DRIVER DISTRACTION AND INATTENTION IN THE USA LARGE TRUCK AND NATIONAL MOTOR VEHICLE CRASH CAUSATION STUDIES

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Abstract

This study focuses on data from two USA crash causation studies: large tucks (2001–2003) and light motor vehicles (2005–2007). We examine the relationship between crashes and driver distraction/inattention in 956 large truck crashes and 2,470 passenger vehicle crashes. Causation is defined as factors that increase the risk that a crash will occur. Distraction/Inattention is the most important risk-increasing factor in fatal and injury large truck crashes, and the second most important factor in car crashes. Major factors linked to distraction/inattention are fatigue, alcohol, conversation, work pressure, and total hours driving.

Keywords

crash, driver distraction. Inattention, large truck, passenger vehicle, Large Truck Crash Causation Study, LTCCS, National Motor Vehicle Crash Causation Study, NMVCCS

Background

The Federal Motor Carrier Safety Administration (FMCSA) and the National Highway Traffic Safety Administration (NHTSA) of the United States Department of Transportation conducted the Large Truck Crash Causation Study (LTCCS) involving large trucks (trucks with a gross vehicle weight rating over 10,000 pounds). The NHTSA conducted the National Motor Vehicle Crash Causation Study (NMVCCS) involving light vehicles (gross vehicle weight rating of 10,000 pound or less). Both studies collected extensive data on driver crash factors, including distraction and inattention.

Literature

Two types of crash causation studies reach very different conclusions about the level of driver distraction and inattention in motor vehicle crashes. Traditional post-crash studies find less than half of crashes involve distraction/inattention, while new naturalistic driving studies find a large majority of crashes involve these two factors. For example, a review of weighted

1995–1999 Crash Dataworthiness data from the NHTSA found that 8.3 percent of the drivers were distracted.[1] The limitations of post-crash studies is illustrated in part by the 35.9 percent “unknown/no driver” result of the study.

By contrast naturalistic driving studies, where in-vehicle cameras record driver actions and the flow of events around the vehicle, find a much higher level of distraction/inattention. A recent study using 100 passengers cars concluded that in 78 percent of crashes and 68 percent of near crash misses driver inattention was a factor.[2] A recent webinar combining data from two naturalistic 100 vehicle driving studies of large truck drivers concluded that 79 percent of all crash relevant conflicts and 82 percent of all safety-critical driving events involved some type of driver distraction.[3] There were no drivers coded “unknown” in these studies.

The large difference in the estimates of distraction and inattention leads to the conclusion that data collection methodology accounts for the observed differences. Nevertheless, there is wide agreement in the highway safety community that driver distraction and inattention are serious highway safety problems.

Data

For the LTCCS the National Automotive Sampling System (NASS) of the NHTSA selected a sample of 963 crashes that took place from April 1, 2001 through December 31, 2003 and involved at least one fatality or one injury. The crashes involved 1,123 large trucks (77 percent were tractors pulling a semi-trailer) and resulted in 249 fatalities and 1,654 people injured. This paper excludes vehicles in which no driver was present, reducing the number of crashes involving large trucks to 956 and the number of large trucks to 1,112.

The NMVCCS was also conducted by the NHTSA’s NASS. The study focused on a sample of 5,470 crashes involving 10,494 vehicles from July 1, 2005 through December 31, 2007 that involved a fatality, injury, or at least one vehicle being towed from crash scene. Of the 10,494 vehicles in the crashes 10,097 (96.2 percent) were light vehicles. The crashes resulted in 122 deaths and 2,980 people injured.

This paper uses the variable passenger vehicles to narrow the number of NMVCCS cases to those that involve passenger cars, pickup trucks, vans, and sport utility vehicles. Motorcycles, other motored cycle types, and all-terrain vehicles are excluded. The paper also includes only NMVCCS cases that result in a fatality or injury, and excludes vehicles for which no driver was present during the crash. With these changes the paper focuses on 2,095 crashes involving 3,609 passenger vehicles.

Data was collected at 24 NASS primary sampling units in 17 States in both the LTCCS and NMVCCS. A crash researcher attempted to arrive at each crash scene before they were cleared and began collecting data. In the LTCCS a trained truck inspector accompanied the crash researcher. Data was collected on about 1,000 data elements in the LTCCS and 600 in the NMVCCS. Researchers collected data at the crash scene through interviews, scene diagrams, and photographs. Away from the scene researchers conducted telephone interviews with witnesses, friends and relatives of deceased drivers, and motor carriers (LTCCS). They also reviewed police accident reports, emergency medical service records, autopsy reports, and other official crash documents.

The LTCCS and NMVCCS employed the same basic methodology, data was collected by same field staff, and results were coded by the same offsite staff. The major differences between the studies was that in the LTCCS large trucks received Level 1 North American Standard vehicle and driver inspections, and data concerning driver-employer relations was collected at the crash scene and through follow-up interviews.

Defining Causation

Motor vehicle crashes are complex events, and usually involve two or more vehicles. Elements that influence the occurrence of a crash may take place hours, days, or months before the crash. These include driver training and experience; driver condition; vehicle design and manufacture; highway design, condition and signaling; and weather conditions. Other elements take place immediately before a crash, such as a decision to turn in traffic, brake failure, or snow. Crash reconstruction experts rarely conclude that crashes are the result of a single factor.

Fatigue, drinking alcohol, and speeding are major factors in motor vehicle crashes. Although their presence does not always result in a crash, these three factors, as well as other driver, vehicle, and environmental factors, can increase the risk that a crash will occur. In the LTCCS and NMVCCS "causation" is defined as factors that increase the risk that motor vehicles will be involved in crashes.

Driver Distraction and Inattention

From the LTCCS and the MNVCCS data for this paper we created a combined driver Distraction/Inattention variable which consists of the following three individual variables. Data on these variables was collected by field investigators based on interviews with the drivers themselves, surrogate drivers in cases where the driver died or was incapacitated, other vehicle occupants, other driver, witnesses, and police reports.

- Inattention—Coded when the driver's mind has wandered from the driving task for some non-compelling reason. In this circumstance the driver is typically focusing on internal thoughts (i.e. daydreaming, problem solving, worrying about family problems, etc.) and not focusing attention on the driving task.
- Internal Distraction—Coded when the driver's attention is directed to some event, object, person, or activity inside the vehicle. Relevant examples include tuning the radio, adjusting the heat/cooling system, engaging in a conversation with a passenger, using a cell phone, retrieving fallen objects, reading books/magazines/maps/invoices, etc.
- External Distraction—Coded when the driver's attention is directed to some event object, person, or activity outside the vehicle. Relevant examples include searching for a street address, construction activity, looking at a building or scenery, looking at a sign, looking at a previous crash site.

Distraction/Inattention is used as an independent variable when explaining the critical reason for crashes, and as the dependent variable when examining the factors that lead to the condition.

Crash Causation Variables

Many variables were coded from the hundreds of data elements collected on each crash. Three key variables were coded for assessing crash risk:

- Critical Event—The action or event that put the vehicle or vehicles on a course that made the collision unavoidable. In this paper we use the critical event coded to the vehicle that was also coded with the crash critical reason.
- Critical Reason—The immediate reason for the critical event, i.e., the failure leading to the critical event. The critical reason is coded to only one vehicle in each crash. It can be coded as a driver condition or error, vehicle failure, or environmental condition (roadway or weather).
- Associated Factors—All person, vehicle, and environmental conditions present at the time of the crash from among all factors that are generally considered to be possible contributory elements to motor vehicle crashes. No judgment is made as to whether any factor is related to the reason for a particular crash, just whether the factor was present. The list of the many factors that can be coded provides enough information to describe the circumstances of the crash.

All associated factors were recorded at the 24 primary sampling unites or through later data collection. After examining all data collected, crash case coders in two locations (Buffalo, New York and San Antonio, Texas) had to choose factors that were the critical events and critical reasons for the crashes. For example, a driver who was coded by a crash researcher at the crash scene with distraction/inattention might also be assigned the crash critical reason, with distraction/inattention coded as the specific reason. However, not every driver coded with distraction/inattention is automatically assigned the critical reason, and even if the driver is coded with the critical reason, it could be another factor. Consider these two examples:

- A passenger vehicle crosses the center line on a curve and collides head-on with a large truck. The driver of the large truck was coded with distraction/inattention. However, the critical reason (driving too fast for conditions) is assigned to the driver of the passenger vehicle, because that vehicle took the action that made the crash inevitable.
- The tire on a passenger vehicle explodes and as a result the vehicle runs off the road and into a tree. The driver is coded with distraction/inattention because he admits he was day dreaming, but the crash critical reason is coded as a vehicle failure.

Three major types of critical events were assigned to the vehicles coded with the critical reason in the two studies. The three accounted for 92 percent of the critical events in the LTCCS and 97 percent in the NMVCCS. They were:

- Vehicle traveling out of the travel lane, off the edge of the road, or crossing or turning at an intersection—47 percent of the large trucks in the LTCCS and 72 percent of passenger vehicles in the NMVCCS;

- Vehicle loss of control due to traveling too fast for conditions, cargo shift, vehicle systems failure, poor road conditions, or other reasons—24 percent of LTCCS large trucks and 9 percent of NMVVC passenger vehicles; and
- Other vehicle in the travel lane stopped, traveling in the same direction, or traveling in the opposite direction—21 percent of LTCCS large trucks and 16 percent of NMVCCS passenger vehicles.

In 55 percent of the LTCCS crashes large trucks which made up a majority of vehicles in the crashes were assigned the critical reasons. In the NMVCCS passenger vehicles which made up 95 percent of vehicles in the crashes were coded with 96 percent of the critical reasons. Table 1 compares the large truck critical reasons in the LTCCS with the passenger vehicle critical reasons in the NMVCCS. In Table 1 driver critical reasons are coded in four categories:

- Non-Performance—The driver was unable to perform the task because he (she) was asleep, disabled by a heart attack or seizure, or physically impaired for another reason.
- Recognition—The driver failed to correctly recognize the pre-crash situation because he was inattentive, distracted by something inside or outside the vehicle, or failed to observe the situation adequately, or other recognition failure.
- Decision—The driver made an incorrect decision such as driving too fast for conditions, misjudging the speed of other vehicles, or following other vehicles too closely, making in illegal maneuver, or other decision error.
- Performance—The driver made a driving performance error as a result of panicking, overcompensating, exercising poor directional control, or other performance error.

Vehicle critical reasons include brake failure, flat tires, cargo shift, and other vehicle defects. Environmental reasons include both adverse weather conditions and roadway problems. Table 1 shows the general type of critical reasons coded to large trucks and passenger vehicles in the two causation studies. Driver factor predominate.

Table 1 - Critical Reasons Coded to Trucks and Passenger Vehicles

Critical Reasons	**LTCCS Large Trucks**	**NMVCCS Passenger Vehicles**
Driver	**87.7%**	**96.7%**
Non-Performance	11.8%	9.2%
Recognition	28.6%	38.0%
Decision	38.0%	28.8%
Performance error	5.4%	11.6%
Unknown driver reason	3.8%	9.1%
Vehicle	**10.0%**	**1.6%**
Environment	**2.3%**	**1.7%**
Total	**100.0%**	**100.0%**

Note: For both the LTCCS and the NMVCCS an attempt was made to construct a national representative sample of the focus vehicles (large truck in the LTCCS and light vehicles in the NMVCCS) by weighting the raw data. The percentages shown are based on weighted estimates of the two types of vehicles involved in fatal and injury crashes during the two study time frames. The estimates may differ from true values, because they are based on a probability sample of crashes and not a census of all crashes.

Table 2 lists the top 20 driver associated factors for large trucks in the LTCCS and for passenger vehicles in the NMVCCS, the percent of each type of vehicle driver coded with the factor.

Table 2 - Driver Associated Factors from the LTCCS and NMVCCS

LTCCS Large Trucks		**NMVCCS Passenger Vehicles**	
Factors	**%**	**Factors**	**%**
Prescription drug use	26	Prescription drug use	34
Traveling too fast for conditions	23	**Distraction/Inattention**	29
Unfamiliarity with roadway	22	Inadequate surveillance	25
Distraction/Inattention	20	Inadequate vehicle control	15
Over-the-counter drug use	18	Physical impairment	14
Inadequate Surveillance	14	Unfamiliar with roadway	11
Fatigue	13	Illegal Maneuver	8
Illegal maneuver	9	Incorrect assumption – other's actions	8
Work pressure	9	Fatigue	8
Physical impairment	8	Traveling too fast for conditions	8
Inadequate evasive action	7	Inadequate evasive action	7
Following too close	5	Over-the-counter drug use	6
Jackknife	5	Alcohol	5
Incorrect assumption – other's actions	5	Inexperienced driver	4
Misjudgment of others actions, gap	3	Illegal drug use	5
In a hurry	3	In a hurry	4
Illness	3	Upset	4
Upset	2	Illness	4
Alcohol	1	Work pressure	3
First time driving truck	1	Misjudgment of others actions, gap	3

Note: See note for Table 1.

Relative Risk Analysis

Relative risk analysis of associated factors and critical reasons allows the sorting out of factors into those merely present at the time of the crash and those that increase the risk of having a crash. It also allows examining the relationship between associated factors and the occurrence of other associated factors. The analysis here will use associated factors (independent variables) to explain the coding of the critical reason (dependent variable).

The large trucks and passenger vehicles involved in LTCCS and MNVCCS crashes can be divided into two groups: those that were assigned the critical reason and those that were not. When the presence of associated factors coded to the two groups is compared, the relative risk of each factor can be assessed, as the following example illustrates: There was a statistically significant positive relationship between the coding of traveling too fast for conditions and the assignment of the critical reason for large trucks in the LTCCS. Table 3 shows the coding of the critical reason and traveling too fast for all trucks in the study.

Table 3 - Relative Risk for Large Trucks Traveling too Fast for Conditions

Traveling too Fast For Condition	Critical Reason	
	Yes	No
Yes	(a) 24,715	(b) 7,811
No	(c) 43,274	(d) 62,904

Note: See note for Table 1. Calculations are based on the exact weighted numbers, but results presented below will be rounded to the nearest 1,000.

The formula for calculating the relative risk ratio is:

$$\frac{a\ (24{,}715)\ /\ a\ (24{,}715) + b\ (7{,}811)}{c\ (43{,}274)\ /\ c\ (43{,}274) + d\ (62{,}904)}$$

The result is 1.86, meaning that large trucks traveling too fast for conditions are almost twice as likely to be assigned the critical reason for a fatal or injury crash than those trucks not traveling to fast.

There are two important questions about crash associated factors:

- How often the factor occurs.
- How likely is the factor to increase crash risk (i.e. how dangerous is the behavior).

Relative risk analysis answers the second question. A combination of the two numbers provides an estimate of the importance of the safety problem of the factor—what we will call a Danger Index. Tables 4 and 5 show:

- The 15 driver associated factors that were coded most frequently for large trucks in the LTCCS and passenger vehicles in the NMVCCS where there was a statistically significant association between the factor and the assignment of the critical reason.
- The relative risk ratio for each factor.
- A Danger Index for each factor derived by multiplying percentage of trucks assessed with each factor and the relative risk ratio. For example, distraction/inattention is was coded for 20 percent of the large trucks in the LTCCS and the relative risk ratio relating the presence of that factor to the crash critical reason coding is 2.2. Thus, the Danger Index is 44.0 ($20 \times 2.2 = 44.0$).

Table 4 - Associated Factors in the LTCCS, Relative Risk Ratio, and Danger Index

Factors	Large Trucks*	Percent of Total	Relative Risk Ratio	Danger Index

Distraction/Inattention	28,000	20	2.2	44.0
Traveling too fast for conditions	32,000	23	1.9	43.7
Unfamiliar with roadway	31,000	22	1.4	30.8
Inadequate surveillance	20,000	14	2.2	30.8
Fatigue	18,000	13	2.1	27.3
Felt under work pressure from carrier	16,000	10	1.8	21.6
Over-the-counter drug use	25,000	17	1.1	19.8
Made illegal maneuver	13,000	9	2.0	18.0
Following too close	7,000	5	2.1	10.5
Physical impairment	11,000	8	1.2	9.6
Inadequate evasive action	9,000	6	1.4	8.4
Jackknife	7,000	5	1.6	8.0
Incorrect assumption of other road user's actions	7,000	5	1.3	6.5
Illness	4,000	3	1.4	4.2
Illegal Drugs	3,000	2	1.4	2.8

* Results shown in Column 2 are national estimates for the 141,000 large trucks involved in fatal and injury crashes during the 33-month study period. The estimates may differ from true values, because they are based on a probability sample of crashes and not a census of all crashes. Estimates are rounded to the nearest 1,000 large trucks, because the estimates are subject to sampling and non-sampling errors.

Table 5 - Associated Factors in the MNVCCS, Relative Risk Ratio, and Danger Index

Factors	Passenger Vehicles*	Percent of Total	Relative Risk Ratio	Danger Index
Inadequate surveillance	401,000	25	1.8	45.0
Distraction/Inattention	**452,000**	**29**	**1.4**	**40.6**
Inadequate vehicle control	238,000	15	2.0	30.0
Physical impairment	223,000	14	1.2	16.8
Traveling too fast for conditions	123,000	8	1.7	13.6
Made illegal maneuver	132,000	8	1.6	12.8
Fatigue	125,000	8	1.5	12.0
Alcohol	87,000	6	1.7	10.2
Inexperienced driver	86,000	5	1.5	7.5
Over-the-counter drug use	100,000	6	1.2	7.2
Illness	56,000	4	1.7	6.8
Illegal drug use	63,000	4	1.6	6.4
Upset	59,000	4	1.6	6.4
In a hurry	61,000	4	1.5	6.0

* Results shown in Column 2 are national estimates for the 1,579,000 passenger vehicles involved in fatal and injury crashes during the 24-month study period. The estimates may differ from true values, because they are based on a probability sample of crashes and not a census of all crashes. Estimates are rounded to the nearest 1,000 passenger vehicles, because the estimates are subject to sampling and non-sampling errors.

Distraction/Inattention has a higher danger index number than any other driver factor in the LTCCS, and the second highest danger index number of any passenger vehicle driver factor in the NMVCCS—trailing inadequate surveillance, and a much higher danger index than all other factors. Even prescription drug use was the number one truck driver and passenger driver factor (Table 2), it did not increase the likelihood of being assigned the crash critical reason, and thus was not included in tables 4 and 5.

Econometric Analysis

We developed econometric models to evaluate the factors associated with inattention and distraction. Because we will be using dependent variables that are binary—for example, driver is attributed with the critical reason, or driver is not attributed with the critical reason critical reason—a logistic regression was the appropriate form of model to employ. The general expression of a logistic model is:

$$P(Y) = \frac{1}{1+e^{-(\alpha+\beta X_i)}}\ .$$

P(Y) is the probability that for a given a crash, the driver will be assigned a critical reason, and Xi is a vector of explanatory variables. The equation above can be expressed as the odds ratio of Y, which is the probability of Y occurring divided by the probability of Y not occurring.

$$\frac{P(Y)}{1-P(Y)} = \frac{\dfrac{1}{1+e^{-(\alpha+\beta X_i)}}}{1-\dfrac{1}{1+e^{-(\alpha+\beta X_i)}}} = \frac{\dfrac{1}{1+e^{-(\alpha+\beta X_i)}}}{\dfrac{e^{-(\alpha+\beta X_i)}}{1+e^{-(\alpha+\beta X_i)}}} = \frac{1}{e^{-(\alpha+\beta X_i)}}$$

The natural logarithm of the odds ratio transforms the model into a linear function:

$$\log\left(\frac{P(Y)}{1-P(Y)}\right) = \log\left(\frac{1}{e^{-(\alpha+\beta X_i)}}\right) = \alpha + \beta X$$

Although the LTCCS and NMVCCS samples are designed to be representative, they are finite draws from separate sampling subunits corresponding to geographic areas. These data do not have independent errors across the entire sample, and, as Winship and Radbill[4] have shown, estimates of the standard errors will be biased (even in logistic models), although the direction and magnitude of the bias is difficult to predict. Consequently, we used the SAS SURVEYLOGISTIC procedure, which accounts for the survey design features.

Data

Table 6 presents the datasets used in the models. All told, 1,093,850 weighted passenger vehicles and 137,647 weighted trucks were represented, although “unknowns” and removal of outliers resulted in the loss of observations for some variables. The NMVCCS coding scheme was much more detailed than that for the LTCCS.

Table 6 - Dataset for Models (Weighted Values)

Trucks				Passenger Vehicles			
	N	Σ(Xi=1)	Percent		N	Σ(Xi=1)	Percent
Inattention/ Distraction Critical Reason	137,647	9,105	6.6	Inattention/ Distraction Critical Reason	1,093,850	115,982	10.6
Associated Factors				**Associated Factors**			
Prescription Drugs	137,647	36,059	26.2	Prescription Drugs	1,093,850	365,349	33.4
OTC Drugs	137,647	24,605	17.9	Physical Impairment	1,093,850	177,955	16.3
Work Pressure	122,539	12,721	10.4	Conversation	1,093,850	159,128	14.5
Inattention	121,652	12,116	10.0	Driver Age>60	1,086,203	148,447	13.7
Physical Impairment	137,647	10,640	7.7	Fatigue	1,022,995	105,782	10.3
Driver Age>60	137,647	9,326	6.8	Inattention	1,093,850	100,358	9.2
Other External Distraction	137,647	8,405	6.1	Illness	1,200,536	55,541	4.6
Conversation	137,647	4,867	3.5	Work Pressure	1,160,987	50,749	4.4
Illness	126,360	4,057	3.2	Approaching Traffic	1,059,115	45,986	4.3
Illegal Drugs	137,647	3,166	2.3	Alcohol	1,075,540	44,011	4.1
Other Internal Distraction	137,647	2,498	1.8	Illegal Drugs	1,576,762	62,541	4.0
Approaching Traffic	137,647	1,543	1.1	Passenger Movement	1,049,483	19,550	1.9
Alcohol	123,279	1,034	0.8	Eating/ Drinking	1,049,483	19,111	1.8
External Person	137,647	681	0.5	Other Internal Distraction	1,049,483	18,916	1.8
Floor Retrieval of Item	137,647	648	0.5	Other Outside Focus	1,059,115	16,037	1.5
Looking for Street Address	137,647	571	0.4	Adjusting Radio	1,049,483	12,958	1.2
Earlier Crash	137,647	352	0.3	Other Item Retrieval	1,049,483	10,732	1.0

Adjusting Radio	137,647	250	0.2	Other External Distraction	1,059,115	10293	1.0
Looking at Building	137,647	73	0.1	Vehicle Controls	1,049,483	5,667	0.5
Passenger Movement	137,647	0	0.0	Smoking	1,049,483	5,496	0.5
Dialing Phone	137,647	0	0.0	Looking at Building	1,059,115	4,447	0.4
Vehicle Controls	137,647	0	0.0	External Person	1,059,115	4,318	0.4
Other Item Retrieval	137,647	0	0.0	Floor Retrieval of Item	1,212,985	5,208	0.4
Other Outside Focus	137,647	0	0.0	Looking for Street Address	1,059,115	3,997	0.4
				Dialing Phone	1,049,483	2,013	0.2
				Earlier Crash	1,059,115	1,802	0.2
				Reading (incl. Map/ Directions)	1,049,483	1,282	0.1
				Text Messaging	1,049,483	0	0.0
Time of Day: 00:00–05:59	137,647	20,787	15.1	Time of Day: 00:00–05:59	1,093,850	0	0.0
Time of Day: 06:00–08:59	137,647	22,576	16.4	Time of Day: 06:00–08:59	1,093,850	206,132	18.8
Time of Day: 09:00–14:59	137,647	63,821	46.4	Time of Day: 09:00–14:59	1,093,850	471,350	43.1
Time of Day: 09:00–14:59	137,647	18,837	13.7	Time of Day: 09:00–14:59	1,093,850	256,261	23.4
Time of Day: 18:00–23:59	138,149	11,668	8.4	Time of Day: 18:00–23:59	1,093,850	160,107	14.6

We also examined hours of drive time and total trip time, which may account for multiple drivers' drive times. In NMVCCS, driving time was coded as a categorical variable with values ranging from 1 to 9 corresponding to half-hour increments, with a value of 9 corresponding to all times equal to or greater than 4 hours. Trip time is measured continuously. As figure 1 shows, trip time and drive time as nearly identical. However the top-coding of drive time at results in a steeper function after hour 4 that may cause misleading results, so the trip time variable was used.* Trip hours were not measured in LTCCS, which

* One (unweighted) crash with an inattention/distraction associated factor occurred in both the eight and tenth hours of trip time. In both cases, these were the only crashes occurring in these hours, so we confined our analysis to crashes that occurred within the first six hours of trip time. For similar reasons, we use LTCCS data within the first 14 hours of drive time.

instead used a continuous measure of drivers' drive time. We believe that NMVCCS trip hours provide the best analog to LTCCS drive time.

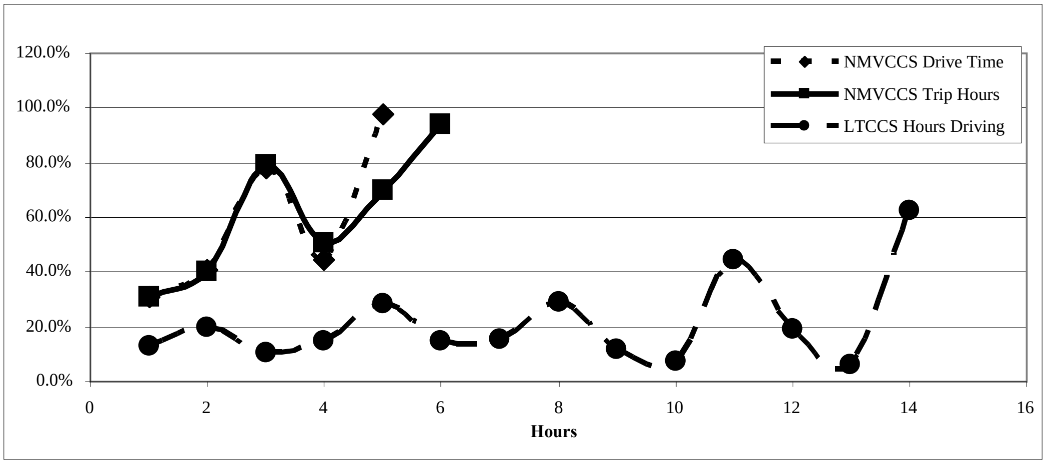

Figure 1 - Percentage Crashes with Inattention/Distraction Associated Factor by Hour

In both the LTCCS and NMVCCS, inattention appears to be more prevalent at higher drive times. Interestingly, the rate of increase in inattention is much lower for truck drivers than it is for passenger vehicle drivers. There are several possible explanations for this. First, as table 2 shows, the prevalence of distraction/inattention is 9 percentage points lower for trucks than it is for passenger vehicles. Second, the average trip duration is lower of for passenger vehicles, so crashes in general will be compressed into a smaller range of trip times. Still, the prevalence of inattention and distraction reaches a higher maximum, perhaps because truck drivers may be better acclimated to long drive times

Factors That Increase Inattention and Distraction

We next attempt to demonstrate how other associated factors are linked with inattention and distraction. From such an analysis, it may be possible to infer a causal link between another factor and inattention/distraction; for example, fatigue and long drive times may lead to inattention. The associated factors we focus on are those that affect overall driver physical and mental condition. It is useful to study the effects of these factors because, while inattention and distraction occur "at the moment", so to speak, factors such as fatigue, drug use, physical impairment, stress, etc. are usually present even before driving has begun. If these factors later lead to a distraction or inattention critical reason, steps can be taken remediate them *before* a trip begins. However, the variable definitions in NMVCCS and LTCCS are such that distraction is generally event driven and, one might say, mostly self-explanatory. For this reason, we analyzed inattention, interior distraction, and exterior distraction separately with the expectation that inattention would most likely find its root causes in other variables.

We estimated models by regressing the dependent variables inattention, conversation/interior distraction, and exterior distraction associated factors on a constant term, non-inattention/distraction associated factors, drive time, time of day of crash, and a dummy variable for drivers over age 60. All the models use the same independent variables and model specification. The results are shown in Table 7.

Table 7 - Stage 1 Model Results

	Trucks			Passenger Vehicles		
Y=	**Inattention**	**Internal Distraction**	**External Distraction**	**Inattention**	**Internal Distraction**	**External Distraction**
	Odds Ratio (P>ChiSq)	Odds Ratio (P>ChiSq)	Odds Ratio (P>ChiSq)	Odds Ratio (P>ChiSq)	Odds Ratio (P>ChiSq)	Odds Ratio (P>ChiSq)
Constant*	-3.2 (<0.01)	-3.3 (<0.01)	-4.3 (<0.01)	-2.8 (<0.01)	-1.2 (<0.01)	-2.4 (<0.01)
Fatigue	**2.1 (0.07)**	**1.7 (0.60)**	1.5 (0.44)	**2.1 (0.07)**	1.1 (0.66)	0.8 (0.56)
Illness	2.4 (0.13)	<0.1 (<0.01)	0.0 (<0.01)	2.4 (0.14)	0.7 (0.42)	0.7 (0.44)
Work Pressure	**2.9 (0.03)**	**3.4 (0.08)**	0.6 (0.55)	**3.7 (<0.01)**	1.4 (0.28)	1.8 (0.24)
Prescription Drugs	0.8 (0.68)	1.0 (0.89)	1.0 (1.00)	1.2 (0.20)	0.8 (0.43)	**2.5 (0.02)**
OTC Drugs	2.4 (0.21)	**2.6 (0.01)**	0.9 (0.85)	0.8 (0.59)	1.3 (0.12)	0.7 (0.23)
Illegal Drugs	<0.1 (<0.01)	<0.1 (<0.01)	<0.1 (<0.01)	0.7 (0.57)	**2.9 (<0.01)**	1.1 (0.94)
Alcohol	<0.1 (<0.01)	<0.1 (<0.01)	**6.4 (0.06)**	1.3 (0.55)	0.7 (0.20)	0.4 (0.08)
Driver Age >60	0.1 (<0.01)	<0.1 (<0.01)	0.3 (0.15)	1.8 (0.19)	0.8 (0.56)	0.7 (0.11)
Physical Impairment	2.5 (0.18)	0.7 (0.70)	1.4 (0.57)	1.2 (0.65)	0.6 (0.01)	0.6 (0.10)
Hours Driving	1.0 (0.43)	1.0 (0.99)	**1.2 (<0.01)**	1.0 (0.61)	**1.3 (<0.01)**	**1.5 (<0.01)**
Time: 00:00–05:59	1.1 (0.93)	3.1 (0.17)	0.3 (0.41)	---- (----)	---- (----)	---- (----)
Time: 06:00–08:59	1.9 (0.44)	1.3 (0.85)	**11.0 (0.01)**	1.1 (0.91)	0.5 (0.07)	0.4 (0.21)
Time: 09:00–14:59	1.4 (0.67)	1.4 (0.74)	1.1 (0.88)	1.2 (0.81)	0.7 (0.31)	0.8 (0.56)
Time: 15:00–18:59	0.9 (0.91)	0.3 (0.09)	1.6 (0.62)	0.9 (0.79)	1.3 (0.62)	0.6 (0.25)

*The coefficient estimate for the constant term is presented.

For trucks, most of our explanatory variables have weak statistical links to the inattention factor, except for fatigue and work pressure. The model shows that the odds of inattention are 2–3 times greater when these factors are present. The model results indicate that these factors and over-the-counter (OTC) drug use increase the risk of internal distraction in truck drivers. The model found that alcohol use and hours driving are statistically linked to elevated external distraction risk, with alcohol increasing that risk about 6.5 times. The external distraction model for trucks also show a strong time-of-day effect during morning rush hours (defined as 06:00–08:59), during which the odds of external distraction are 11 times greater.

The passenger vehicle models show similar results but with a few interesting differences. Fatigue and work pressure are highly significant, increasing the odds of inattention 2.1 and 3.7 times, respectively. Illegal drugs were found to have a statistically significant link to internal distraction, and prescription drugs to external distraction. The models indicate that for passenger vehicles, hours driving has a strong statistical link to both internal and external distraction.

Inattention/Distraction Causes and Critical Reason

In our stage 2 model we estimate the odds of a driver being assigned an inattention/distraction critical reason by analyzing the underlying factors that cause inattention and the most prevalent individual types of driver distraction. The results are presented in Table 8.

Table 8 - Stage 2 Model Results
Dependent Variable: Inattention Critical Reason

	Trucks		Passenger Vehicles	
	Odds Ratio	P>ChiSq	*Odds Ratio*	P>ChiSq
Constant*	-4.1	<.0001	-3.143	<.0001
Fatigue	1.6	0.433	1.6	0.520
Illness	<0.001	<.0001	0.4	0.010
Work Pressure	0.5	0.610	1.0	0.767
Prescription Drug Use	**1.1**	**0.943**	1.4	0.105
OTC Drug Use	3.3	0.180	1.2	0.370
Illegal Drug Use	<0.001	<.0001	0.7	0.707
Alcohol	<0.001	<.0001	**2.2**	**0.009**
Driver Age >60	<0.001	<.0001	0.5	0.310
Physical Impairment	1.3	0.817	1.0	0.946
Hours Driving	**1.2**	**0.101**	0.8	0.044
Conversation	**8.6**	**0.009**	**2.0**	**0.001**
Other Internal	2.1	0.386	**26.5**	**<.0001**
Other External	1.8	0.289	1.5	0.605
Traffic	----	----	1.7	0.508
Floor Retrieval	----	----	94.1	<.0001
Passenger Movement	----	----	**7.9**	**<.0001**
Time: 00:00–05:59	0.2	0.108	----	----
Time: 06:00–08:59	3.0	0.166	1.0	0.933
Time: 09:00–14:59	1.4	0.554	**2.5**	**0.049**
Time: 15:00–18:59	0.2	0.084	2.0	0.268

*The coefficient estimate for the constant term is presented.

The effects of neither of the two factors, fatigue and work pressure, that were shown to be statistically linked to the inattention factor pass through into the increased risk of truck or passenger vehicle driver inattention/distraction critical reason. However, the stage 2 model indicates that prescription drug use and hours driving may have a slight effect on increasing the risk of an inattention or distraction critical reason for truck drivers, although the statistical significance is somewhat weak. However, for passenger vehicles, alcohol has a highly significant effect, with the odds of critical reason at 2.2 greater for this factor. The model also shows which types of distraction have the greatest and most significant risk. For trucks, only conversation was found to have a significant effect, with the odds of a critical reason being about 8½ times greater when that factor was present. For passenger vehicles, conversation and internal factors (passenger movement and other) were found to have strong statistical links to the inattention/distraction critical reason. (We ignored the outsized estimate for "floor retrieval of item" because we believe it represents a "bad draw" of crashes.) This model also indicates a significant between-rush-hour (09:00–14:59) time of day effect, where the odds of an inattention/distraction critical reason are 2½ times greater for passenger vehicles

Conclusion

The cause of inattention can be traced to fatigue and work pressure for both passenger vehicles and trucks, and these factors are also linked to internal distraction for truck drivers however, the presence of those factors are not reliable predictors of a driver critical reason. Total hours driving for truckers were found to have a strong link to external distraction, and a moderately significant effect passed to driver critical reason. Alcohol was found to have a strong link to passenger vehicle critical reason. Of all the sources of distraction, for both trucks and passenger vehicles, large and significant risks were associated with conversation. The greatest risk of critical reason for passenger vehicle drivers was found to arise from internal distraction factors.

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