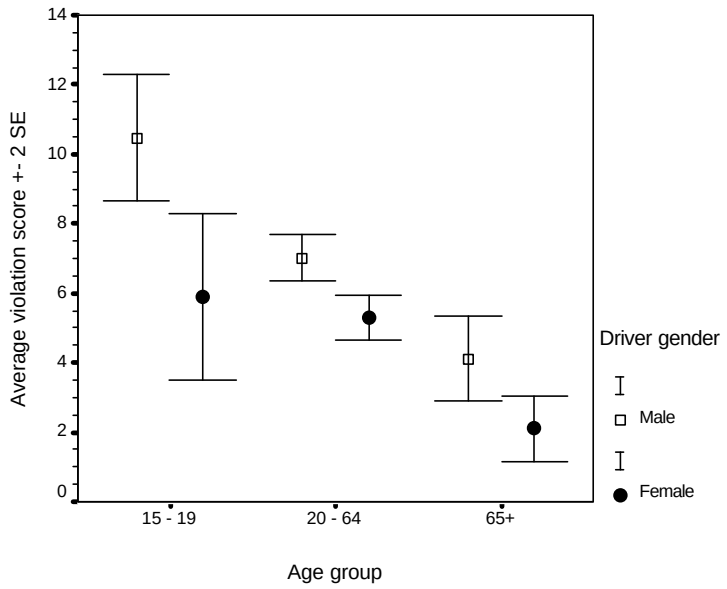

Figure 34. Average scores for violations for men and women.

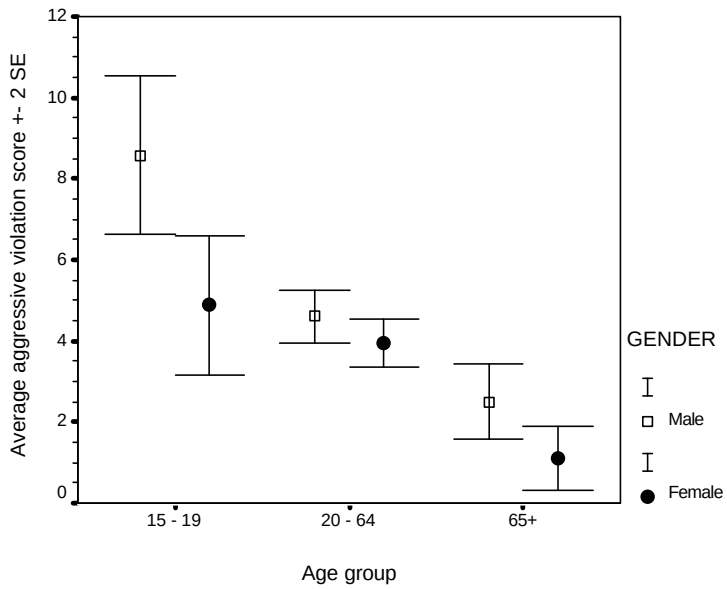

Figure 35. Average scores for aggressive violations for men and women.

Of all the DBQ components, the error scores were the most highly correlated with the participants' risk ratings. The error scores were significantly correlated with each participant's average ratings of risk ($r = .199$, $p < .01$), their average willingness to accept risk ($r = .163$, $p < .01$), their own driving skill, ($r = .166$, $p < .01$), and ratings of other drivers ($r = -.135$, $p < .01$). Thus, drivers with high error rates (regardless of their age) had higher overall risk ratings, were less willing to accept risk, had lower ratings of their own driving skill, and were more likely to see other drivers as posing a serious problem.

Table 4 compares ratings from four violations and three aggressive violations items from this study to the results from drivers in other countries. Comparing the ratings of the violations items by the participants in this study (the first column of the table) to the ratings from other countries, it can be seen that the general New Zealand population has somewhat higher average ratings than drivers in the United Kingdom and Sweden, lower than Australian drivers on the drink driving and overtaking items, and lower than drivers in China for all the items.

Table 4. Comparison of average ratings for 7 DBQ items.

	NZ	NZ yng	NZ old	NZ trk 1	UK 2	UK yng 3	UK old 4	UK com 5	Aus 6	Swe 7	Chi 8
Violations											
Drive when you suspect you might be over the legal blood alcohol limit	.41	.41	.36	.24	.28	.32	.20	.23	.61	.11	.85
Overtake a slow driver on the inside	.71	1.12	.34	.24	.67	1.19	.58	1.16	2.24	.54	1.74
Drive so close to the car in front that it would be difficult to stop in an emergency	.85	1.50	.36	.69	.73	1.13	.37	.84	.79	.71	1.44
Cross an intersection knowing that the traffic lights have already turned against you	.98	1.18	.44	.54	.75	1.06	.48	.60	.33	.14	1.08
Aggressive violations											
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	.30	.76	.03	.28	.32	.52	.11	.19	.29	.22	.97
Race away from traffic lights with the intention of beating the driver next to you	1.00	2.56	.39	.50	.37	.56	.16	.97	.50	.51	1.09
Become angered by a certain type of driver and indicate your hostility by whatever means you can	.98	1.53	.50	.93	.50	.97	.27	.93	.54	.86	.98

Notes:
1. Sample of 378 commercial truck drivers in New Zealand. Sullman & Meadows (2000).
2. Sample of 1842 drivers in the United Kingdom. Parker et al (1995).
3. Sample of 1601 young drivers in the United Kingdom. Meadows (1994), cited in Stradling et al (1998).
4. Sample of 817 older drivers (50-80 yrs) in the United Kingdom. Stradling et al (1998).
5. Sample of 441 commercial car drivers. Dimmer & Parker (2001).
6. Sample of 135 drivers in Western Australia. Blockley & Hartley (1995).
7. Sample of 1400 drivers in Sweden. Aberg & Rimmo (1998).
8. Sample of 263 drivers in China. Stradling et al (1998).

In terms of the aggressive violations, our drivers' ratings for "racing away from the lights" and "indicate hostility" are higher that ratings of any other drivers except the Chinese

sample. The high scores on these two items were primarily due to the young men in our sample who had an average rating of 3.13 for "racing" and 1.75 for "indicate hostility" (as compared to .91 and 1.0 for middle aged drivers of both sexes). Looking at our young drivers' scores on these two items (the second column of the table) we see that they are much higher than any of the other samples, including a sample of young drivers in the United Kingdom.

Conclusions – Perceptions and Attitudes.

Based on an examination of the road use and demographic data, our sample of 327 drivers appeared to be a very good approximation of the New Zealand driving population described in the first half of this report, and the scenarios employed in the risk assessment paradigm showed a good range of risk ratings. Overall, situations involving trucks and motorcycles were rated as significantly riskier than other vehicles. Motorway scenarios were rated as being the riskiest and urban scenes the least risky. There were significant differences in the risk ratings of various road user groups. Rural drivers and women drivers had somewhat higher risk ratings across all of the driving scenarios, but much higher ratings for the high risk scenarios. Men indicated the greatest willingness to accept the risk in the driving situations and rated their own driving skill as higher. Finally, older drivers rated all driving situations as having the highest risk of any age group and young drivers tended to rate the lower risk situations as less risky than other drivers.

In terms of driving behaviour as measured with the DBQ, young men reported very high levels of violations and aggressive violations. The male drivers' rates of violations and aggressive violations were significantly higher than the women drivers' and the number of both decreased significantly with age. Women reported the highest rate of driving lapses, while young drivers reported the highest number of errors. DBQ error scores correlated with the risk ratings such that drivers with high error scores had the highest risk perceptions, were least willing to accept the risk in a situation, rated their own driving skill lowest, and were most likely to see other drivers as posing a serious problem.

This pattern of findings corresponds well to overseas results. As with our New Zealand sample, older drivers and women drivers in the United Kingdom and the United States rate dangerous driving situations as being higher in risk whereas young drivers and men drivers are more willing to accept the risk in these situations and rate their own driving abilities higher (Groeger & Chapman, 1996; Lerner & Rabinovich, 1997). Similarly, young drivers in the

United Kingdom have higher rates of violations and aggressive violations as measured with the DBQ, just as our young New Zealand drivers did. New Zealand drivers, however, (particularly our young males) appear to have much greater propensity for some types of aggressive violations such as racing other drivers at stop lights. This finding is perhaps indicative of the high level of acceptance of speeding by New Zealand drivers'. In the Public Attitudes To Road Safety Survey 2000, 46% of male drivers and 34% of females said that they enjoyed driving fast on the open road (LTSA, 2001b). This attitude is strongest among our young male drivers; in the 2001 version of the Survey 65% of male drivers aged between 15 and 24 said they liked driving fast, including 22% who said they liked it 'very much' (LTSA, 2002). Young drivers were also the most likely to report having received a speeding ticket from a speed camera in the preceding year; 26% as compared to 17% of all drivers).

DISCUSSION

Based on our results to date, several clear generalisations can be made about the road using population in New Zealand. First, there is a profound gender difference in the driving behaviour and perceptions of men and women drivers. Men drive more than women and they are on the road earlier in the morning and later at night. Men rate high-risk scenarios as being less risky, they show a greater willingness to accept the risk, and they rate their own driving skill higher. They have significantly higher violation and aggressive violation scores. Men also have a higher crash risk (injury and fatality) than women Further, these differences appear to be a direct gender effect rather than any effect associated with men's higher amount of driving; a multivariate analysis of covariance with amount of driving as a covariate found same gender effects on risk perceptions and driving behaviour indicated above, all significant beyond the .01 level.

Second, there are significant differences in driver behaviour and perceptions due to age. Young and older drivers drive less than middle-aged drivers. Young drivers drive later in the day, while older drivers tend to avoid peak hours by driving in the middle of the day. Older drivers tend to rate both high and low risk situations as being riskier than other drivers do. Young drivers have much higher violation and aggressive violation scores and a higher rate of driving errors. There are, however, notable similarities between young and older drivers in terms of their crashes. Compared to middle aged drivers, older drivers have more crossing, turning, & manoeuvring crashes during the mid-afternoon hours. Young drivers also have high rates of crashes involving crossing and manoeuvring at these times of day, as well as the highest rates of loss of control and cornering crashes later in the day. Given the differences in the perceptions and attitudes of young and older drivers, why do they share a propensity for mid-afternoon crashes at intersections? One potential clue to this puzzle lies in how these perceptual and attitudinal differences are manifested in the driving styles of the two groups. Perhaps by virtue of their greater experience on the road, older drivers have a heightened perception of risk as compared to young drivers. This is accompanied, however, by older drivers' greater difficulty perceiving, interpreting, and judging the movements and intentions of other drivers (in part due to some degradation in perceptual abilities with age). When driving on inner city roads the elderly are much more likely than other drivers to ignore red lights at controlled intersections and often fail to follow give way rules at intersections. In contrast, young drivers perceive inner city driving as less hazardous than older drivers and typically

drive at higher speeds, make more overtaking manoeuvres, accept smaller gaps between vehicles when turning at intersections, and a display a generally more dynamic driving style (rapid acceleration and deceleration, sharp braking, etc.). When these two different perceptual and behavioural styles share the same road (during the mid-afternoon), it is not at all surprising that older and young drivers have the majority of midafternoon crashes at intersections.

There are also differences in driver behaviour and perceptions of residents of rural and urban areas. Rural drivers drive further, but make fewer trips than residents of urban and secondary urban areas. Rural residents rate high and low risk situations as slightly more risky than urban and secondary urban drivers and interestingly, rural drivers report a higher number of violations. Statistically, rural roads are associated with a higher rate of injury crashes but a lower rate of fatality crashes.

The results of the present research can also offer some clues regarding trends for the future of our driving population. We know from population demographics that the next few decades will result in an aging population (Statistics NZ, 2002). Given those demographics we might expect to see an increasing proportion of road users with the road use, risk perception, and driving behaviour characteristics of the older drivers described in this study: fewer driving hours, more driving in the middle of the day, higher perceptions of risk, and a higher proportion of crossing, turning, & manoeuvring crashes. Further, the gender differences observed in this study were the greatest for older drivers. It may be the case that even greater gender differentiation between drivers will be observed as the average age of licensed drivers increases. While it could be argued that the lack of gender differentiation in the amount of travel among young drivers might offset this trend as these young drivers age with their driving patterns intact, the finding that the perceptual and behavioural differences between men and women exist in spite of differences in road use (or the lack thereof) leads us to believe that the differences in men and women drivers are fundamental and will continue to be observed in an aging population of road users.

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APPENDIX A

DRIVING SCENES

APPENDIX B

MANCHESTER DRIVER BEHAVIOUR QUESTIONNAIRE

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over, say, the past year.

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time

	never					all the time
please tick the most appropriate column for EACH item	**0**	**1**	**2**	**3**	**4**	**5**
Hit something when reversing that you had not previously seen						
Intending to drive to destination A, you "wake up" to find yourself heading for destination B, maybe because the latter is a more usual destination						
Drive when you suspect you might be over the legal blood alcohol limit						
Get into the wrong lane approaching a roundabout or an intersection						
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front						
Fail to notice that pedestrians are crossing when turning into a side street from a main road						
Sound your horn to indicate your annoyance at another road user						
Fail to check your rear-view mirror before pulling out, changing lanes, etc.						
Brake too quickly on a slippery road, or steer the wrong way in a skid						
Pull out of an intersection so far that the driver with right of way has to stop and let you out						
Disregard the speed limit on a residential road						
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers						
On turning left, nearly hit a cyclist who has come up on your inside						
Miss "Give Way" signs, and narrowly avoid colliding with traffic having right of way						
Attempt to drive away from the traffic lights in third gear						
Attempt to overtake someone that you hadn't noticed to be signalling a right turn						
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind						
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane						
Forget where you left your car in a car park						
Overtake a slow driver on the inside						
Race away from traffic lights with the intention of beating the driver next to you						
Misread the signs and exit from a roundabout on the wrong road						
Drive so close to the car in front that it would be difficult to stop in an emergency						
	0	**1**	**2**	**3**	**4**	**5**

all the

ROAD USER INTERACTIONS

	never					time
(continued)	**0**	**1**	**2**	**3**	**4**	**5**
Cross an intersection knowing that the traffic lights have already turned against you						
Become angered by a certain type of driver and indicate your hostility by whatever means you can						
Realise that you have no clear recollection of the road along which you have just been travelling						
Underestimate the speed of an oncoming vehicle when overtaking						
Disregard the speed limit on the open road						
	0	**1**	**2**	**3**	**4**	**5**