U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

NHTSA
www.nhtsa.gov

DOT HS 811 380

September 2010

Distracted Driving and Driver, Roadway, and Environmental Factors

1. Report No. DOT HS 811 380	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **Distracted Driving and Driver, Roadway, and Environmental Factors**		5. Report Date September 2010 6. Performing Organization Code NPO-421
7. Author(s) Santokh Singh, Ph.D. Mathematical Statistician, Bowhead Systems Management, Inc. contractor working at NCSA		8. Performing Organization Report No.
9. Performing Organization Name and Address: Mathematical Analysis Division, National Center for Statistics and Analysis National Highway Traffic Safety Administration 1200 New Jersey Avenue SE., Washington, DC 20590		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Mathematical Analysis Division, National Center for Statistics and Analysis National Highway Traffic Safety Administration 1200 New Jersey Avenue SE., Washington, DC 20590		13. Type of Report and Period Covered NHTSA Technical Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Drivers often perform non-driving activities that divert their attention from the primary task of driving. This may be due to conversing with a passenger, dialing or hanging up a cell phone, having a phone conversation, or adjusting the radio or other vehicle controls. A driver may also lose focus on driving due to engaging in non-driving cognitive activities, such as being lost in thought or thinking about personal or financial problems. In addition, some crash-associated factors such as driver age and gender, roadway traffic, and environmental conditions may influence a driver's likelihood of engaging in non-driving activities.

NHTSA conducted the National Motor Vehicle Crash Causation Survey (NMVCCS) to collect on-scene information on several crash factors, including the ones related to driver inattention. The NMVCCS data was used in this study to look at two facets of distracted driving, namely distraction from sources within the vehicle and non-driving cognitive activities, as associated factors.

A descriptive analysis of the weighted data brought out some interesting facts about distracted driving. For example, the results show that, among the crash-involved drivers, distraction from internal sources was more common than distraction due to non-driving cognitive activities. The data also revealed that conversing with a passenger was the most common source of distraction from internal sources, while inattentiveness due to unknown thought focus was the most prevalent factor among the non-driving cognitive activities. Other important patterns detected include the decreasing trend in distraction from internal sources with increasing driver age; the high incidence of drivers under 16 who were thinking about personal problems, and drivers 16 and older who were inattentive due to some unknown thought focus during the pre-crash phase.

This report provides necessary details of the NMVCCS data followed by discussion on the choice of the relevant variables and the analysis methodology. The results from univariate and bivariate analyses are discussed in detail, reflecting on the impact of distracted driving on crash occurrence.

17. Key Words Associated factor, Internal sources, Cognitive activities, Inattention, Descriptive analysis, Bivariate analysis	18. Distribution Statement Document is available to the public through the National Technical Information Service. www.ntis.gov		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 40	22. Price

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EXECUTIVE SUMMARY

Distraction is a specific type of inattention that occurs when a driver's attention is diverted from the driving task to focus on a non-driving activity instead. This may happen due to interaction with sources inside the vehicle, such as dialing/hanging up a phone or conversing on a phone. It could also be due to being engaged in a non-driving cognitive activity, such as being lost in thought or thinking about financial problems. The knowledge about the role of inattention in crash occurrence is of great importance in developing and implementing the crash prevention measures.

With the goal of understanding the role of inattention in a crash occurrence, NHTSA's National Center for Statistics and Analysis conducted the National Motor Vehicle Crash Causation Survey (NMVCCS) between 2005 and 2007. Information on the driver-, vehicle-, environment-, and roadway-related factors was collected immediately after the crash occurrence. The information was collected from driver and witness interviews, as well as NMVCCS researcher's assessments. The study focused on the associated factors recorded as "other non-driving activities," "conversation," and "inattention" in the NMVCCS data. Each factor was assessed as being present in the pre-crash phase without implying whether or not it contributed to the crash occurrence or became a cause of the crash. Two categories of inattention-related associated factors were considered, namely, a driver's interaction with in-vehicle sources of distraction, e.g., dialing or hanging up a phone, talking on phone, retrieving objects, and the cognitive activities such as thinking about personal, financial, or family problems. The NMVCCS weighted data was analyzed with a focus on the distracted driving and the influence that other associated factors such as driver age and gender, roadway traffic flow, speed limit, and environmental conditions may exert on drivers' engagement in non-driving activities.

The weighted analysis of the NMVCCS data shows that, overall, the inattention attributable to distraction from internal sources was a more prevalent form of inattention among the NMVCCS crash-involved drivers than that caused by the non-driving cognitive activities

Among 14 internal sources of distraction, conversing with a passenger was the most frequently recorded source -- 17 percent of the estimated 2,188,970 NMVCCS crashes accounted for this factor and 57 percent of the estimated 657,065 drivers who were distracted from one or more internal sources reported as engaged in this activity. However, these statistics may merely indicate that a large number of drivers were conversing with a passenger prior to the crash occurrence rather than suggesting that this factor actually contributed to crash occurrence to that extent. In the case of non-driving cognitive activities, about 8 percent of the estimated 3,889,775 drivers were assessed as being engaged in these activities. The largest percentage of these drivers were recorded as inattentive, thought focus unknown (43%) prior to the crash occurrence, though without indicating that this factor may have actually contributed to crash occurrence so frequently.

The data was also analyzed to study the effect of other factors on drivers' inattention. To study the effect of driver age, four age groups, under 16, 16 to 25, 26 to 64, and 65 and older, were considered. The drivers who were distracted most (about 22%) by one or more internal sources belonged to the age group 16 to 25. The results also show that the frequency of drivers with distraction from internal sources decreases with increasing age. A breakdown of each age group based on the internal sources of distraction shows that, leaving aside conversing with a passenger, looking at movements or actions of other occupants, adjusting radio/CD player, focused on internal objects, and conversing on phone were some of the significant internal sources of distractions for drivers in most of the age groups. In terms of driver gender, both male and female drivers had the same representation (about 17%) among drivers who were distracted from at least one internal source. Distraction from internal sources was found to be the most common factor among male drivers 16 to 25 as compared to other gender/age groups.

In the case of inattention due to non-driving cognitive activities, the results show that, leaving aside the drivers 65 and older, the frequency of the drivers who were inattentive due to some undetermined thought process going on in their minds increases with increasing age. In the case of "personal problems," the male drivers show a decreasing trend with increasing age.

The analysis of data pertaining to drivers who were distracted from at least one internal source shows that conversing on phone was more common in the congested traffic, construction work zone, or when there was no traffic flow interruption. In addition, a significant percentage of drivers were focused on internal objects when there was a previous crash nearby. In regard to the impact of posted speed limit on diverting a driver's attention, conversing with a passenger was the most frequently recorded internal source of distraction in almost all speed limit ranges with the highest frequency in the 35 mph and below speed limit zone. Conversing on phone, focus on other internal objects, eating or drinking, retrieving objects from floor/seat, adjusting radio/CD player, and looking at movements or actions of other occupants were some of the other significant in-vehicle sources of distraction recorded for almost all speed limit zones. Most of the drivers conversed with a passenger regardless of the environmental condition. Conversing on a phone or focused on other internal objects accounted for significant percentages of drivers who were distracted by at least one internal source; the highest percentage was assessed as being such in rainy or snow/sleet environment conditions.

1. INTRODUCTION

Driving is a multitasking operation that involves manual, visual, and cognitive tasks. However, drivers often tend to perform non-driving activities that divert their attention from the primary task of driving. These may be due to drivers' interaction with in-vehicle sources or engaging in cognitive activities. In both cases, the activity performed may enhance the likelihood of crash occurrence. For instance, a driver conversing on a cell phone may not be able to respond to an emerging driving scenario that requires immediate attention as well as maneuvering the vehicle. Similarly, a driver retrieving an object from the floor may fail to avoid striking a braking vehicle in front. Conversing with a passenger, adjusting in-vehicle controls, dialing or hanging up a phone, being lost in thought, and thinking about personal problems are only a few of a long list of non-driving activities that could divert a driver's attention.

Driver inattention has been one of the major concerns of traffic safety advocates. This concern has led to many studies and data collection initiatives. The studies conducted in the past used different data sources to gain knowledge about crash occurrence due to distracted driving. Treat et al. (1977, 1979) used the Indiana Tri-level study data in concluding that some form of "recognition failure" was responsible for 56 percent of the crashes. Knipling et al. (1994, 1995, and 1996) used the National Automotive Sampling System-Crashworthiness Data System (NASS-CDS) to show that the crash occurrence of about 25 to 30 percent of the crashes could be attributed to distraction. "The 100-Car Naturalistic Driving Study" (Klauver et al., 2006) showed that some form of driver inattention was present in nearly 80 percent of crashes.

To understand the pre-crash scenarios and the reasons underlying the critical pre-crash events that lead to a crash, NHTSA conducted the National Motor Vehicle Crash Causation Survey. Among other factors, firsthand information related to driver inattention was collected at the crash scene. In this study, a descriptive analysis was conducted to study patterns of driver distraction from sources within the vehicle, as well as those related to cognitive activities of the driver. The on-scene information provided by the NMVCCS data was used for this purpose. Univariate analysis was focused on different aspects of distraction, as discussed in NHTSA's Driver Distraction Program Plan (2010.) Additionally, distracted driving was studied in the presence of some of the driver-, roadway-, and environment-related associated factors. Furthermore, bivariate analysis was conducted to bring out the effect of these factors on drivers' interaction with in-vehicle sources of distraction, as well as cognitive activities while driving.

2. THE NMVCCS DATA

Several efforts have been made in the past to collect data capturing inattention-related information. Some of these include the Indiana Tri-Level Study of the Causes of Traffic Accidents conducted in the 1970s, NHTSA's Crashworthiness Data System (CDS) and General Estimates System (GES) of the National Automotive Sampling System (NASS), and the 100-Car Driving Study conducted during 2000-2004 (Dingus et al., 2006; Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). The NMVCCS is the most recent survey in which, along with other information related to driver, vehicle, and environment, driver inattention-related information was collected. The survey was conducted by NHTSA's National Center for Statistics and Analysis during a three-year period (January 2005 to December 2007). A multistage sampling design was used to acquire a nationally representative sample. The NMVCCS data pertain to only those crashes that occurred between 6 a.m. and midnight. Additionally, at least one of the first three crash-involved vehicles had to be a light passenger vehicle that was towed due to damage. The availability of police accident reports and notification of Emergency Medical Service units were some of the other requirements. Finally, in order for the crash investigation to proceed, at least one of the first three crash-involved vehicles and the police needed to be present at the crash scene when the NMVCCS researcher arrived. Each crash must have resulted in a harmful event associated with a vehicle in transport. A total of 6,949 crashes met the specified criteria and hence were investigated in NMVCCS.

These crashes made up about 48 percent of all crashes occurred during the same period in the United States. Due to specific requirements met at the back end of each NMVCCS crash, the NMVCCS data differs from other crash databases such as NASS-CDS or NASS-GES.

The availability and reliability of crash information often changes with the passage of time. Once away from the crash scene, a driver's or witness's recollection of events can be difficult. In addition, the information crucial to the sequence of events leading up to the crash may be manipulated by the crash-involved persons. To reduce this possibility, the NMVCCS researchers arrived at the crash scenes when everything was fresh – crash-involved vehicles, drivers, and witnesses, if any, were present. The information was collected using the perspective that a crash is a simplified chain of events ending with the critical event that precedes the first event during the crash occurrence that caused injury or property damage. The information was recorded from drivers and witnesses interviews at the crash scene. Vehicle assessment and evaluation of the roadway infrastructure were performed where necessary. It is important to note that none of this information was intended to suggest an assignment of fault to the driver, vehicle, or environment.

Out of the total 6,949 investigated crashes, 5,470 were assigned sampling weights to form a nationally representative sample. This was done by taking into account the probability of selecting a crash through a multi-stage sampling scheme. Several factors (variables) including those pertaining to the driver's inattention were recorded as being present in the pre-crash phase without implying that a crash factor contributed to or caused the crash. The NMVCCS data consists of the driver-, vehicle-, and environment-related information compiled into more than 600 variables. Although more than one vehicle may have been involved in a crash, the detailed information on certain variables is available only for the first three vehicles in-transport. In NMVCCS, these vehicles are referred to as "case vehicles." Since an associated factor is recorded for each of the case vehicles involved in a crash, one or more of these factors could have been present in the crash. In the subsequent discussion, a "case vehicle" is referred to as a "vehicle."

The NMVCCS data was collected from the motor vehicle crashes that met certain criteria mentioned earlier in this section. Therefore, the estimates obtained from these data may not be comparable with those obtained from other crash databases such as NASS-GES or NASS-CDS. In addition, the interpretation of the results based on the NMVCCS data must be made in the context of the coverage of this survey as well as the source of these data. Based on a sample design, all estimates obtained from the NMVCCS data are subject to sampling errors. The NMVCCS data has certain limitations. The small sample sizes due to a large number of unknowns and/or certain segmentations of the data as a requirement in certain investigations of interest may affect the precision of the estimates. The interpretation of results also needs caution, if the analysis variables are subjective in nature, as the inattention-related variables are. Due to the multiple choices used in recording certain variables including inattention-related variables, the classes generated by the attributes of such variables may overlap. This violates the basic assumption of mutual exclusiveness required for certain techniques such as contingency analysis. Consequently, these techniques may not be available as straightforward applications.

3. ANALYSIS METHODOLOGY

The analysis in this study is focused on the role of distraction as a specific type of inattention that occurs when a driver's attention is diverted from the driving task to focus on another activity. In the subsequent analysis and discussion, the term "distraction" is used strictly in this sense. NMVCCS recorded information on the two likely roles of inattention in crash occurrence, namely as a critical reason and as an associated factor. While a critical reason is the immediate reason for an action or the event that puts a vehicle on the course that makes the collision unavoidable, an associated factor is the factor that was assessed as being present in the pre-crash phase. It is important to note that none of these suggests an assignment of fault to the driver, vehicle, or environment. Therefore, care needs to be taken in interpreting the results of the analysis.

This study is focused on inattention as an associated factor, both due to distraction from internal sources and non-driving cognitive activities. In NMVCCS, the detailed information on driver's inattention as an associated factor is available through the variables "other non-driving activities," "driver conversing," and "driver inattention." The attributes of the variable "other non-driving activities" establish other interior factors or events occurred during the pre-crash phase. The intent in recording this information is to identify factors that might have reduced or interfered with the driver's attention to the driving task. Listening to a radio or CD is not considered as "other non-driving activity," though adjusting these devices is. The variable "driver conversing" documents a driver's participation in conversation. This may be conversation with a passenger, talking on a cell phone, or talking on a CB radio during the pre-crash phase. The attribute "conversing with a passenger" was recorded when the driver was conversing with at least one other passenger in the vehicle, while "talking on phone" was recorded when the driver was conversing on a phone without distinguishing between "hands free" and hand-held use. Distraction from one or more internal sources may be attributed to a crash-involved driver. In addition, the variable "driver inattention" records what the driver was thinking about immediately before the crash. If the researcher was convinced of a driver's inattentiveness but was unable to determine the nature of the driver's thoughts, the associated factor was recorded as "inattentive, thought focus unknown." As a word of caution, even when the thought area could be identified, the corresponding attribute does not necessarily imply a causal relationship of the cognitive activity with crash occurrence. Unlike internal sources of distraction, where multiple choices is used, only one cognitive activity is attributed to a crash-involved driver whenever the driver is assessed as inattentive due to a non-driving cognitive activity.

Based on the definition of distraction used in this study, the variables mentioned above were regrouped into two categories: Distraction from internal sources and non-driving cognitive activities, as shown in Table 1. In the subsequent discussion, the term "cognitive activity" refers to "non-driving cognitive activity." The NMVCCS definitions of the attributes of the variables in each category are provided in the Appendix.

The variables (factors) listed in Table 1 were used in the analysis to assess the extent to which inattention was present in NMVCCS crashes. Lack of attention during driving is a behavioral issue. Therefore, the demographic factors such as driver age and gender are some of the obvious factors that may have an impact on distracted driving. In addition, certain environmental conditions, roadway traffic flow, and posted speed limits may be more conducive to certain non-driving activities. The analysis in this study is also focused on identifying distraction patterns in the NMVCCS crash data in the presence of these associated factors. A descriptive analysis, comprising of the weighted percentage distributions, was used. Univariate percentage distributions were employed to assess the extent to which the internal sources of distraction and cognitive activities were associated with the NMVCCS crashes and drivers. To study distraction patterns with respect to other crash associated factors, the bivariate frequency distributions were used.

The analysis conducted in this study is based on the estimated 2,188,970 NMVCCS crashes and the estimated 3,889,775 drivers involved in these crashes.

Table 1. Attributes of distraction from internal sources and cognitive activities used in this study (NMVCCS data)

internal sources of distraction	Looking at movement/actions of other occupants
	Dialing/hanging up phone
	Adjusting radio/CD player
	Adjusting other vehicle controls
	Retrieving object from floor and/or seat
	Retrieving object from other location
	Eating or drinking
	Smoking
	Reading map/directions/newspaper, etc.
	Focused on other internal object
	Conversing with passenger
	Driver talking on phone
	Text messaging
	Talking on CB radio
Non-driving cognitive activities	Inattentive, thought focus unknown
	Future event (vacation, wedding, etc.)
	Preceding argument
	Financial problems
	Family problems
	Personal problems

4. INTERNAL SOURCES OF DISTRACTION IN NMVCCS CRASHES

To study the role of in-vehicle sources in distracted driving, 14 elements listed in Table 1 were considered. Figure 1 presents the weighted percentages of crashes with these elements among the estimated 2,188,970 crashes. The most frequently recorded factor was "conversing with a passenger" (about 16%), while none of the other factors was assessed as present in more than 4 percent of the crashes. As a word of caution, conversing with a passenger as an associated factor in a large number of crashes should not be taken to understand that this factor actually caused distraction so frequently. NMVCCS data merely indicates the presence of this factor in many crashes, i.e. one or more crash involved drivers were recorded as conversing with a passenger in the pre-crash phase. The phone use (conversing on phone, dialing or hanging up phone, and text messaging) is the second most recorded associated factor accounting for about 3.4 percent of the crashes. The statistics for other elements demonstrate some subtle differences between almost similarly performed activities. For example, retrieving objects from floor or seat (2%) was a more frequently recorded factor as compared to retrieving objects from other locations that accounted for a mere 0.7 percent. In addition, eating and drinking was more frequent (1.7%) than smoking (0.5%); and in more crashes (1.2%), adjusting the radio or CD was assessed as an associated factor as compared to adjusting other vehicle controls (0.3%.) In 70 percent of the crashes, there was no distraction from any internal source (not displayed in Figure 1.)

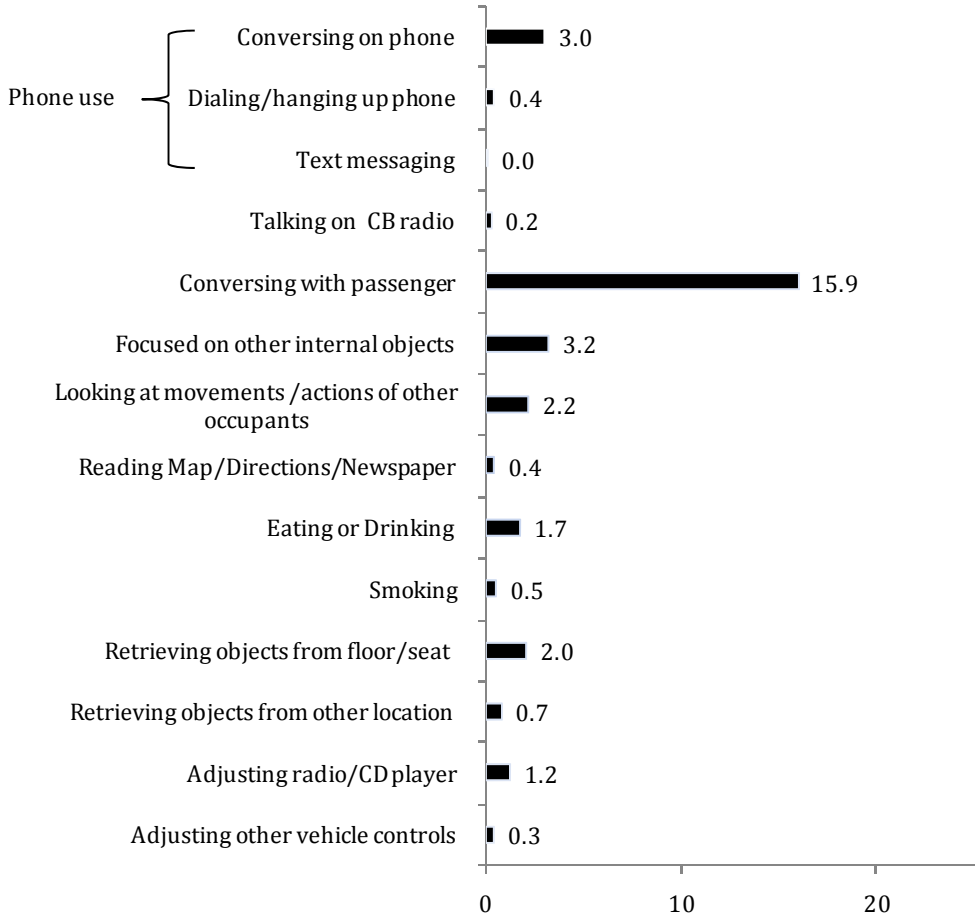

Figure 1. Percentages of crashes with drivers distracted from fourteen internal sources of distraction (one or more distractions may have been present in a crash.)

5. NON-DRIVING COGNITIVE ACTIVITIES IN NMVCCS CRASHES

Cognitive involvement of a driver is essential to safe driving. Nevertheless, a driver may fail to recognize a situation that demands a response because his/her attention has wandered from the driving task for some non-compelling reason. When this happens, the driver is typically focused on internal thoughts (i.e., daydreaming, problem solving, etc.) and not focused on the driving task. Six elements accounting for non-driving cognitive activities of the driver (Table 1) were considered to compare the frequencies of their presence in the NMVCCS crashes. One or more of the drivers involved in a crash may have been engaged in cognitive activities. Thus, one or more forms of cognition may be associated with a crash. However, only one cognitive activity was attributed to a driver, if assessed as inattentive.

Figure 2 displays the weighted percentage of crashes with the six non-driving cognitive activities recorded in NMVCSS. Of these, "inattentive, thought focus unknown" was the most frequently recorded (6.1%) form of inattention in the estimated 2,188,970 crashes. Regarding other cognitive activities, inattention due to personal problems was more frequent (3.3%) as compared to family problems (2.3%) or financial problems (0.3%).

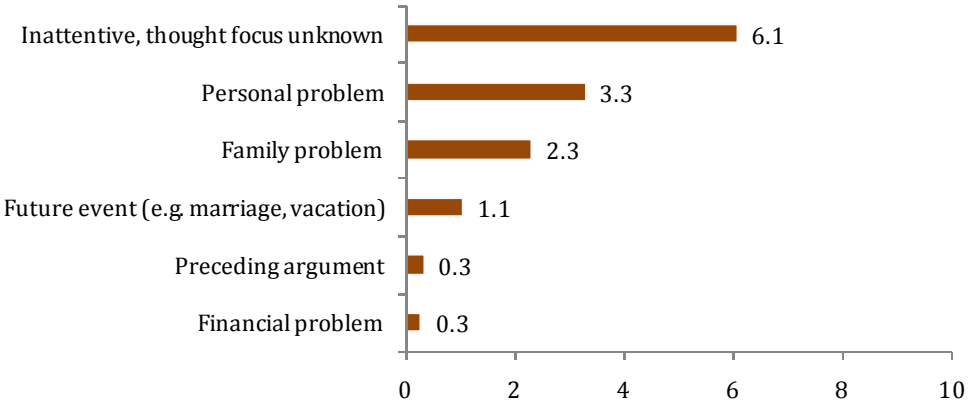

Figure 2. Percentage of crashes with drivers engaged in six cognitive activities (one or more driver may have been engaged in the same cognitive activity in a crash.)

6. ROLE OF INTERNAL SOURCES OF DISTRACTION IN DISTRACTED DRIVING

NMVCCS collected distraction-related information on an estimated 3,889,775 number of drivers using multiple choices. Each of these drivers had either no distraction from an internal source or one or more of the 14 listed in Table 1 were recorded as driver-associated factors. The NMVCCS data shows that about 17 percent of the crash-involved drivers were distracted from at least one internal source. In contrast, about 59 percent of the drivers had no distraction and in the case of 24.2 percent, the distraction from internal sources, if present, was unknown (Figure 3.)

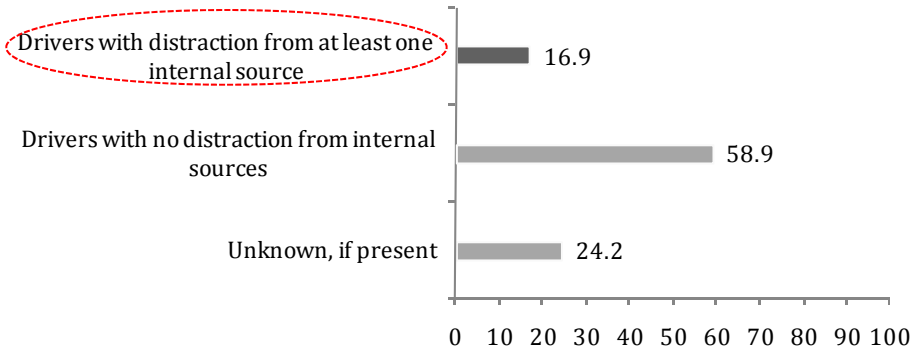

Figure 3. Percentage distribution of drivers based on driver's distraction status.

The subsequent analysis is focused on the estimated 657,065 drivers who were distracted by at least one internal source. The distribution of these drivers over 14 internal sources of distraction is displayed in Figure 4. About 57 percent of these drivers were conversing with a passenger in the pre-crash phase. However, it may not reflect the cause of the distraction. In fact, it is difficult to determine how much conversation can contribute to driver inattention. In addition, about 11 percent were engaged in phone use (talking on phone, dialing or hanging up a phone, and text messaging). The statistics presented in Figure 4 show patterns in terms of some comparable internal sources of distraction. For example, about 11 percent of drivers were focused on internal objects compared to 7.4 percent who were looking at movements or actions of other occupants. In addition, eating or drinking was more frequently (5.7%) recorded as an associated factor than smoking (1.6%). Similarly, more drivers (6.8%) were assessed as retrieving objects from the floor or seat than 2.5 percent of the drivers who retrieved objects from other locations; and adjusting the radio or CD was more common (about 4.0%) than adjusting other vehicle controls (1.2 percent).

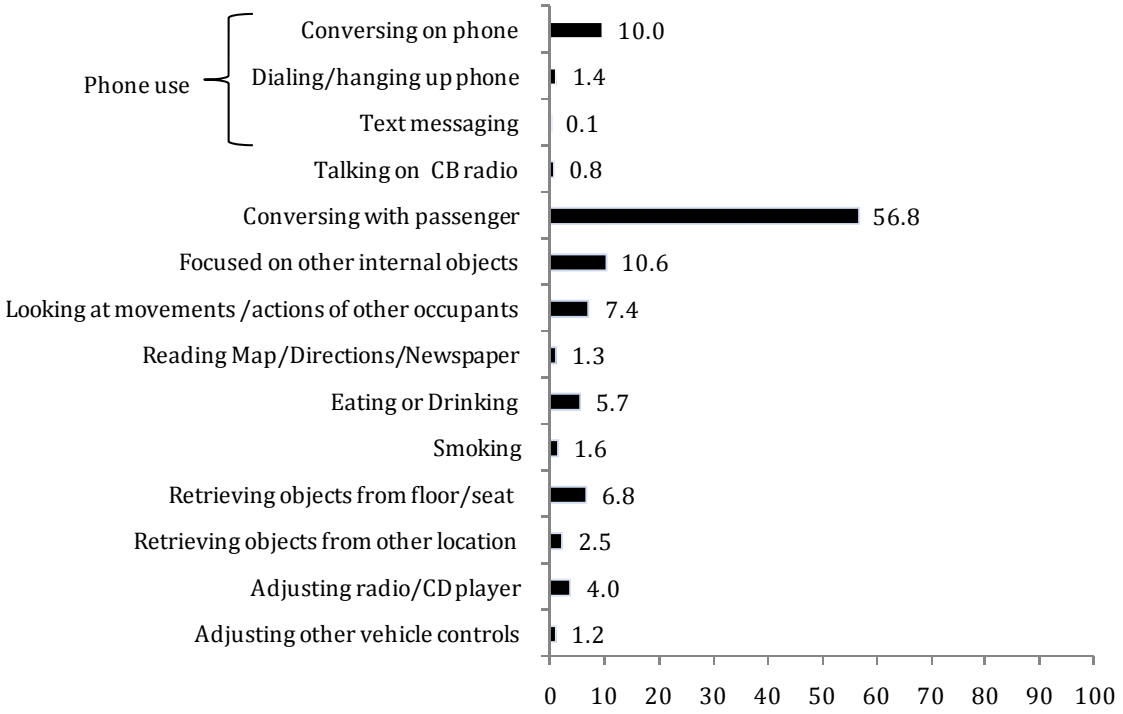

Figure 4. Percentage distribution of drivers over fourteen internal sources of distraction (base population: drivers distracted from at least one internal source)

7. ROLE OF NON-DRIVING COGNITIVE ACTIVITIES IN DISTRACTED DRIVING

When a driver is not able to pay adequate attention to the driving tasks because he/she is engaged in a cognitive activity such as thinking about personal or family problems, the inattention thus caused may play a role as an associated factor in crash occurrence.

The analysis of the NMVCCS data shows that an estimated 305,874 (about 7.9 percent of the total estimated 3,889,775) drivers were inattentive due to being engaged in one of the six cognitive activities listed in Table 1. Sixty-eight percent of the total estimated number of drivers were attentive and for about 24 percent the cognitive activity was unknown (Figure 5.)

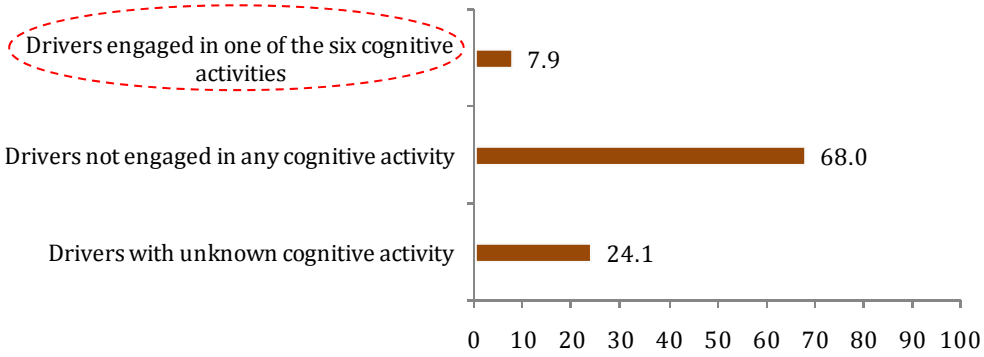

Figure 5. Percentage distribution of drivers based on their cognitive engagement status

Figure 6 shows a breakdown of the drivers who were recorded engaged in one of the six cognitive activities. The statistics show that among these drivers, “inattention, thought focus unknown” was the

most frequently recorded cognitive activity (about 43%). In addition, more of these drivers were assessed as inattentive due to thinking about personal problems (about 24%) as compared to those who were thinking about family problems (16.8%). The contribution of inattention due to thinking about a preceding argument (2.5%), financial problems (2.1%), or a future event (7.6%) was comparatively much lower.

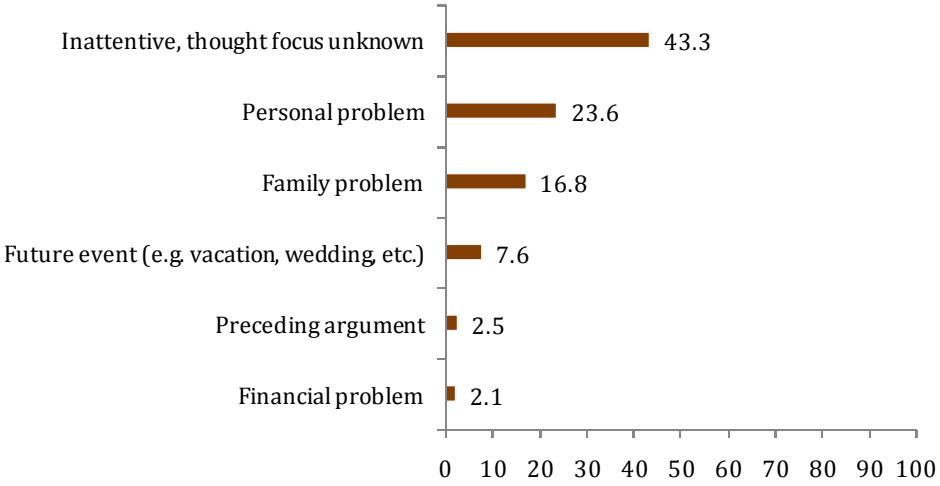

Figure 6. Percentage distribution of drivers over six cognitive activities (base population: drivers engaged in cognitive activities; the categories, "unknown", and "other" not shown)

8. DISTRACTION FROM INTERNAL SOURCES AND OTHER DRIVER-RELATED FACTORS

The likelihood of distraction from internal sources may be enhanced in the presence of some of the driver-, roadway-, and environment-related factors. The NMVCCS data was segmented based on these factors to study patterns that could reveal conditions that were more conducive to distraction from within the vehicle. A driver may lose focus from the task of driving in several ways at the same time – a driver may be conversing with a passenger while tuning the radio. This is true also of some other associated factors. For example, the environment condition at the time of crash occurrence might have been a combination of cloudy and rainy conditions.

8.1 DISTRACTION FROM INTERNAL SOURCES AND DRIVER AGE

To study patterns of distraction from internal sources based on the driver age, four age groups were considered, namely under 16, 16 to 25, 26 to 64, and 65 and older. These age groups, respectively, account for 0.2, 29.6, 59.1, and 9.4 percent of the total estimated 3,889,775 drivers in NMVCCS crashes (Figure 7.) The ages of 1.8 percent of the drivers were unknown (not shown in this figure.)

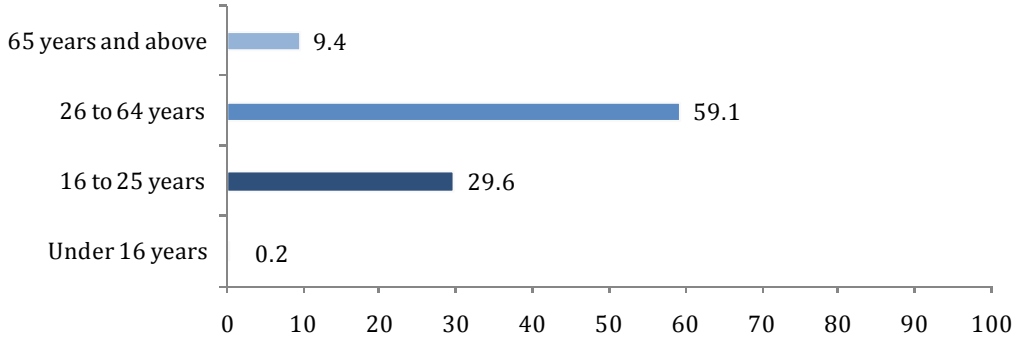

Figure 7. Percentage distribution of drivers over four age groups (the category "unknown" not shown).

Figure 8 shows percentages of each age group drivers over two categories: drivers with distraction from at least one internal source and the drivers who had no distraction from an internal source. Among four age groups, the drivers under 16 had the highest frequency (36.8%) of those who were distracted from at least one internal source, while drivers 65 and older had the lowest percentage (12.3%). The percentages corresponding to distracted drivers in different age groups also demonstrate that their frequency decreases with increasing age.

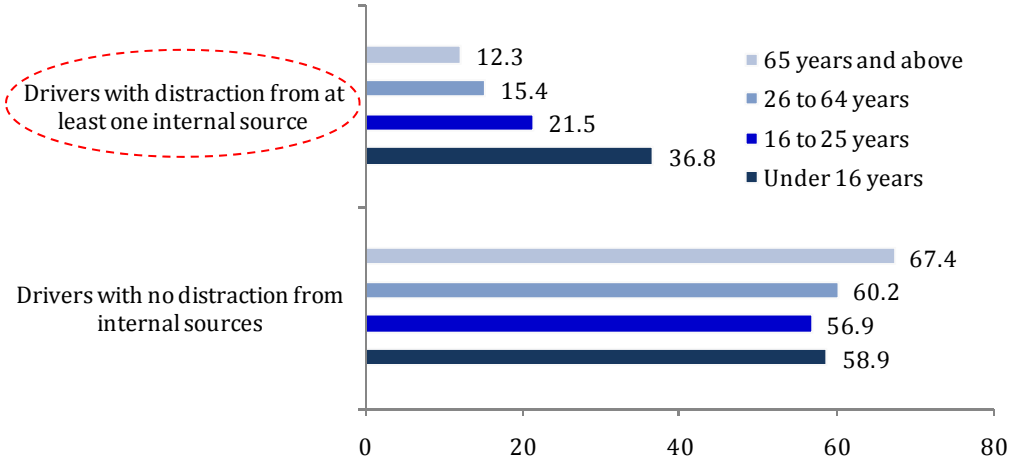

Figure 8. Percentage distributions for four age groups over distraction status categories: distracted from at least one internal source and not distracted from an internal source (percentages of unknowns are not shown.)

The above analysis provides a broad picture of the distracted driving. Analysis was further conducted to study the distraction patterns of the estimated 657,065 drivers who were distracted from at least one internal source. Figure 9 presents percentages of these drivers belonging to the four age groups over the 14 internal sources of distraction.

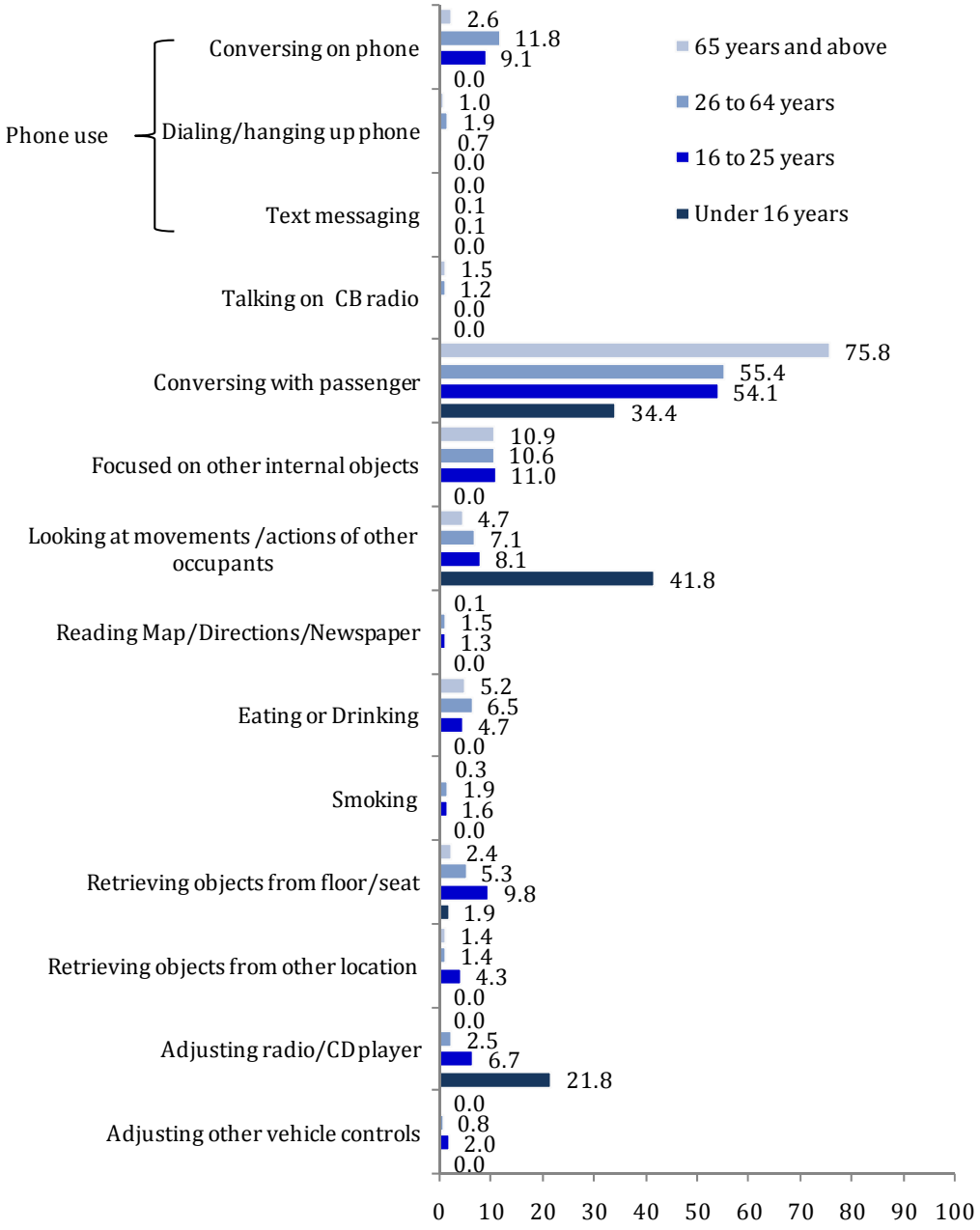

Figure 9. Percentage distributions of drivers for four age groups over fourteen internal sources of distraction (base population: drivers who were distracted from at least one internal source.)

The statistics in this figure show that irrespective of driver age, conversing with a passenger was the most frequently recorded internal sources of distraction. In addition, all age groups demonstrate some common characteristics. In each age group, more drivers were assessed as "focused on other internal objects" than the ones who were "looking at movements and actions of other occupants." Similarly, more drivers of each age group were eating and drinking than those who were smoking. Retrieving objects from floor or seat was an associated factor for more crash-involved drivers as compared to retrieving objects from other locations.

Some differences attributable to age can be noticed for other internal sources of distraction, as well. For instance, more 26- to 64-year-old drivers were inattentive due to phone use (text messaging, conversing on phone, and dialing or hanging up phone) as compared to other age groups. Similarly, more drivers under 16 were assessed inattentive due to adjusting the radio or CD player, while more of the drivers 16 to 25 were recorded as adjusting other vehicle controls, retrieving objects from floor or seat, or retrieving objects from other locations.

8.2 DISTRACTION FROM INTERNAL SOURCES AND DRIVER GENDER

In an estimated 3,889,775 drivers, about 54 percent were male drivers and about 46 percent were female. Analysis was conducted to study patterns in terms of internal sources of distraction and driver gender. Figure 10 shows distribution of male and female drivers over the two categories: drivers with distraction from at least one internal source and drivers with no distraction from an internal source. The statistics show that nearly equal percentages (about 59% female and 60% male) of drivers in the two gender groups had no distraction from an internal source. Even though the female drivers had a smaller percentage (46%) among crash-involved drivers than male drivers (54%), both groups had the same percentage (about 17%) among those distracted from at least one internal source.

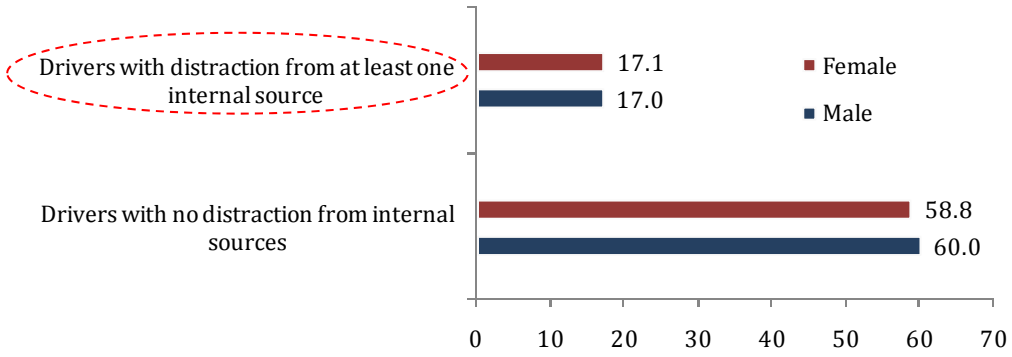

Figure 10. Percentage distributions for two gender groups over distraction status categories: distracted from at least one internal source and not distracted from an internal source (the category "unknown" not shown.)

The data pertaining to drivers who had distraction from at least one internal source were analyzed to explore patterns in terms of internal sources of distraction and driver gender. The results are presented in the frequency distributions for the two groups over 14 internal sources of distraction in Figure 11. The statistics show that more male drivers were assessed as focused on other internal objects, eating or drinking, retrieving objects from floor or seat, and adjusting radio or CD player than female drivers. On the other hand, the percentages of female drivers engaged in conversing with a passenger, conversing on a phone, and looking at movements or actions of others were higher as compared to male drivers. Regarding other internal sources of distraction, such as smoking, retrieving objects from other locations, the two groups had almost the same representation among the distracted drivers.

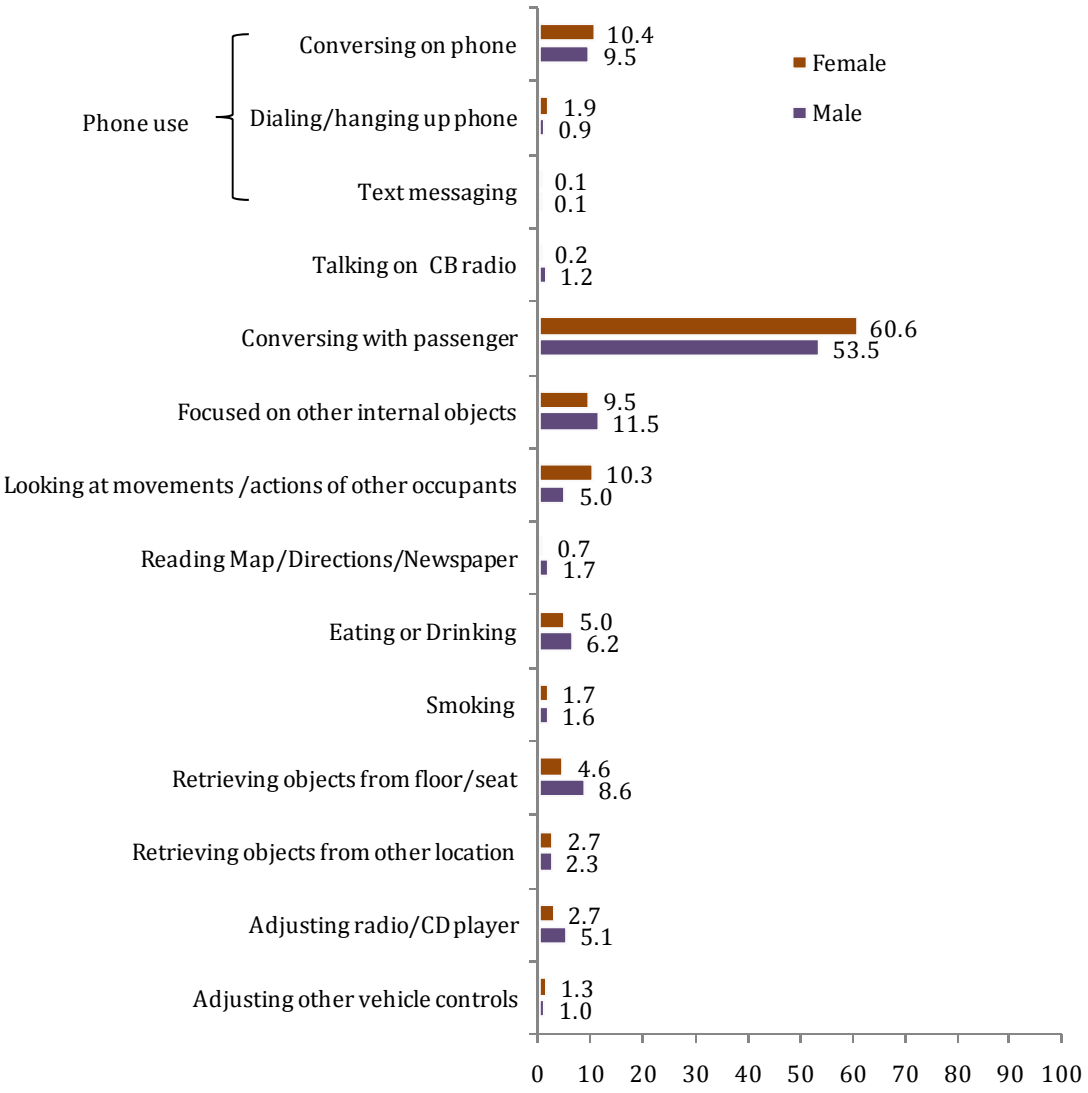

Figure 11. Percentage distributions for two gender groups over fourteen internal sources of distraction (base population: drivers who were distracted from at least one internal source)

8.3 DISTRACTION FROM INTERNAL SOURCES AND DRIVER AGE AND GENDER

Driver age and gender can have a joint effect on the likelihood of drivers being distracted from internal sources. Figure 12 shows percentage distribution of drivers over six gender/age groups: male drivers 16 to 25, female drivers 16 to 25, male drivers 26 to 64, female drivers 26 to 64, male drivers 65 and older, and female drivers 65 and older. The data contains the highest percentage (27.4%) of 65-and-older male drivers followed by female drivers (20.5%) of the same age group. Both male and female drivers 26 to 64 had the least representation (close to 10.5 percent), while the drivers 16 to 25 of the two gender groups had the same representation (about 10%).

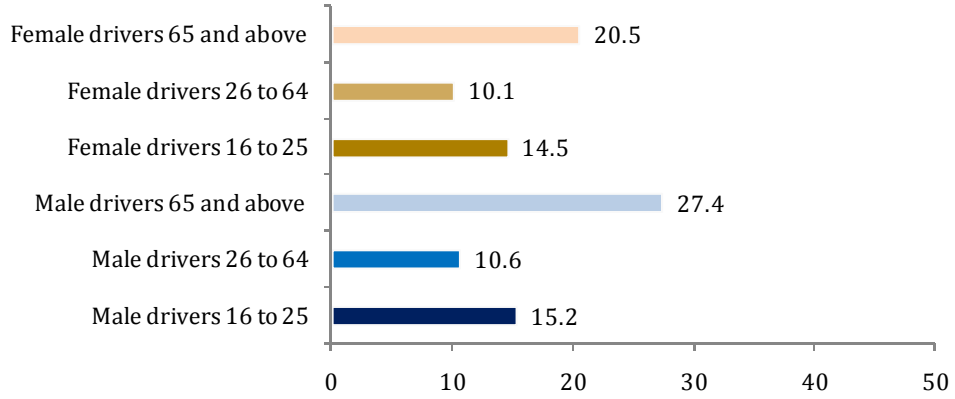

Figure 12. Percentage distribution of drivers over six gender/age groups (the category of drivers under 16 and with unknown age not shown)

The distributions of drivers of six gender/age groups over the two distraction categories -- drivers with distraction from at least one internal source and drivers with no distraction from an internal source – are presented in Figure 13. These statistics show that the incidence of distraction from one or more internal sources was the highest (24.4%) among male drivers 16 to 25 and the lowest (12.7%) among male drivers 65 and older. Both gender groups show a decreasing trend over increasing age, though the trend is clearer in the case of male drivers.

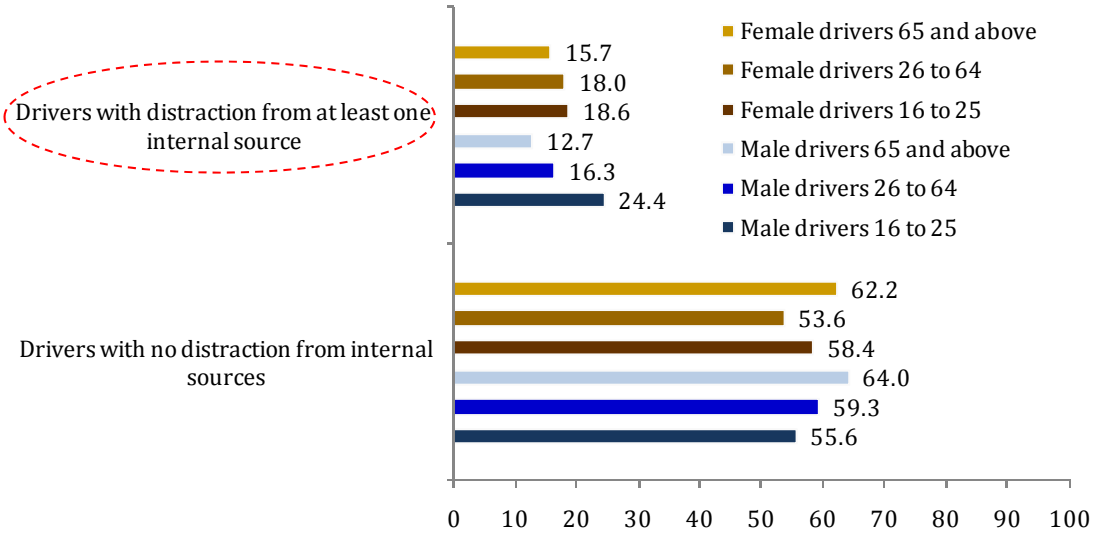

Figure 13. Percentage distributions for six gender/age groups over distraction status categories: distracted from at least one internal source and not distracted from an internal source (the category "unknown" not shown)

Of particular interest in this study are the drivers who were distracted from at least one internal source. The frequency distributions of these drivers over internal sources of distraction in each gender/age group are presented in Figure 14. Conversing on the phone was more common among female drivers 26 to 64 and male drivers 65 and older. Overall, of all the gender/age groups, the female drivers 65 and older were most engaged in conversing with a passenger. In addition, the female drivers in each age group had a higher frequency of drivers who were conversing with a passenger as compared to their male counter parts.

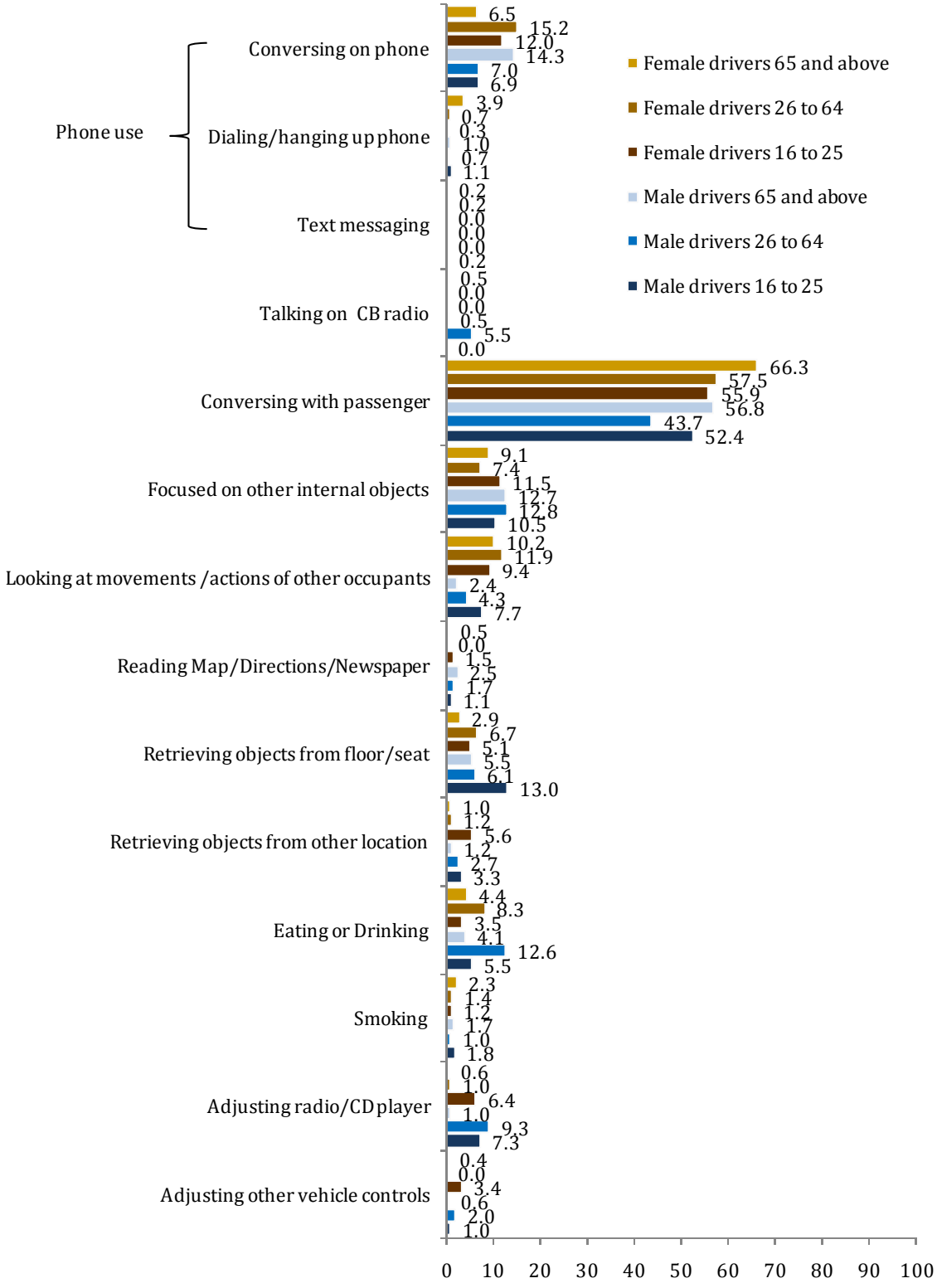

Figure 14. Percentage distributions for six gender/age groups over fourteen internal sources of distraction (base population: drivers who were distracted from at least one internal source)

9. NON-DRIVING COGNITIVE ACTIVITIES AND DRIVER-RELATED FACTORS

Engaging in a cognitive activity, such as thinking about problems while driving is not uncommon among drivers, though its likelihood may depend on driver age and gender. As listed in Table 1, the NMVCCS data recorded information on six cognitive activities. The analysis in this section is focused on patterns of inattention due to these cognitive activities in the presence of other driver-related factors, age, and gender.

9.1 NON-DRIVING COGNITIVE ACTIVITIES AND DRIVER AGE

Figure 15 presents percentages in each of the two categories: drivers engaged in cognitive activities and drivers not engaged in any cognitive activity, for the four age groups. The results show that the percentage of the former type was the highest for drivers 16 to 25 (9.2%). This is almost the same as for drivers under 16. Drivers 26 to 64 had the lowest percentage (7.4%) engaged in a cognitive activity.

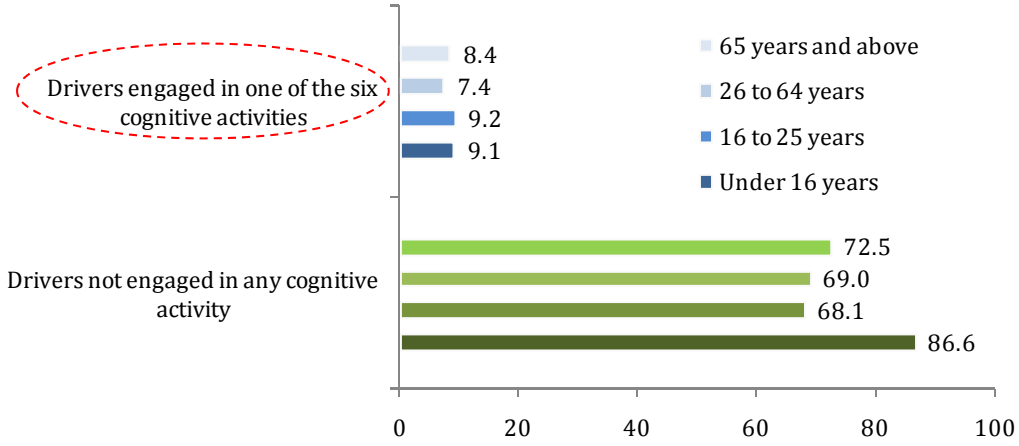

Figure 15. Percentage distributions for four age groups over driver's cognitive engagement status: drivers engaged in a cognitive activity and drivers not engaged in any cognitive activity (the category "unknown" not shown.)

The estimated 305,874 drivers who were engaged in a cognitive activity are distributed over six cognitive activities in each age group. The results are presented in Figure 16. The highest recurring factor among all age groups was the "inattentive, thought focus unknown," except for drivers under 16, who reported "thinking about personal problems" as the most common factor (79.3%). Excluding the age group 65 and above, the percentage of drivers assessed as "inattentive, thought focus unknown" increases with increasing age.

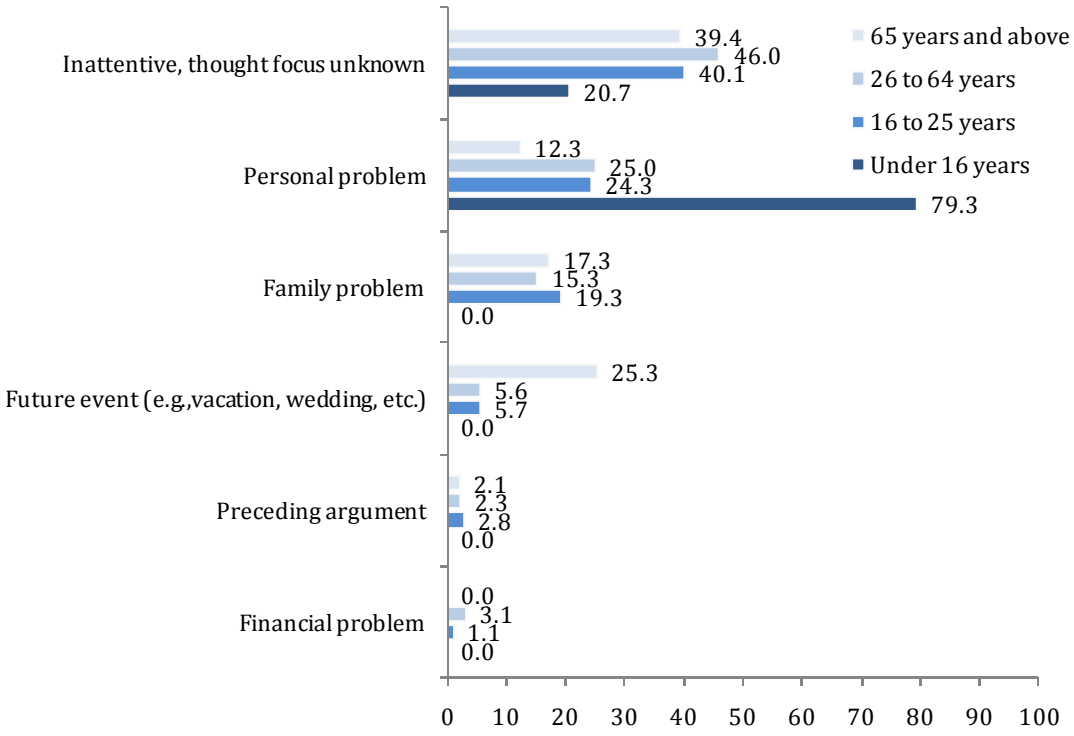

Figure 16. Percentage distribution for four age groups over six cognitive activities (base population: drivers engaged in cognitive activities)

9.2 NON-DRIVING COGNITIVE ACTIVITIES AND DRIVER GENDER

Whether a driver was inattentive due to being engaged in a cognitive activity may also depend upon the gender of the driver. The analysis results presented in Figure 17 illustrate the effect of driver gender on engaging in a cognitive activity. The female drivers were more frequently recorded as being engaged in a cognitive activity (9.3%) as compared to the male drivers (6.8%). A detailed analysis of the drivers who were engaged in a cognitive activity was conducted for the purpose of specificity in terms of the cognitive activities.

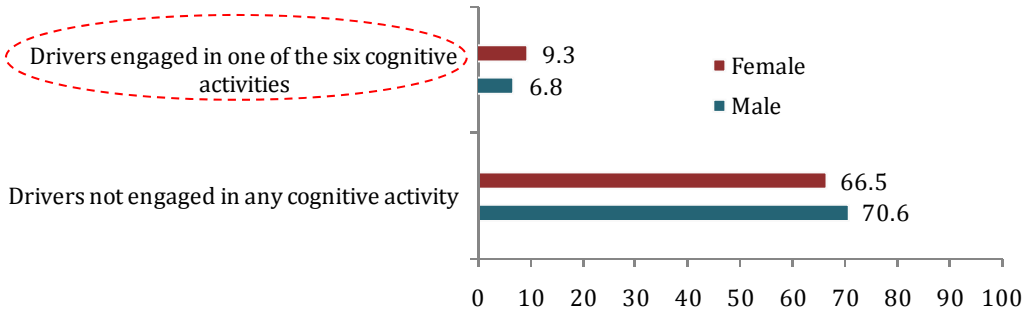

Figure 17. Percentage distributions for two gender groups over driver's cognitive engagement status: drivers engaged in a cognitive activity and drivers not engaged in any cognitive activity (the category "unknown" not shown.)

Figure 18 presents percentage distributions for each gender group over six cognitive activities. More (45.9%) female drivers were assessed as "inattentive, thought focus unknown" as compared to the male

drivers (40.2%). Regarding other cognitive activities, the male drivers had slightly smaller or the same percentages as the female drivers.

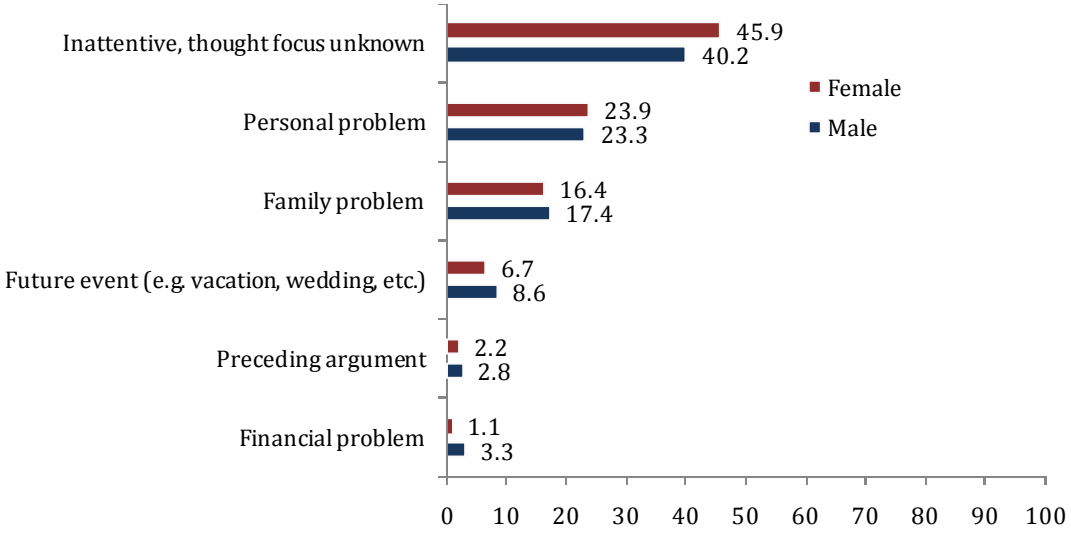

Figure 18. Percentage distributions for gender groups over six cognitive activities (base population: drivers engaged in cognitive activities)

9.3 NON-DRIVING COGNITIVE ACTIVITIES AND DRIVER AGE AND GENDER

The data were segmented in six gender/age groups to explore the possibility of the joint effect of these demographic factors on driver inattention. As a preliminary analysis, the drivers in each gender/age group were distributed over two broad categories: drivers engaged in one of the six cognitive activities and drivers not engaged in any cognitive activity. Among all gender/age groups, the female drivers generally had a higher (9.3%) percentage of drivers who were engaged in a cognitive activity (Figure 19.) Among male drivers, 16- to 25-year-old drivers had the highest frequency (9%) of those engaged in a cognitive activity. The male drivers show a decreasing trend with increasing age.

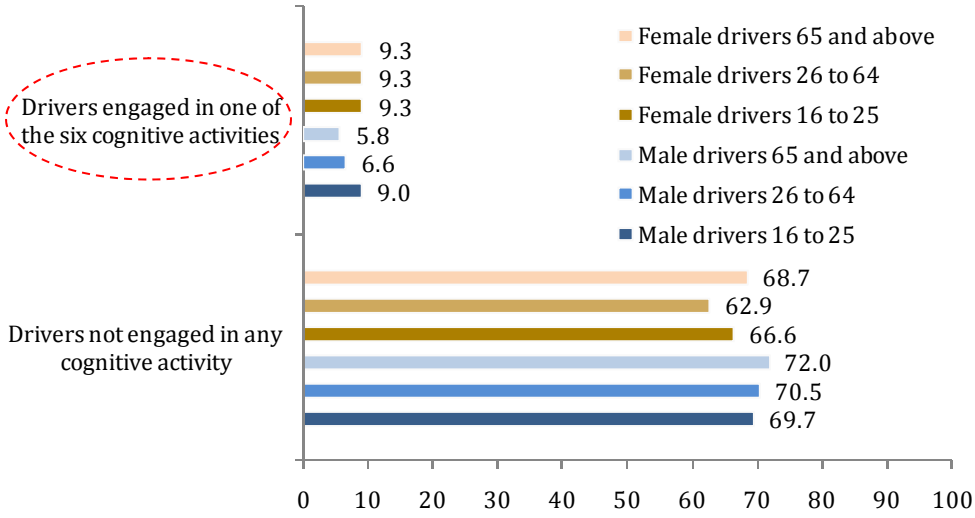

Figure 19. Percentage distributions for six gender/age groups over driver's cognitive engagement status: drivers engaged in a cognitive activity and drivers not engaged in any cognitive activity (the category "unknown" not shown.)

The drivers in each gender/age group, who were engaged in one of the six cognitive activities, were distributed over the six cognitive activities listed in Table 1. Figure 20 presents results in terms of percentages of instances of the cognitive activities in each group. The cognitive activity "inattention, thought focus unknown" is the most recorded activity: 54.3 percent for the female drivers 65 and older and 46.4 percent for the male drivers 26 to 64. The female drivers 26 to 64 demonstrated the highest frequency of those who were engaged in thinking about "personal problems." Two significant patterns were observed. Male drivers show an increasing trend in the case of "financial problems" and a decreasing trend for "personal problems" with increasing age.

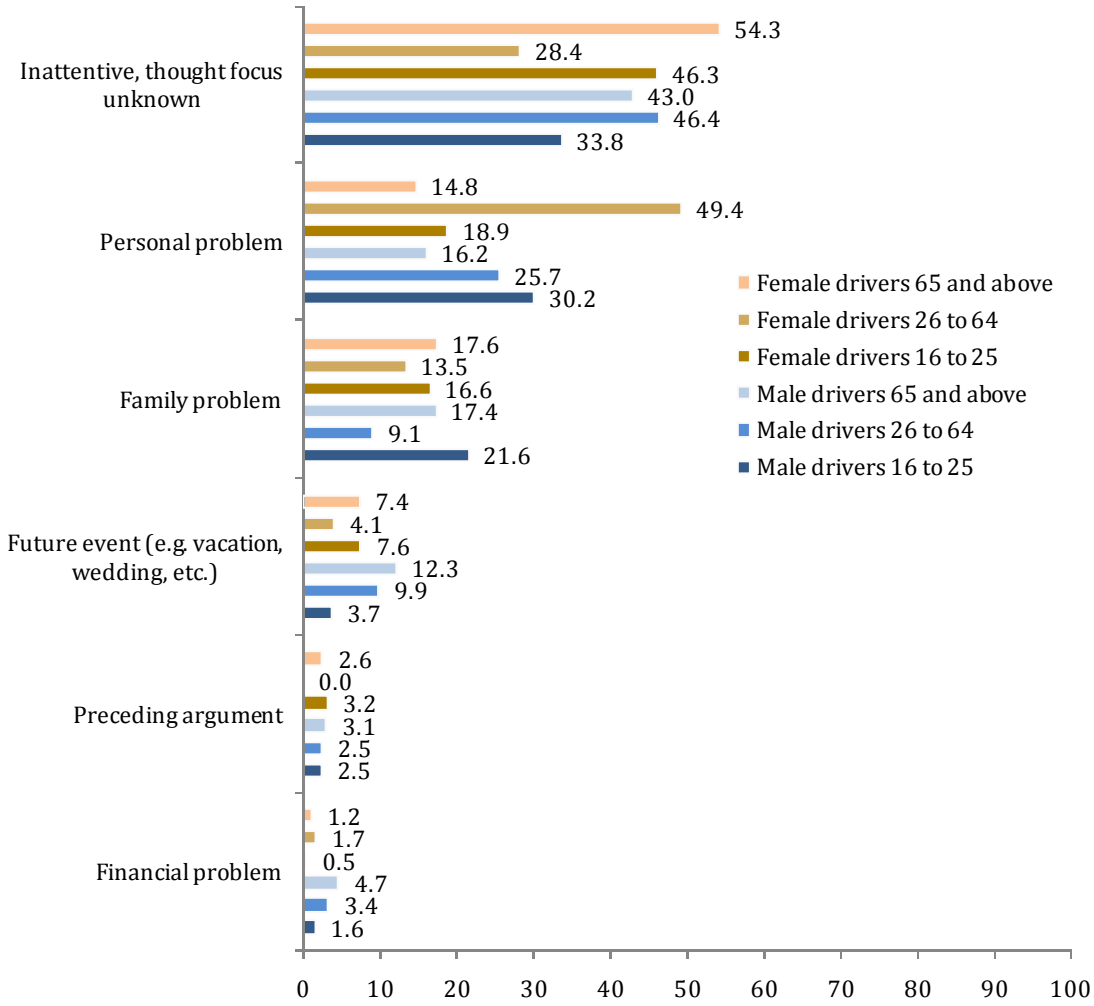

Figure 20. Percentage distributions for six gender/age groups over six cognitive activities (base population: drivers engaged in cognitive activities)

10. DISTRACTION FROM INTERNAL SOURCES AND ENVIRONMENT-RELATED FACTORS

In addition to the effect of age and gender on a driver's distraction from internal sources, some of the other associated factors, such as posted speed limit, traffic flow interruption, and environmental conditions may also play a role. The analysis results based on these associated factors with reference to distraction from internal sources are presented in the subsequent sections.

10.1 DISTRACTION FROM INTERNAL SOURCES AND ROADWAY-RELATED FACTORS

Six traffic flow conditions recorded in the NMVCCS data were considered to study interaction between internal sources of distraction and traffic flow conditions. These include disabled vehicle or object in roadway, congested traffic, emergency vehicle approaching, construction work zone, previous crash nearby, and no traffic flow interruption. The percentage distribution for each of these conditions over the two categories: drivers with distraction from at least one internal source and drivers with no distraction from an internal source are presented in Figure 21. The highest percentage of drivers belonging to the first category was of drivers who were in the traffic with a disabled vehicle or object in the roadway (27.5%). The traffic flow conditions "previous crash nearby," "congested traffic," and "no traffic flow interruption" accounted for almost the same percentage (close to 17 percent) of the distracted drivers. The lowest incidence was reported for "construction zone" (12.4%).

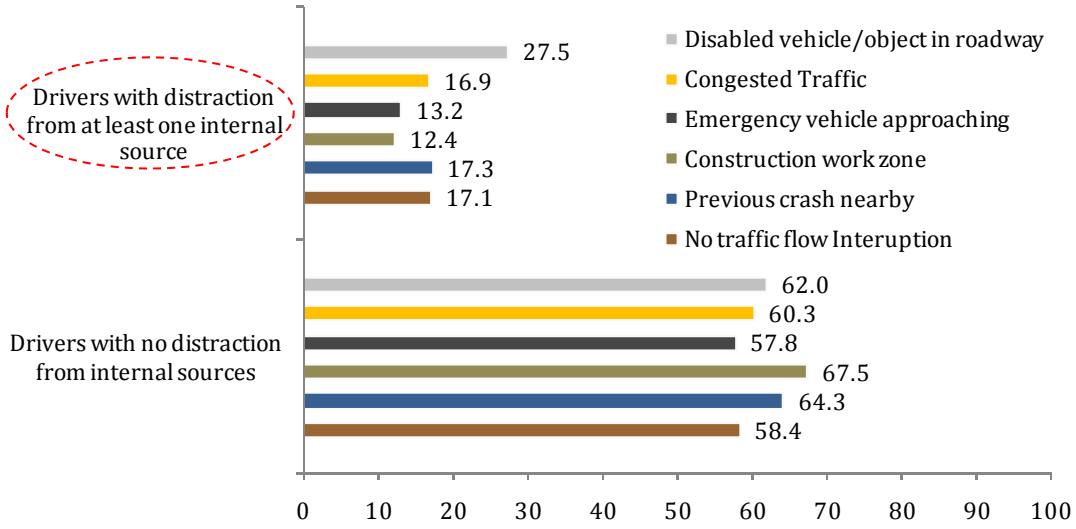

Figure 21. Percentage distributions for six traffic flow conditions over distraction status categories: distracted from at least one internal source and not distracted from an internal source (the category "unknown" not shown.)

Figure 22 displays percentage distributions of the distracted drivers over 14 internal distraction sources due to which drivers were recorded as inattentive while driving in six roadway-related conditions. Drivers were engaged most in conversing with a passenger in all traffic flow conditions; the highest percentage of drivers was recorded as such when they were driving in a construction work zone (67.3%). The highest percentage of drivers conversed on a phone (10.3%) when there was no traffic flow interruption. Relatively smaller percentages were reported conversing on a phone in a construction work zone (9.8%) and congested traffic (9.3%). Significantly high percentages were focused on other internal objects (29.8%), when there was a previous crash nearby and/or adjusting the radio or CD (38.3%), when an emergency vehicle was approaching.

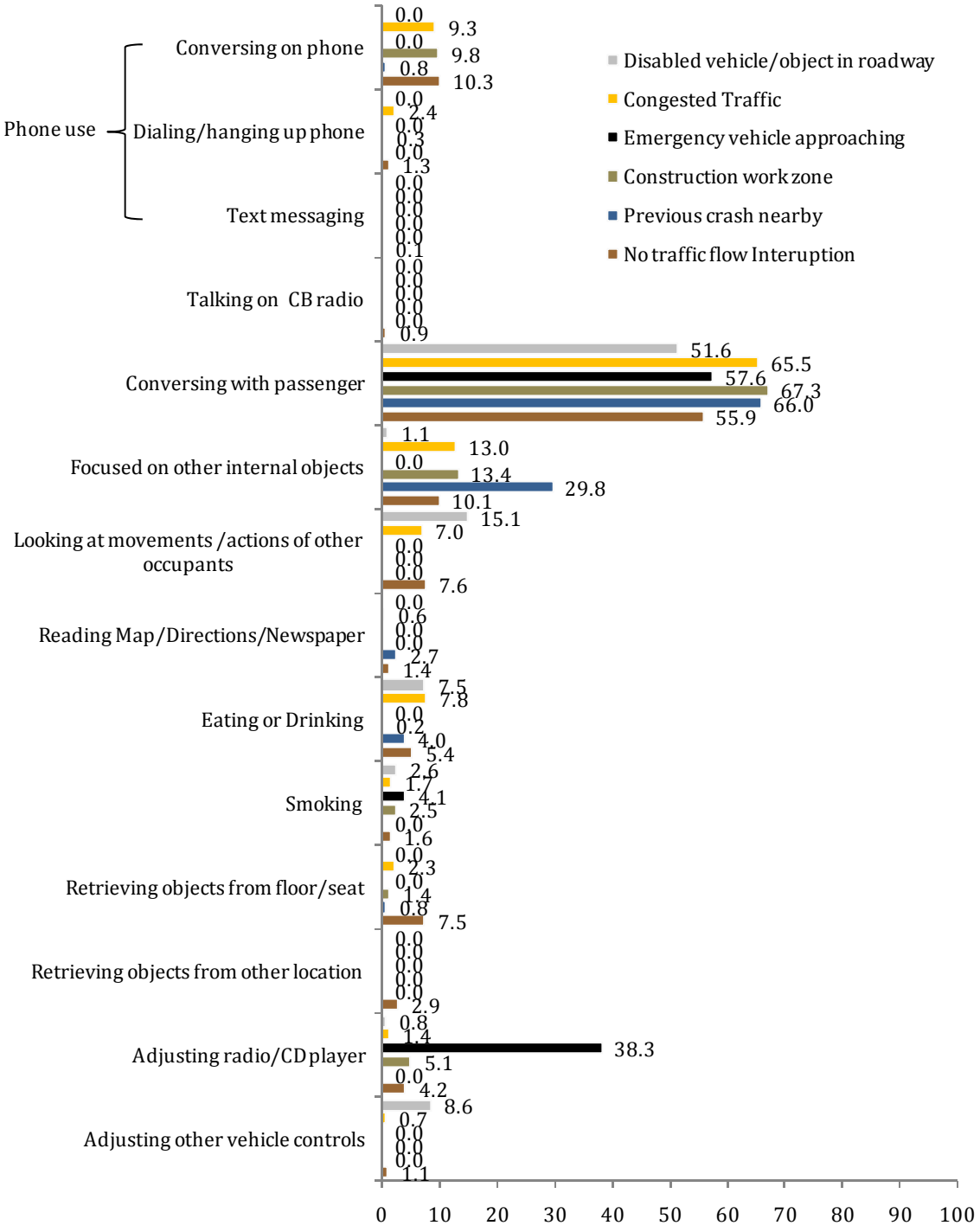

Figure 22. Percentage distributions for six traffic flow conditions over fourteen internal sources of distraction (base population: drivers distracted from at least one internal source.)

10.2 DISTRACTION FROM INTERNAL SOURCES AND POSTED SPEED LIMIT

To study the effect of posted speed limit on distracted driving, six speed limit ranges were considered: up to 35 mph, 40 to 50 mph, 55 to 60 mph, above 65 mph, and no speed limit. A comparison of drivers who were distracted by internal sources while driving in these speed limit zones is shown in Figure 23. These statistics do not show any clear patterns in terms of the speed limit zones. However, they indicate that the frequency of the distracted drivers was the highest in the 60 mph and above posted speed limit zone (19.6%) and the lowest in "no speed limit zone" (8.2%).

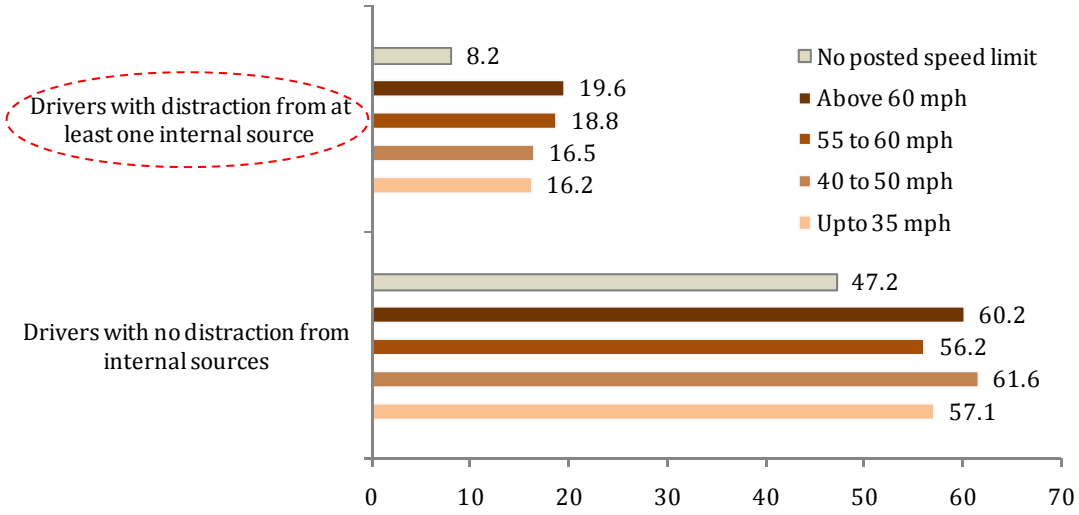

Figure 23. Percentage distributions for five speed limit zones over distraction status categories: distracted from at least one internal source and not distracted from an internal source (the category "unknown" not shown)

The percentage distributions of the distracted drivers over 14 internal sources of distraction in six speed limit ranges are shown in Figure 24. Except for the no speed limit zone, conversing with a passenger was the most frequently recorded non-driving activity for all speed limit zones – most percentages are above 45 percent with the maximum percentage (62.1%) for the 35 mph and below speed limit zone. Conversing on the phone was the most frequent (16.7%) in the 60 and above speed limit zone. Focused on other internal objects was the most recorded (71.8%) distraction type in the no speed limit zone. Eating or drinking was most common among drivers in the 55 to 60 mph posted speed limit zone (8.8%) and the drivers were engaged most in retrieving objects from other locations (about 4%) while driving in the 40 to 50 mph speed limit zone. In the case of "retrieving objects from floor or seat," the highest incidence was reported for the above 60 mph speed limit zone (9.4%).

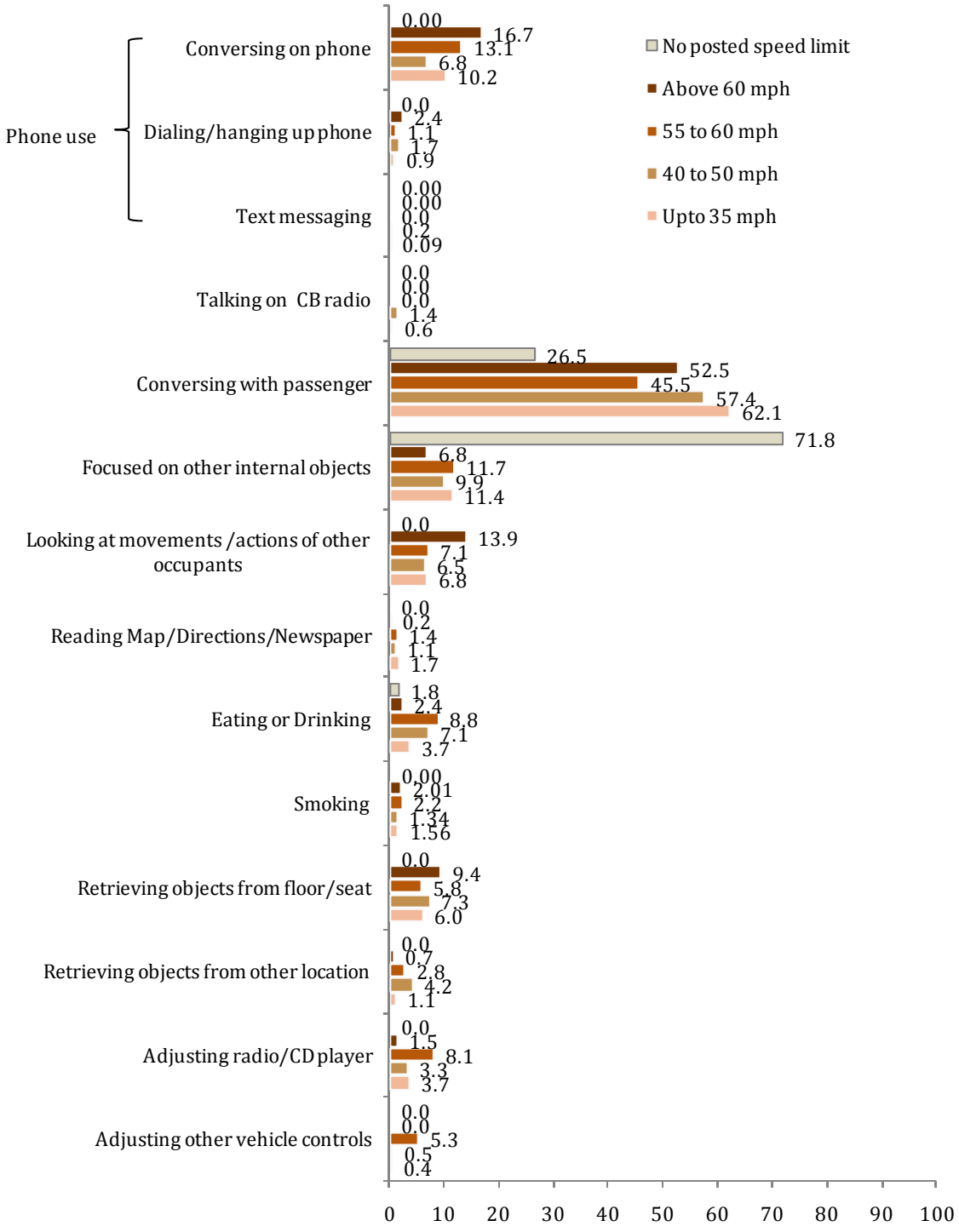

Figure 24. Percentage distributions for five speed limit zones over fourteen internal sources of distraction (base population: drivers who were distracted from at least one internal source.)

10.3 DISTRACTION FROM INTERNAL SOURCES AND ENVIRONMENTAL CONDITIONS

NMVCCS has recorded information about crash occurrence under five environmental conditions: clear environment, cloudy, rainy, snow/sleet, and other environmental conditions. Two categories of drivers were considered for preliminary analysis, namely the drivers who were distracted from at least one internal source and the drivers who were not distracted by any internal source. Figure 25 shows that the snow/sleet condition accounted for the highest percentage (33.0%) of drivers distracted from internal sources, while under other environmental conditions, almost the same percentage of drivers were distracted from one or more internal sources.

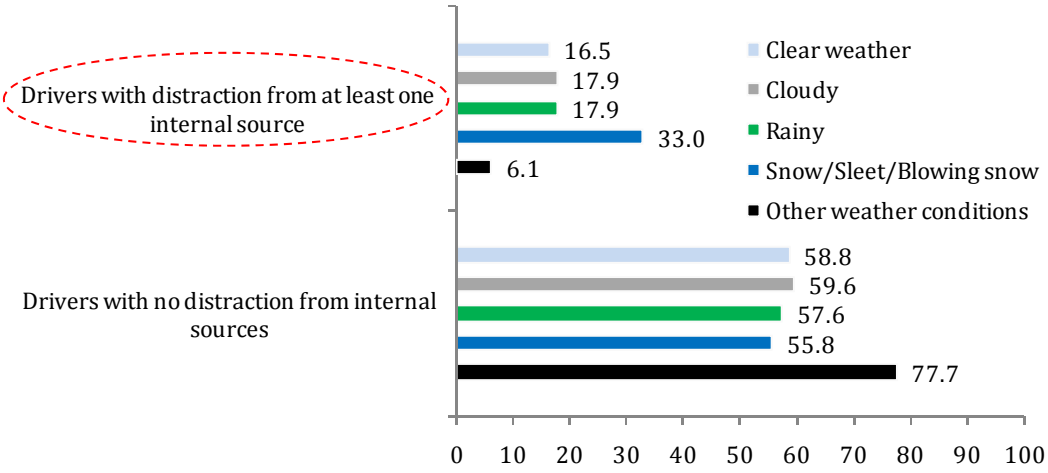

Figure 25. Percentage distributions for five environmental conditions over distraction status categories: distracted from at least one internal source and not distracted from an internal source (the category "unknown" not shown.)

Further breakdown of drivers distracted from at least one internal source over the internal sources of distraction can reveal if there was any effect of environmental conditions on a driver's inattention. The statistics in Figure 26 show that while in all environmental conditions most drivers were conversing with a passenger (more than 54%,) under rainy conditions and other environmental conditions, the percentages of such drivers was significantly high, being, 73.8 and 75 percent respectively. Regarding the frequencies of other internal sources of distraction, clear environmental conditions seem to be the associated factor in crash involvement of most drivers.

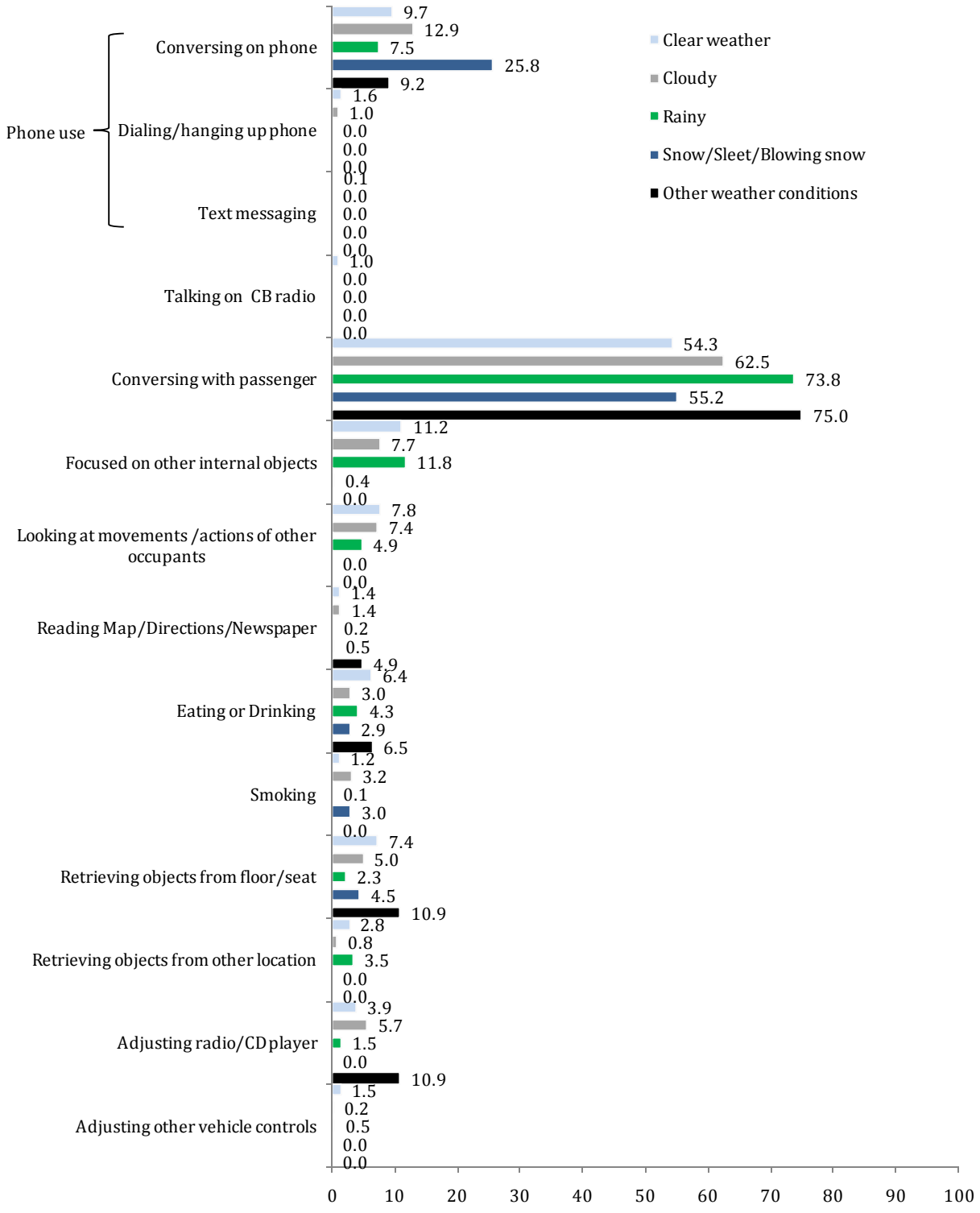

Figure 26. Percentage distribution for five environmental conditions over fourteen internal sources of distraction (base population: drivers distracted from at least one internal source)

11. SUMMARY AND DISCUSSION

Many interesting observations were made in this study about the distracted driving that may be caused by a driver's interaction with internal sources or engaging in non-driving cognitive activities. Fourteen of the former and 6 of the latter were recorded in the NMVCCS data. Overall, interacting with in-vehicle sources of distraction was more common among crash-involved drivers as compared to engaging in the cognitive activities. The tendency of drivers to perform activities involving internal sources decreases with increasing age. However, no significant change was observed in terms of the cognitive activities with change in age. Even though the female drivers had a lower representation among crash-involved drivers as compared to male drivers, distracted driving was an equally practiced mode of driving for the two groups.

Conversing with a passenger was found as top of the list factor among non-driving activities that involved drivers' interaction with internal sources of distraction. This was true irrespective of driver age and gender, or the speed limit zone, weather, and traffic flow conditions in which the drivers were driving. However, this observation cannot be used to jump to the conclusion that conversing with a passenger was responsible for distracted driving to that extent. In fact, this factor was recorded for its presence in the crash without implying crash causation. Other factors such as phone use, especially conversing on a phone, focusing on internal objects, or looking at movements/actions of other occupants are worthy of attention, too. The phone use (conversing on phone, dialing or hanging up phone, and text messaging) was observed as the second most recorded factor that was more common among young to middle aged drivers. This was also a more frequently performed activity by female drivers as compared to male drivers.

Many interesting observations about distracted driving in the presence of environment-, and roadway-related factors were also made in this study. The highest percentage of drivers distracted from in-vehicle sources was found in the traffic with a disabled vehicle or object in the roadway and the lowest in the construction zone. Drivers mostly conversed on phone when there was no traffic flow interruption. Distracted driving was more common in the 60 mph and above posted speed limit zone. In addition to phone use, focusing on internal objects, and looking at actions or movements of other occupants also showed prominence, in general, and particularly in the presence of other crash factors such as speed limit zone, weather conditions and trafficway flow.

Of all the drivers engaged in cognitive activities, the NMVCCS researchers assessed most as inattentive, but could not determine the nature of their thought focus. More female drivers were found engaged in cognitive activities than their male counter parts. More than any other activity, drivers under 16 were observed thinking about their personal problems. The female drivers of all ages generally have higher percentage of drivers who were engaged in cognitive activities as compared to male drivers, while the male drivers show a decreasing trend with increasing age.

Although at the backend of the results is the data that was collected at the crash scene to maintain the reliability and integrity of information, its subjective nature ought not to be overlooked in arriving at conclusions. It must also be kept in mind that NMVCCS was not designed specifically for studying distracted driving and hence may produce some unexpected statistics. Yet, the results can be used as guidelines for future data collection and other safety initiatives specifically targeted at distracted driving.

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13. APPENDIX: NMVCCS DEFINITIONS OF INTERNAL SOURCES OF DISTRACTION AND COGNITIVE ACTIVITIES

This appendix provides NMVCCS definitions of internal sources of distraction and non-driving cognitive activities listed in Table 1 of section 3 that were used in this study.

Internal sources of distraction

Looking at movement/actions of other occupants
Used when the driver is distracted by other occupants in the vehicle. The specific intent is to identify instances when the driver is distracted by movements or actions initiated by these occupants.

Dialing/hanging up phone
Used when the driver is distracted as a result of either dialing or hanging up a phone during the pre-crash phase. This element value is also used when the driver is adjusting phone controls or is attempting to retrieve voicemail messages.

Adjusting radio/CD player
Used when the driver is distracted as a result of attempting to adjust sound system controls.

Adjusting other vehicle controls
Used when the driver is distracted as a result of attempting to adjust the heat, vent, or air conditioning controls. This category also includes attempted adjustments to other original equipment manufacturer (OEM) and after-market controls.

Retrieving object from floor and/or seat
Used when the driver is attempting to retrieve an object from either indicated location while driving. The objects in this category include everything with the exception of items related to smoking or eating which are addressed in selection of those individual attributes.

Retrieving object from other location
Used when the driver is attempting to retrieve an object from a location other than the floor or seat. Objects in this category include everything with the exception of items related to smoking or eating which are addressed in selection of those individual attributes.

Eating or drinking

Smoking

Reading map/directions/newspaper etc.

Focused on other internal object
Use this attribute when the driver is not attending to the driving task due to focus on any object in the interior of the vehicle not related to other specific attributes for this variable.

Conversing with passenger
Used when the driver is conversing with at least one other passenger in the vehicle during the immediate pre-crash phase.

Talking on phone
Used when the driver is conversing on a phone during the immediate pre-crash phase. Drivers using "hands-free" phone set-ups are included in this category.

Text messaging
Any short electronically transmitted message. Typically sent to a handheld device such as a pager, PDA, or cell phone.

Talking on CB radio
Used when the driver is conversing on a CB radio during the immediate pre-crash phase.

Non-driving Cognitive activities

Personal problem
Used when the driver is thinking about a personal problem. This problem type may be work related or may involve interpersonal relationships in the work environment. This problem type also includes other interpersonal relationships (excluding family members) outside the work environment and a variety of legal matters.

Family problem
Used when the driver is thinking about a family problem. This problem type may involve interpersonal relationships within the family or an interpersonal relationship between another family member and a nonfamily individual. It also includes a variety of legal matters involving other family members.

Financial problem
Used when the driver is thinking about a personal financial problem involving bills, overall debt, credit card payments, etc. Financial problems involving other family members are classified as a family problem.

Preceding argument
Used when the driver is thinking about a preceding argument with other individual(s). These arguments may have occurred more than 12 hours prior to the crash.

Future event (vacation, wedding, etc.)
Used when the driver is thinking about a future event. These events should have pleasant connection. For example, if the driver is thinking about attending a funeral, this problem type should be classified in the other category.

Inattentive, thought focus unknown
This attribute is used when it is believed that the driver is inattentive, but the nature of the thoughts cannot be determined. It is different from the attribute "unknown" recorded for this cognitive activity, which is used when there is insufficient information to determine if the driver was inattentive because of focusing on internal thought process.

DOT HS 811 380
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