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

NHTSA
www.nhtsa.gov

DOT HS 811 757

April 2013

The Impact of Hand-Held And Hands-Free Cell Phone Use on Driving Performance and Safety-Critical Event Risk

Final Report

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Suggested APA Format Citation:

Fitch, G. A., Soccolich, S. A., Guo, F., McClafferty, J., Fang, Y., Olson, R. L., Perez, M. A., Hanowski, R. J., Hankey, J. M., & Dingus, T. A. (2013, April). *The impact of hand-held and hands-free cell phone use on driving performance and safety-critical event risk.* (Report No. DOT HS 811 757). Washington, DC: National Highway Traffic Safety Administration.

REPORT DOCUMENTATION PAGE		*Form Approved* *OMB No. 0704-0188*
1. AGENCY USE ONLY (Leave blank) DOT HS 811 757	2. REPORT DATE April 2013	3. REPORT TYPE AND DATES COVERED Final Report
4. TITLE AND SUBTITLE The Impact of Hand-Held and Hands-Free Cell Phone Use on Driving Performance and Safety-Critical Event Risk		5. FUNDING NUMBERS DTNH22-11-D-00236, Task Order 0005 DTNH22-05-D-1002, Task Order 0022
6. AUTHOR(S) Gregory M. Fitch, Susan A. Soccolich, Feng Guo, Julie McClafferty, Youjia Fang, Rebecca L. Olson, Miguel A. Perez, Richard J. Hanowski, Jonathan M. Hankey, and Thomas A. Dingus		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Virginia Tech Transportation Institute 3500 Transportation Research Plaza (0536) Blacksburg, VA 24061		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Department of Transportation National Highway Traffic Safety Administration 1200 New Jersey Avenue SE. Washington, DC 20590		10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES Data collection for this study was performed in 2010 by the Virginia Tech Transportation Institute and Westat, Inc., under NHTSA contract DTNH22-05-D-1002, Task Order 0022. The Contracting Officer's Technical Representative for the current study was Lisandra Garay-Vega.		
12a. DISTRIBUTION/AVAILABILITY STATEMENT This document is available to the public through the National Technical Information Service, Springfield, VA 22161.		12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This study investigated the effects of distraction from the use of three types of cell phones: (1) hand-held (HH), (2) portable hands-free (PHF), and (3) integrated hands-free (IHF). Through a naturalistic driving study (NDS), 204 drivers were continuously recorded for an average of 31 days. Only drivers who reported talking on a cell phone while driving at least once per day were recruited. A key feature was that drivers provided their cell phone records for analysis, making this the first NDS to date to combine call and text records with continuous naturalistic driving data. Results show that drivers talked on a cell phone 10.6 percent of the time the vehicle was in operation (28% of all calls and 10% of all text messages occurred while the vehicle was being operated). Talking on a cell phone, of any type, while driving was not associated with an increased safety-critical event (SCE) risk. SCEs comprised crashes, near-crashes, and crash-relevant conflicts. Visual-manual (VM) subtasks performed on an HH cell phone, however, were associated with an increased SCE risk. HH cell phone use in general was thus found to be associated with an increased SCE risk. In contrast, PHF and IHF cell phone use, absent of any VM HH cell phone subtasks, were not found to be associated with an increased SCE risk. However, VM HH cell phone subtasks were frequently observed during hands-free cell phone use. Driver performance when using a cell phone was also investigated through a within-subject comparison. VM HH cell phone subtasks were found to significantly increase the percentage of time drivers took their eyes off the forward roadway, while talking on an HH cell phone significantly decreased the percentage of time drivers took their eyes off the forward roadway. The effects of cell phone use on vehicle control were less pronounced.

14. SUBJECT TERMS Cell phone, crash risk, driver distraction, driver performance, integrated hands-free, motor vehicle portable electronic device, naturalistic driving, portable hands-free, safety			15. NUMBER OF PAGES 273 16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

ACRONYMS

ANOVA	analysis of variance
CI	confidence interval
COTR	Contracting Officer's Technical Representative
DAS	data acquisition system
DF	degrees of freedom
FACS	Facial Action Coding System
FARS	Fatality Analysis Reporting System
F Stat	F statistic
GES	General Estimates System
GPS	global positioning system
HF	hands-free
HH	hand-held
HVAC	heat, ventilation, and air-conditioning
IHF	integrated hands-free
LCL	lower confidence limit
LOS	level-of-service
M	mean
Max	maximum
Min	minimum
n	sample size
NB	negative binomial
NDSs	naturalistic driving studies
NHTSA	National Highway Traffic Safety Administration
NOPUS	National Occupant Phone Use Survey
PHF	portable hands-free
OBD-II	on-board diagnostics port
OR	odds ratio
RV	rear vehicle
SCE	safety-critical event
SHRP2	Strategic Highway Research Program 2
SE	standard error
SV	subject vehicle

TEORT	total eyes off road time
TTC	time-to-collision
UCL	upper confidence limit
VM	visual-manual

Definitions

Case-control approach	Refers to a method for investigating the safety-critical event risk associated with cell phone use and inherent subtasks. Cases (i.e., safety-critical events) are identified. Random baseline periods are then selected based on drivers' exposure. The presence of cell phone use and its inherent subtasks in both the cases and baseline periods is then determined. The odds of a case occurring when cell phone use is present is then compared to the odds of a baseline occurring when just driving takes place. If the produced odds ratio and confidence intervals are greater than 1, then it is determined that cell phone use is associated with an increased safety-critical event risk relative to just driving.
Cell phone use	Refers to when drivers performed visual-manual and/or talking subtasks on a cell phone (HH, PHF, or IHF). It does not include holding a cell phone, however.
Cognitive distraction	Driver distraction is the diversion of attention from activities critical for safe driving to a competing activity (US-EU Bilateral ITS Technical Task Force, 2010). Although a definition for cognitive distraction is still being developed, it can be thought of as occurring when drivers focus their attention away from the driving task. Cognitive distraction is difficult to measure in a naturalistic driving study because measurement is typically invasive and discourages natural driving behavior. Measures of drivers' physiological state, and self-reports of mental workload immediately after performing a cognitive task, were not taken as a result. However, just talking, also referred to as "talking/listening" and "conversing" in this report, were investigated.
Crash	Any contact with an object, either moving or fixed, at any speed in which kinetic energy is measurably transferred or dissipated, and includes other vehicles, roadside barriers, objects on or off of the roadway, pedestrians, pedalcyclists, or animals.
Crash-relevant conflict	Any circumstance requiring a crash avoidance response on the part of the subject vehicle, any other vehicle, pedestrian, pedalcyclist, or animal that is less severe than a rapid evasive maneuver, but greater in severity than a "normal maneuver" to avoid a crash. The crash avoidance response can include braking, steering, accelerating, or any combination of control inputs. A crash avoidance response for the SV is defined as a control input that falls outside of the 99 percent confidence limit for control input as measured for the same subject.
Curb strike	Any crash that results from the subject vehicle making contact (intentional or unintentional) with a curb.
Driving	Refers to when the vehicle is traveling above 8 km/h. The term 'vehicle operation' was used to describe when the vehicle ignition was on and the data acquisition system was recording.
General driving	Refers to driving in which the driver can perform various non-cell-phone-related secondary tasks. An example would be when a driver eats food while driving a vehicle.

Hand-Held	The term “HH cell phone” was used at the onset of the study when recruiting drivers. It described cell phone use where all subtasks (including reaching, dialing, and talking) were performed on a hand-held phone. This included holding the cell phone while its built-in speakerphone feature was enabled. However, for analysis purposes, cell phone interactions were classified as “HH cell phone” when the talking/listening subtask was done on a hand-held phone. Cell phone interactions that involved the driver using an HH device to place a call, but performing the talking/listening subtask on a PHH or IHF cell phone, were not included in this category. Note: using the speakerphone feature while the cell phone was not held constituted PHF cell phone use.
Hand-Held: Dialing	Also reported as “HH: Dial.” Refers to when the driver is pressing buttons or interacting with a touch screen on a hand-held cell phone in order to dial a phone number to make a call. This can include dialing, searching for a contact’s number, entering a voice mail password, etc. It was only specified when the cell records indicated that the driver made an outgoing phone call. It did not include pressing a button to answer a call (which fell under “HH: locating/reaching/ answering”) or pressing a button to end a call (which fell under “HH: End Task”). NOTE: Additionally, “HH: Dialing” does NOT include pressing buttons or interacting with a touch screen in order to type/read a text message (which should be coded as “HH: Text messaging” if driver types or “HH: Viewing/Browsing/Reading” if driver reads) or browsing the Internet/using phone applications (which should be coded as “HH: Viewing/Browsing/Reading”).
Hand-Held: End task	Also reported as” HH: End Task.” Refers to when the driver completed a specific cell phone interaction by either pressing a button to end the call, putting the phone down after ending a call or text, or flipping/sliding the phone closed after ending a call or text.
Hand-Held: Holding	Also reported as “HH: Hold.” Refers to when the driver held a hand-held cell phone in his/her hand but did not interact with it. It did not include when the phone was resting on the driver’s seat (next to or between legs), or on the driver’s lap (both of which would end the cell phone interaction and be coded as no cell phone task). If the driver was viewing, dialing, or performing another subtask with a hand-held phone, and held the phone without visually or manually interacting with it for at least 5 consecutive seconds, then this “break” period was coded as “HH: Holding.” If the driver resumed another (or the same) subtask before the 5-consecutive-seconds period ended, “HH: holding” was not coded. Rather, the initial subtask was extended until a new task was begun.
Hand-Held: Locate/Reach/ Answer	Also reported as “‘HH: Locate/Answer.” Refers to when the driver looks for or reaches towards his/her hand-held cell phone. Includes when the driver removes a hand-held cell phone from the case before using it.

Hand-Held: Talk/Listen/Voice Commands	Also reported as "HH: Talk/Listen." Refers to when a driver conversed on a hand-held cell phone or had the phone up to his/her ear as if listening to a phone conversation or waiting for a person being called to pick up the phone. If the driver used the speaker phone function on a hand-held cell phone, then it was coded as "HH: Talk/Listen/Voice Commands" if the driver kept the hand-held phone in his/her hand(s) while using the speaker phone function. It was coded as "PHF: Talk/Listen/Voice Commands" if the driver put the phone down and was no longer holding it in his/her hand(s) while using the speaker phone function.
Hand-Held: Text messaging	Also reported as "HH: Text." Refers to when a driver is pushing buttons or interacting with a touch screen on a hand-held cell phone in order to type a text message. It was only specified when the cell records indicated that the driver sent a text message on a hand-held phone. It did not include reading a text message, which was coded as "HH: Viewing/Browsing/Reading." If the cell records indicated that the driver received a text message, and the driver was seen checking and then replying to this text message in the video, then the subtask was coded as follows: 1. If the driver replied to the text message within 10 seconds after reading the text message, then the reply was considered part of the same subtask, and was coded as "HH: Text." The initial reading of the received text message was coded as "HH: View/Browse." 2. If the driver did not reply to the text message within 10 seconds and simply held the phone (coded as "HH: Hold") for 10+ seconds or put the phone down (coded as "HH: End Task"), then the sent text was considered a separate, non-sampled subtask and was not reduced.
Hand-Held: Viewing/Browsing/ Reading	Also reported as "HH: Browse/Read." Refers to when the driver viewed the hand-held cell phone display with or without pressing buttons or manipulating the touch screen for a purpose other than making/receiving a call or sending a text message. Examples include when the driver used the cell phone to check the time, read a received text message, browse the Internet or email, or use the phone's other applications. This included reading a received text message. Exceptions included: 1) When a call was ending, the subtask was coded as "HH: End Task" if the driver looked at the phone and/or pressed a button to end a call. 2) When a call was being answered, any glances or associated button presses were coded as "HH: Locate/Reach/Answer."
Hands-Free (HF)	A general term used to describe portable hands-free and integrated hands-free cell phones.
Headway	Also known as following distance, this is a measurement of the time between two vehicles in a transit system. It is computed by dividing the range to the lead vehicle by the travel speed of the subject vehicle (SV). The unit of measurement is seconds, and reflects the amount of time that it would take for the SV to reach the position of the lead vehicle at that instant in time.

Integrated Hands--Free (IHF)	The term "IHF cell phone" was used at the onset of the study when recruiting drivers. It described cell phone use where some cell phone subtasks, including reaching, dialing, and talking, were done with a cell phone technology that was integrated into the vehicle. This included equipment installed by the vehicle manufacturer such as microphones and speakers for cell phone use, a speech-based user interface to dial the phone, and other phone controls built into the vehicle (e.g., center stack and/or steering wheel buttons). IHF included both vehicles that had a cell phone built into the vehicle itself, and vehicles that detected and interacted with the user's portable device without requiring direct manipulation of the phone itself. However, for analysis purposes, cell phone interactions were classified as "IHF cell phone" when the talking/listening subtask involved the use of cell phone technology that was integrated into the vehicle. This included equipment installed by the vehicle manufacturer such as microphones and speakers for cell phone use, a speech-based user interface to dial the phone, and other phone controls built into the vehicle (e.g., center stack and/or steering wheel buttons). Integrated Hands-free devices included vehicles that had a cell phone built into the vehicle itself, and vehicles that detected and interacted with the user's nomadic device requiring direct manipulation of the phone itself. Cell phone interactions involving the driver using an IHF device to place a call, but then talking/listening on an HH or PHF cell phone, were not included in this category.
Integrated Hands-free: Press button to begin/answer	Also reported as "IHF: Begin/Answer." Refers to when the driver pressed a button on the steering wheel or center stack in order to begin a cell phone interaction. It included pushing to answer a call, pushing to voice dial, or pushing to enter a voice command.
Integrated Hands-Free: Press button to end	Also reported as "IHF: End Task." Refers to when the driver pressed the button on the steering wheel or center stack in order to end the cell phone interaction.
Integrated Hands-Free: Talk/Listen/Voice commands	Also reported as "IHF: Talk/Listen." Refers to when a driver talked, listened, or gave voice commands on an integrated device. The driver had to be observed talking repeatedly with no obvious passenger interaction. Additionally, this subtask was only coded when the cell records indicated that the driver made or received a call.
Intersection violation	Any stop at a controlled intersection where the subject vehicle either (1) stops past the stop bar and/or in the path of cross traffic, (2) performs a rolling stop at a stop sign or right-on-red with a minimum speed >=15mph regardless of relation to stop bar, or (3) passes through a red light in a straight crossing or left turn path.
Just driving	Refers to driving in which the driver does not perform any observable non-driving-related secondary tasks. It is considered the purest form of driving.
Just talking	Refers to when a driver is conversing on a cell phone and not performing any other cell phone subtasks; in particular, visual-manual cell phone subtasks.

Near-crash	Any circumstance requiring a rapid, evasive maneuver by the subject vehicle (SV), or any other vehicle, pedestrian, pedalcyclist, or animal to avoid a crash. A rapid, evasive maneuver is defined as a steering, braking, accelerating, or any combination of control inputs that approaches the limits of the vehicle capabilities. As a guide: SV braking >0.5 g or steering input that results in a lateral acceleration >0.4 g to avoid a crash constitutes a rapid maneuver.
Portable Hands-free (PHF)	The term "PHF cell phone" was used at the onset of the study when recruiting drivers. It described cell phone use during which some cell phone subtasks, including reaching, dialing, and talking were performed with a PHF device. PHF devices included headsets (wired or wireless) or other aftermarket Bluetooth or hands-free devices that were not integrated into the vehicle by the manufacturer. PHF included voice activation performed through the PHF device. However, for analysis purposes, cell phone interactions were classified as "PHF cell phone" when the talking/listening subtask was done on a portable hands-free device. Portable Hands-Free devices included headsets (wired or wireless) or other aftermarket Bluetooth or hands-free devices that were NOT integrated into the vehicle by the manufacturer. PHF could include some voice activation. Cell phone interactions involving the driver using a PHF device to place a call, but then talking/listening on an HH or IHF cell phone, were not included in this category.
Portable Hands--Free: Holding/Wearing Headset/Earpiece	Also reported as "PHF: Hold/Wear." Refers to when a driver was holding a headset/earpiece in his/her hand or wearing it on his/her head but not interacting with it (and not involved in a phone conversation).
Portable Hands--Free: Locate/Put-on Headset/Earpiece	Also reported as "PHF: Locate/Put on." Refers to when the driver looked for or reached towards a headset or earpiece.
Portable Hands--Free: Push button to begin/answer	Also reported as "PHF: Begin/Answer." Refers to when the driver pressed a button on the headset/earpiece in order to begin a cell phone interaction. This included pushing to answer a call or pushing to give a voice command to make a call. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone. Note, if the driver pushed a button or dialed on a hand-held phone instead of pushing a button on the headset/earpiece to answer or make a call, then this was coded as "HH: Dialing" or "HH: Locate/Reach/Answer," even if the subsequent conversation took place via a Portable Hands Free device.
Portable Hands--Free: Push button to end	Also reported as "PHF: End Task." Refers to when the driver pressed the button on the headset/ear piece in order to end the cell phone interaction. The button could be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone. If the driver pushed a button on a hand-held phone instead of pushing a button on the headset/earpiece to end a call, then this subtask was coded as "HH: End Task," even if the conversation took place via a portable hands-free device.

Portable Hands--Free: Talk/Listen/Voice commands	Also reported as “PHF: Talk/Listen.” Refers to when a driver talked on a headset, earpiece, or other aftermarket device, OR listened to a phone conversation, OR waited for a person being called to pick up the phone. The driver had to be observed talking repeatedly with no obvious passenger interaction to conclude that the headset/earpiece was in use. This subtask was coded if the talking subtask was performed on a portable hands-free device, even if the dialing, answering, or call-ending subtask was performed using a hand-held phone. If the driver used the speaker phone function on a hand-held cell phone, then the subtask was coded as “hand-held: Talk/Listen/Voice Commands” if the driver kept the hand-held phone in his/her hand(s) while using the speaker phone function. It was coded as “Portable Hands-Free: Talk/Listen/Voice Commands” if the driver put the phone down and was, thus, not holding it in his/her hand(s) while using the speaker phone function.
Risk rate approach	Refers to a method for investigating the safety-critical event risk associated with cell phone use and inherent subtasks. It is a ratio of two rates. The first rate is the number of safety-critical events that occur when using a cell phone divided by the number of minutes spent using a cell phone while driving. The second rate is the number of safety-critical events that occur when not using a cell phone divided by the number of minutes spent not using a cell phone while driving. If the first rate is found to be greater than the second rate using a mixed-effect Poisson regression, then using a cell phone is determined to be associated with an increased safety-critical event risk. The method is used to investigate risk relative to general driving.
Safety-critical event	Refers to unsafe driving. A safety-critical event can be a crash (where measurable contact is made between the subject vehicle and an object), a near-crash (where a crash would have transpired had a rapid evasive maneuver not been made), and a crash-relevant conflict (which is a conflict that is less severe than a near-crash, but more severe than normal driving).
Total eyes off road time	When considering a specific driving time interval, Total Eyes Off Road Time (TEORT) refers to the sum of all glances away from the forward roadway (including glances to the side and rear-view mirrors) that are made during the time interval. It is a measure of visual distraction.
Vehicle operation	Refers to when the vehicle ignition is on and the data acquisition system is recording.

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Executive Summary

The purpose of this study was to investigate the effects of distraction from the use of three types of cell phones while driving: (1) hand-held, (2) portable hands-free, and (3) integrated hands-free. A naturalistic driving study of drivers' cell phone use was performed. Data was collected from 204 drivers who each took part in the study for 31 days (on average) from February 2011 to November 2011. Only drivers who reported talking on a cell phone while driving at least once per day were recruited. Data acquisition systems in the participants' own vehicles continuously recorded video of the driver's face, the roadway, and various kinematic data such as the vehicle speed, acceleration, range and range rate to lead vehicles, steering, and location. A key feature of this study was that participants provided their cell phone records for analysis. This is the first NDS to date that combines call and text records with continuous naturalistic driving data. The cell phone records allowed the determination of when drivers used their cell phone, while the video data allowed the determination of the type of cell phone used, how long it was used for, and what subtasks were executed. The result was a rich data set of driver behavior and performance when using a cell phone. Three main objectives were then pursued and the results are presented below. Exploratory analyses were also performed and the results are presented in the report.

Objective 1: Investigate Drivers' Cell Phone Use

It was found that 14,754 calls (28 percent of the calls in the cell phone records) and 8,610 text messages (10 percent of the text messages in the cell phone records) overlapped with periods of driving. By comparing participants' cell phone minutes to the recorded driving time, drivers were estimated to be talking on a cell phone 10.6 percent of the time. The mean call duration, according to the call logs, while driving was 4.02 minutes (Min = 0.08 minutes, Max = 146 minutes).

Although drivers were recruited based on self-reports of specific types of cell phone use, video inspection was required to confirm the cell phone type used. Approximately 10 percent of all calls and 10 percent of all text messages that occurred while driving underwent a video review. The exact beginning and end of all cell phone subtasks performed during each call were recorded. Driver, vehicle, and environmental factors present at the time were also recorded. This data subset provided a comprehensive estimate of drivers' cell phone use.

The aggregate cell phone use data were also used to investigate the number of calls made per hour of driving. Drivers who had access to PHF cell phones made more calls per minute of driving (M = 0.0409) than did drivers who had access to IHF cell phones (M = 0.0296) and drivers who had access only to HH cell phones (M = 0.0262). No differences in the number of text messages made per minute of driving were found as a function of cell phone type. Note: hands-free texting was rare and was not considered in this study.

Call duration was also assessed as a function of cell phone type. Each call sampled was classified into HH, PHF, or IHF cell phone interactions based on the cell phone type used during the conversation. When driving at speeds above 8 km/h, drivers talked longer on PHF cell phones

(*M* = 4.96 min) than on IHF cell phones (*M* = 3.78 minutes) or HH cell phones (*M* = 3.00 min). Again considering driving at speeds above 8 km/h, dialing on an HH cell phone lasted 12.4 s, on average, while pushing a button to begin a PHF or IHF call took significantly less time (*M* = 2.9 s and 4.6 s, respectively). Note: although it could not be determined whether dialing consisted of entering 10 digits or using shortcuts, one reason why the subtask exceeded 12 s was because drivers paused to look at the forward roadway. Furthermore, pushing a button to begin an IHF call was likely longer than pushing a button to begin a PHF call because the former could include visual-manual (VM) interactions with the vehicle's integrated display. Text messaging lasted 36.4 s, on average (*Min* = 0.3 s, *Max* = 450.1 s).

Objective 2: Investigate SCE Risk Associated With Cell Phone Use

This study investigated the risk of a safety-critical event associated with using a cell phone. An SCE was defined as a crash (where contact was made with another object), a near-crash (where a crash was avoided by a rapid evasive maneuver), or a crash-relevant conflict (where a crash avoidance response was performed that was less severe than a rapid evasive maneuver, but greater in severity than a "normal maneuver"). SCE risk was investigated using two approaches: (1) a risk rate approach, which assessed the SCE risk relative to general driving (where non-cell-phone secondary tasks could occur), and (2) a case-control approach, which assessed the SCE risk relative to "just driving" (where non-driving-related secondary tasks did not occur). For the risk rate approach, a risk rate estimate was computed as the number of SCEs during cell phone use divided by the total number of minutes spent using a cell phone while driving. This rate was then compared to the risk rate of general driving, computed as the number of SCEs during non-cell-phone use divided by the total number of minutes driving without cell phone use. A mixed effect Poisson regression model was then used to investigate whether the risk rate for cell phone use differed from the risk rate for general driving. Risk rate ratios were also computed for grouped VM cell phone subtasks as well as for talking/listening subtasks. The results are presented in Table 1. Talking on a cell phone was not associated with an increased SCE risk for any of the cell phone types. Both call-related and text-related VM subtasks performed on an HH cell phone were, however, found to increase SCE risk. As a result, HH cell phone use, collapsed across all subtasks, was found to be associated with an increased SCE risk. Pure PHF and IHF cell phone use – where VM HH cell phone subtasks are excluded – were not associated with an increased SCE risk. It must be noted, however, that 55.5 percent of the sampled PHF interactions, and 53.2 percent of the sampled IHF interactions, involved VM HH subtasks. Unless stated as pure use, PHF and IHF cell phone use refers to cell phone interactions that could involve VM subtasks.

Table 1. SCE Risk Associated With Cell Phone Use as Computed Through Risk Rate Approach

Subtask	Rate Ratio	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	p-value
Cell Phone Use – Collapsed	1.32	0.96	1.81	.0917
Visual-Manual	**2.93***	1.90	4.51	< .0001
Call-Related Visual-Manual	**3.34***	1.76	6.35	.0003
Text-Related Visual-Manual	**2.12***	1.14	3.96	.0184
Talking/Listening	0.84	0.55	1.29	.4217
Talking/Listening HH	0.84	0.47	1.53	.5764
Talking/Listening PHF	1.19	0.55	2.57	.6581
Talking/Listening IHF	0.61	0.27	1.41	.2447
HH Cell Phone Use (Collapsed)	**1.73***	1.20	2.49	.0034
PHF Cell Phone Use (Collapsed)	1.06	0.49	2.30	.8780
IHF Cell Phone Use (Collapsed)	0.57	0.25	1.31	.1859

** Indicates a difference at the .05 level of significance*

The risk rate approach generates a powerful estimate of risk by using all accounts of when cell phones were used while driving. It is, however, limited in that it cannot assess the SCE risk relative to "just driving" (defined as driving void of all non-driving-related secondary tasks) without the availability of estimates of the propensity for each potential secondary task that is performed concurrently while driving. The case-control approach was thus used to address this limitation. A total of 2,308 baseline periods were randomly sampled based on each driver's driving time in the study. This number was selected to be at least four times the 342 SCEs that were identified. The odds of an SCE occurring during specific cell phone subtasks were then compared to the odds of an SCE occurring when just driving. Note that "just driving" was only found in 46 percent of the baseline periods. Table 2 presents the odds ratios and 95-percent confidence limits for various cell phone subtasks. As in the previous risk analysis, only VM subtasks performed on an HH cell phone were found to be associated with an increased SCE risk. Conversing on a cell phone (i.e., any type of cell phone) was not found to increase SCE risk.

Table 2. SCE Risk Associated With Cell Phone Use as Computed Through Case-Control Approach

Subtask	OR	LCL	UCL	#SCE	#Baseline periods (BL)	SCE Total	BL Total	Total
Cell Phone Use - Collapsed	1.1	0.8	1.53	57	358	211	1426	1637
Visual-Manual Subtasks	**1.73***	1.12	2.69	29	116	183	1184	1367
Text Messaging/Browsing	1.73	0.98	3.08	16	64	170	1132	1302
Locate/Answer	**3.65***	1.67	8	10	19	164	1087	1251
Dial	0.99	0.12	8.11	1	7	155	1075	1230
Push to Begin/End Use	0.63	0.08	4.92	1	11	155	1079	1234
End HH Phone Use	1.26	0.43	3.71	4	22	158	1090	1248
Talking on Cell Phone	0.75	0.49	1.15	28	259	182	1327	1509

Subtask	OR	LCL	UCL	#SCE	#Baseline periods (BL)	SCE Total	BL Total	Total
HH Talking	0.79	0.43	1.44	13	114	167	1182	1349
PHF Talking	0.73	0.36	1.47	9	86	163	1154	1317
IHF Talking	0.71	0.3	1.66	6	59	160	1127	1287
HH Cell Phone Use (Collapsed)	1.39	0.96	2.03	41	204	195	1272	1467
PHF Cell Phone Use (Collapsed)	0.79	0.4	1.55	10	88	164	1156	1320
IHF Cell Phone Use (Collapsed)	0.62	0.26	1.46	6	67	160	1135	1295

** Indicates a difference at the .05 level of significance*

Objective 3: Investigate Driver Performance When Using a Cell Phone

The third objective of this study was to perform a controlled comparison of driver performance when using a cell phone through a within-subject investigation. Each sampled subtask was compared to a matched 20-second baseline sample selected 30 s prior to the start of each sampled cell phone interaction. Driver, vehicle, and environmental factors were recorded similarly to the cell phone samples. One-way within-subject inferential tests were performed to assess changes in visual behavior, longitudinal vehicle control, lateral vehicle control, and delayed reaction to unexpected external events. Exploratory analyses of the effects of cell phone use on driver compensatory behavior, driver lane change performance, driver performance near intersections, and downstream traffic behavior were also performed.

Overall, drivers' visual behavior was the most sensitive to change when using an HH cell phone. VM subtasks such as locating/answering, dialing, text messaging, browsing, and ending the call were all found to increase the mean percentage of Total Eyes Off Road Time (TEORT). In contrast, the mean percentage TEORT significantly *decreased* when conversing on an HH cell phone. The amount of time drivers' eyes were off the road was then investigated. Drivers' mean TEORT when text messaging (M = 23.3 s), browsing (M = 8.2 s), and dialing (M = 7.8 s) were significantly longer than for locating a cell phone (M = 1.3 s), pushing a button to begin a PHF call (M = 0.5 s), pushing a button to begin an IHF call (M = 2.5 s), and ending a call (M = 1.3 s).

Regarding longitudinal vehicle control, the mean speed standard deviation was found to significantly increase from baseline when ending both HH and IHF cell phone use (M = 6.32 km/h versus M = 4.96 km/h, and M = 5.19 km/h versus M = 3.95 km/h, respectively). Ending HH cell phone use was also associated with a significantly higher peak deceleration compared to baseline (M = 0.105 g versus M = 0.078 g). Although it is possible that drivers braked harder because they were distracted by their cell phone use, it is also possible that drivers chose to end their cell phone conversations when coming to a stop (e.g., in their driveway), or when nearing their destination (e.g., in a parking lot). Regarding lateral vehicle control, the mean unintentional lane bust rate, computed as the number of times the driver unintentionally crossed the lane markings divided by the duration of the sample interval, was found to significantly *decrease* when talking on an HH cell phone (M = 0.001 versus 0.003 lane busts/second). The number of unexpected events observed in this study (n = 13) was not enough to perform a statistical analysis of delayed driving reaction.

There were two findings that could be construed as evidence of compensatory behavior when using a cell phone. First, browsing was performed at significantly lower speeds than the speeds recorded during baseline. Second, text messaging was performed at a significantly greater headway than the headways recorded during baseline. It must be noted, however, that the sample size pertaining to these findings was quite small, making it difficult to generalize the findings. For the most part, drivers did not decrease their speed when performing VM or talking/listening cell phone subtasks. Similar results were found when analyzing commercial motor vehicle speed when drivers engaged in mobile device use (Fitch & Hanowski, 2012).

Analyses of drivers' lane change performance showed that drivers changed lanes significantly more often when locating/answering an HH cell phone compared to baseline (10% versus 4%). However, the likelihood that drivers used their turn signal when changing lanes was not found to differ when using a cell phone. If a lane change was performed, drivers used their turn signal during 59 percent of the baseline periods, 52 percent of the VM cell phone subtasks, and 47 percent of the talking/listening cell phone subtasks.

The likelihood of properly scanning an intersection was not found to differ when using a cell phone. Drivers properly scanned the intersection during 38 percent of the baseline periods, 36 percent of the grouped VM cell phone subtasks, and 35 percent of the grouped talking/listening cell phone subtasks.

Finally, the likelihood of a trailing vehicle traveling close (within 14 m, which is just over the distance between the start of two standard highway lane markings) to the subject vehicle was found to significantly increase during cell phone use. A trailing vehicle was observed to be close during 6.2 percent of the baseline periods, 9.8 percent of the VM cell phone subtasks, and 12.3 percent of the talking/listening cell phone subtasks. Although this could be a result of drivers not keeping pace when using a cell phone, it could also be because drivers are using their cell phones in situations in which vehicles are closer together (e.g., when stopping at an intersection or when in stop-and-go traffic). The likelihood of the trailing vehicle passing the subject vehicle was not found to change.

Summary

The results from this study present a clear finding: VM subtasks performed on HH cell phones degrade driver performance and increase SCE risk. Talking on a cell phone, regardless of the type of interface, was not associated with an increased SCE risk. Pure PHF and IHF cell phone use – where VM HH cell phone subtasks are excluded – were also not associated with an increased SCE risk. Although current hands-free (HF) interfaces allow drivers to communicate with their voice, there is a concern that they still allow, and sometimes require, VM HH cell phone subtasks. Drivers can, and frequently do, initiate HF calls, text/browse during HF calls, and end HF calls with an HH cell phone. HF interfaces also require that drivers enable a Bluetooth connection, pair their cell phone, and manually dial if their voice commands are not recognized. Such VM HH cell phone subtasks detract from the goal of true HF cell phone use.

Furthermore, there is a segment of the driving population which primarily uses cell phones to exchange text messages. Various HF interfaces do not address this type of cell phone use.

1 Introduction

The purpose of NHTSA contract DTNH22-11-D-00236, Task Order 5, was to investigate the effects of distraction from the use of three types of cell phones while driving: (1) hand-held, (2) portable hands-free, and (3) integrated hands-free cell phones. There were three main objectives of this study; each was examined using several research questions.

Objective 1: Investigate Drivers' Cell Phone Use
- How do drivers use their cell phones in their vehicles?
- How does cell phone use differ with cell phone type?
- How are cell phones used in different traffic environments?

Objective 2: Investigate Safety-Critical Event Risk Associated With Cell Phone Use
- What is the SCE risk associated with conversing on a cell phone?
- What is the relative risk of conversing on an HH, PHF, and IHF cell phone?
- What is the SCE risk associated with specific cell phone subtasks?

Objective 3: Investigate Driver Performance When Using a Cell Phone
- How distracted are drivers while using different types of cell phones?
- How much distraction is due to different cell phone subtasks?
- What are the effects of distraction from "just talking" on a cell phone?

1.1 Study Rationale

The National Highway Traffic Safety Administration has a long-term goal of eliminating crashes attributable to driver distraction. To achieve this goal, a plan was formulated, the first initiative of which was to improve the understanding of the extent and nature of the distraction problem (NHTSA, 2010). This initiative has predominantly focused on investigating driver distraction from cell phone use and served as the primary motivation for the current study.

There are several reasons to investigate drivers' cell phone use. They include:

- Cell phone subscriptions are exponentially increasing
- Many people use their cell phones while driving
- Complex cell phone subtasks, such as text messaging, dialing, and locating a cell phone are associated with an increased crash risk
- There are various types of cell phone devices available to drivers
- Drivers continue to use HH cell phones despite the availability of hands-free (HF) technology
- Some people primarily use their cell phone to send/receive text messages ("text messaging"), despite the fact that text messaging while driving has been banned in many states

- There are limited data on the crash risk associated with PHF and IHF cell phones

Given these concerns, this study set out to characterize drivers' cell phone use (i.e., calls and text messages made with HH, PHF, and IHF cell phones), the SCE risk associated with cell phone use, and the impact of cell phone use on driving performance by performing a naturalistic driving study (NDS). An NDS data set was generated by installing video cameras and kinematic sensors in participants' own vehicles and continuously recording their driving performance – without an experimenter in the vehicle – for an extended period of time. Drivers were not given any specific instructions and consequently were expected to behave naturally. Data were collected from 204 drivers, each of whom took part in the study, on average, for 31 continuous days within the overall study period (February 2011 to November 2011). Data acquisition systems (DASs) installed in the participants' own vehicles continuously recorded video of the driver's face, the roadway, and various kinematic data such as the vehicle speed, acceleration, range and range rate to lead vehicles, steering, and location. A key feature of this study was that participants provided their cell phone records for analysis. No NDS to date has combined call and text records with continuous naturalistic driving data. In doing so, the cell phone records allowed an accurate determination of when drivers used their cell phone, while the video data allowed an accurate determination of the type of cell phone used, how long it was used for, and what subtasks were executed. The end result was a rich data set of driver behavior and performance when using a cell phone.

2 Background

Driver distraction has been defined as the diversion of attention from activities critical for safe driving towards a competing activity (US-EU Bilateral ITS Technical Task Force, 2010). It is a behavior that jeopardizes the safety of drivers, passengers, and non-occupants alike. In 2010, 3,092 people were killed (9 percent of all fatal crashes), and 416,000 people were injured (18 percent of all injury crashes), in crashes involving distracted drivers (NHTSA, 2012).

2.1 Driver Distraction From Cell Phone Use

Of the 3,092 people killed in distraction-affected crashes, 408 (13%) occurred in crashes in which at least one of the drivers was using a cell phone at the time of the crash (NHTSA, 2012). Using a cell phone can take many forms, each imposing various levels of distraction. Traditionally, conversing has been the primary form of cell phone use. This activity, however, requires several visual-manual subtasks to initiate and end cell phone use. VM subtasks are a concern because they require drivers to take their eyes off the road and their hands off the steering wheel to be performed. Newer cell phone interfaces have been designed to simplify use by allowing drivers to initiate and end calls with voice commands or with a single button press. In doing so, however, it has become easier for drivers to read and browse using their HH cell phone while simultaneously conversing using HF technology. Furthermore, despite best efforts to redesign how drivers interact with cell phones, there is a growing subset of the population whose primary goal of cell phone use is text messaging. Text messaging is a considerable concern because it imposes distraction that exceeds the VM subtasks inherent to making and ending calls (Olson, Hanowski, Hickman, & Bocanegra, 2009). To understand the distraction that cell phones impose on drivers, it is imperative to take a hierarchical task analysis approach so that the effects of different types of subtasks can be quantified. Doing so will provide a clearer perspective on drivers' cell phone use, the risk associated with using a cell phone, and drivers' performance when using a cell phone.

2.1.1 Drivers' Cell Phone Use

Cell phone subscriptions have increased exponentially since their introduction in the 1980s. The number of subscriptions has surpassed the U.S. population (International Telecommunications Union, 2011). Their prevalence amongst younger and less experienced drivers has also dramatically increased (Lenhart, Ling, Campbell, & Purcell, 2010). Quantifying how much drivers use their cell phones is an essential first step to understanding their impact on transportation safety.

The National Occupant Protection Use Survey (NOPUS) estimates that, in 2010, drivers used an HH cell phone 5 percent of the time (Pickrell & Ye, 2011). Furthermore, the percentage of drivers who were text-messaging or visibly manipulating HH devices was 0.9 percent. These estimates were generated by a nationwide probability-based observational survey, where drivers' electronic device use when stopped was observed at randomly selected controlled intersections throughout the United States. In applying the hands-free to hand-held cell phone ratio observed in NHTSA's 2007 Motor Vehicle Occupant Safety Survey (MVOSS) to the NOPUS findings, NHTSA estimates that 9 percent of drivers were using either an HH or HF cell phone while driving at a typical daylight moment in the United States in 2010 (Pickrell & Ye, 2011).

Drivers' cell phone use has also been estimated using NDS data sets. Fitch and Hanowski (2011) estimated drivers' cell phone use by examining the frequency of cell phone subtasks in both light- and heavy-vehicle NDS data sets. The light-vehicle data set was generated by the 100-Car Study, which collected data from 241 drivers in the Northern Virginia area from January 2003 to July 2004 (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). The heavy-vehicle data set comprised data from two commercial motor vehicle NDSs that collected data from May 2004 to May 2005, and from November 2005 to May 2007 (Olson, Hanowski, Hickman, & Bocanegra., 2009). Light-vehicle drivers were estimated to have used a cell phone (i.e., dial, talk on an HH cell phone, or talk on an HF cell phone) 8.3 percent of the time the vehicle was in motion (i.e., traveling at 24 km/h or faster). These drivers dialed 1.0 percent of the time, conversed on an HH cell phone 6.2 percent of the time, and conversed on an HF cell phone 1.3 percent of the time. Similarly, commercial vehicle drivers were estimated to have used a cell phone 9.2 percent of the time the vehicle was in motion (i.e., traveling at 8 km/h or faster). These drivers dialed on the cell phone 1.0 percent of the time, conversed on an HH cell phone 4.2 percent of the time, conversed on an HF cell phone 4.1 percent of the time, and texted 0.1 percent of the time. Note that text messaging was not observed in the 100-Car Study because it was not a widespread method of communication when the data were collected.

Complementing these estimates, a study that analyzed the naturalistic driving data collected from light vehicles in the Integrated Vehicle-Based Safety System Field Operational Test estimated that drivers used their cell phone 6.7 percent of the time the vehicle was in operation (both stopped and in motion) (Funkhouser & Sayer, 2012). Drivers conversed on an HH or HF cell phone 6.7 percent of the time, and performed VM HH cell phone subtasks 2.3 percent of the time. These estimates were produced by examining every minute of driving data collected from the drivers' first week of driving in the study. These data were collected in 2006. This study showed that drivers used a cell phone more frequently when the vehicle was stopped compared to when it was in motion. Drivers conversed on an HH or HF cell phone 7.2 percent of the time, and performed VM HH cell phone subtasks 2.8 percent of the time, when stopped; while they conversed on an HH or HF cell phone 5.9 percent of the time, and performed VM HH cell phone subtasks 1.9 percent of the time, when moving (Funkhouser & Sayer, 2012).

2.1.2 Crash Risk of Using a Cell Phone

A central component of the NHTSA distraction plan's first initiative is to understand the crash risk of using a cell phone. Early epidemiological research reported that using a cell phone – be it HH or HF – is associated with a quadrupling of the risk of injury and property damage crashes (McEvoy et al., 2005; Redelmeier & Tibshirani, 1997). However, a series of NDSs that investigated the risk of drivers performing specific cell phone subtasks unanimously found that SCE risk was associated with complex subtasks such as text messaging and dialing; in contrast, conversing on a cell phone was not associated with an increased crash risk (Hickman, Hanowski, & Bocanegra, 2010; Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006; Olson, Hanowski, Hickman, & Bocanegra, 2009). These results were observed for both commercial motor vehicle and light-vehicle drivers, as well as across broad classifications of low, moderate, and high driving task demands (Fitch & Hanowski, 2011). These results suggest that: (1) the relative risks of different cell-phone-use subtasks are not equivalent (Hanowski, 2011), and (2) knowing what subtask was executed by the driver prior to a crash is necessary when assessing the risk associated with cell phone use.

It is important to note that the SCE risk of cell phone use – when collapsing across subtasks – estimated in the NDS investigations has never been near the fourfold increase reported in the earlier epidemiological studies. This inconsistency is compounded by a more recent epidemiological study that found that the risk of an airbag crash associated with HF conversation was moderately low (Young & Schreiner, 2009). Dingus, Hanowski, and Klauer (2011) speculate that that this was because the earlier epidemiological studies were unable to precisely know what the driver was doing just prior to the crash. As such, the drivers could have completed their cell interactions up to 10 minutes prior to having to react to a crash circumstance. Additionally, the drivers could have performed a number of tasks with the cell phone, only one of which was a conversation. Young (2011) presents a resolution to this discrepancy. By investigating drivers' exposure to driving, he estimates that the two epidemiological studies mentioned above may have actually had less driving time in their control window on the day before the crash, than in the window just before the crash. This bias may be why they overestimated the relative risk for cell phone use while driving. In correcting for drivers' exposure, Young found that the relative risk for cell phone use reported in the previous epidemiological studies lowered to about 1.0, aligning the estimates with the findings from the NDSs. Note: a relative risk of 1.0 means that there is no difference in risk between using a cell phone while driving and not using a cell phone while driving.

The risk associated with talking on a cell phone is of great interest because it comprises the majority of cell phone use. Previous NDSs have not found SCE risk to be significantly elevated by cell phone conversation. Some NDSs even found that commercial motor vehicle drivers were at a decreased risk when conversing on an HF cell phone (Hickman, Hanowski, & Bocanegra, 2010; Olson, Hanowski, Hickman, & Bocanegra, 2009). In contrast, non-NDS research has found that driving performance degrades when concurrently conversing on a cell phone (Atchley & Dressel, 2004; Drews, Pasupathi, & Strayer, 2004; Horrey, Lesch, & Garabet, 2008; Strayer, Drews, & Johnston, 2003). As such, an investigation of the SCE risk associated with talking on a cell phone using current data is required.

2.1.3 Driver Performance When Using a Cell Phone

Driver performance when using a cell phone has been investigated in previous NHTSA research (Angell et al., 2006; Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006; Ranney, Baldwin, Parmer, Martin, & Mazzae, 2011). Performance measures have included drivers' visual behavior, longitudinal vehicle control, lateral vehicle control, and reaction time to unexpected events. Using a cell phone requires numerous subtasks to be executed (e.g., locating/reaching for the device, dialing a number, talking/listening, and ending the call). Each subtask involves different types and levels of distraction. As such, the degree to which each subtask affects driving performance is of significant interest.

Reaching for a cell phone, dialing, browsing, and text messaging can be classified as complex subtasks because they require the driver to take his/her eyes off the road for an extended period of time. For instance, drivers have been found to take their eyes off the road for 4.6 seconds over a 6-second interval when text messaging (Olson, Hanowski, Hickman, & Bocanegra, 2009). When traveling at a speed of 90 km/h, this equates to a driver traveling the length of a football field without looking at the roadway. Furthermore, when drivers' eyes are off the road, the longitudinal vehicle control, lateral vehicle control, and the ability to detect unexpected events degrade. Consequently, measuring where drivers look when interacting with a cell phone is essential to understanding how cell phone use affects driver performance.

Although the disruption on driving performance from talking on a cell phone has been consistently shown to be less than that which is seen for VM subtasks (Ranney, Baldwin, Parmer, Martin, & Mazzae, 2011), controlled experimentation using driving simulators and test tracks have shown that conversing on a cell phone can negatively affect driving performance. Conversing on a cell phone has been linked to:

- Increases in drivers' ratings of workload (Horrey, Lesch, & Garabet, 2009);
- Missed signals and slower reaction times (Strayer & Johnston, 2001);
- Poor speed maintenance and headway distance (Rakauskas, Gugerty, & Ward, 2004);
- Instances when drivers look but fail to remember seeing objects (Strayer, Drews, & Johnston, 2003);
- Reductions in the area that drivers scan (Atchley & Dressel, 2004; Maples, DeRosier, Hoenes, Bendure, & Moore, 2008);
- Increases in reaction times to unexpected events (Caird, Willness, Steel, & Scialfa, 2008; Horrey & Wickens, 2006)
- Decreases in travel speed (Cooper, Vladisavljevic, Strayer, & Martin, 2008; Young, Regan, & Hammer, 2003)
- Increases in following distance (Cooper et al., 2008)
- Lower lane change frequencies (Cooper et al., 2008)
- Missed navigational signage (Drews, Pasupathi, & Strayer, 2004)
- Increases in stop light violations when in an intersection dilemma zone (Horrey, Lesch, & Garabet, 2008)

At the same time, there is some evidence that conversing on a cell phone can raise alertness in monotonous driving conditions. A field study found that drivers that received regularly scheduled phone calls were more alert and awake during the conversation and up to 20 minutes afterwards (Jellentrup, Metz, & Rothe, 2011). Given these findings, a controlled investigation of the degree to which driver performance is affected by cell phone use using representative data is required.

2.2 Designing to Mitigate Distraction From Cell Phones

A logical progression from previous research findings on driver distraction has been to minimize the need for complex subtasks when interacting with any kind of interface while driving. In the context of cell phones, wired headsets were one of the first attempts at this design goal by allowing drivers to converse without holding a cell phone to their ear. Headsets and earpieces that wirelessly connect to the cell phone were later released to achieve the same purpose more conveniently. Speakerphone devices (either built into the cell phone or wirelessly-connected) are also available in the marketplace. These types of devices form a category which has been termed portable hands-free (PHF) cell phones in this study. Note, speakerphones that continue to be held during use are still considered HH cell phones in this study.

Although PHF cell phones allow drivers to keep their hands on the steering while conversing, they still require drivers to physically manipulate a device. When using the cell phone, drivers may have to reach for the headset/earpiece, or put it away after use. These subtasks have the potential to distract drivers. Although it is recognized that the ideal use of PHF cell phones is to handle the headset/earpiece when the vehicle is stopped, such interactions are possible while the vehicle is in motion.

A design alternative is to integrate the cell phone with the vehicle. Equipment comprising microphones, speakers, steering wheel push buttons, and voice recognition software installed in the vehicle by the manufacturer enables all cell phone subtasks to be performed while the driver keeps his/her eyes on the road and hands on the steering wheel. Such systems are termed integrated hands-free (IHF) cell phones in this study. Research has shown that voice control of in-vehicle devices may allow drivers to keep their eyes on the road longer, track their course more consistently, and have lower mental demand than when these devices are controlled manually (Owens, McLaughlin, & Sudweeks, 2010). However, having IHF systems available does not guarantee that drivers will use them, and physical manipulation of cell phones to initiate and end calls remains possible. Potential concerns include: (1) drivers manipulating an HH cell phone while engaged in an IHF conversation, and (2) drivers interacting with integrated touch-screen displays to initiate and end cell phone use.

Given the findings on HH and HF cell phone use, as well as the widespread availability of newer HF interfaces, NHTSA is focused on improving the understanding of how cell phone use, and its inherent subtasks, distracts drivers and jeopardizes safety. This study was designed to quantify drivers' cell phone use, assess the risk of an SCE associated with such use, and investigate its effect on driver performance. The analysis of *in situ* driver behavior data collected through a large-scale NDS supports the generalization of results to real-world driving conditions.

3 Methods

3.1 Driver Demographics

Data collected from 204 drivers in a previous contract (NHTSA contract DTNH22-05-D-1002) were analyzed in this study. There were 129 females (63%) and 75 males (37%) with a median age of 41 years (18 to 84 years). Drivers were recruited if they reported using a cell phone at least once per day while driving. Drivers were assigned to one of three cell phone groups (HH, PHF, and IHF) if they reported using one type of cell phone at least 50 percent of the time (see Table 3 for an operational definition of each type of cell phone). The assigned groupings, however, were not used in the data analysis. This is because the type of cell phone used in a given interaction could be different from the type of cell phone the driver reported using the majority of the time (e.g., drivers in the IHF group could make calls using HH cell phones). Inspection of the recorded video was thus required to verify the type of cell phone used. The initial group assignments were used to help ensure that a representative sample of each cell phone type was collected. The distribution of the participants by assigned cell phone type and location are shown in Table 4. The reader is referred to section 4 (Investigation of Drivers' Cell Phone Use) which describes how cell phone use was analyzed as HH, PHF, or IHF based on the cell phone type used in the conversation.

Table 3. Definition of Cell Phone Type Used in Recruiting Drivers

Cell Phone Type	Operational Definition
Hand-Held (HH)	All cell phone subtasks including reaching, dialing, and talking are performed on an HH phone. This included holding the cell phone while its built-in speakerphone feature was enabled. Note: using the speakerphone feature while the cell phone was not held constituted PHF cell phone use.
Portable Hands-Free (PHF)	Refers to instances when some cell phone subtasks, including reaching, dialing, and talking were performed with a PHF device. PHF devices included headsets (wired or wireless) or other aftermarket Bluetooth or hands-free devices that were not integrated into the vehicle by the manufacturer. PHF did include voice activation performed through the PHF device.
Integrated Hands-Free (IHF)	Refers to when some cell phone subtasks, including reaching, dialing, and talking, were done with a cell phone technology that was integrated into the vehicle. This included equipment installed by the vehicle manufacturer such as microphones and speakers for cell phone use, a speech-based user interface to dial the phone, and other phone controls built into the vehicle (e.g., center stack and/or steering wheel buttons). IHF included both vehicles that had a cell phone built into the vehicle itself, and vehicles that detected and interacted with the user's portable device without requiring direct manipulation of the phone itself.

Table 4. Distribution of Participants by Cell Phone Usage Group and Location

	HH	PHF	IHF	Total
Northern Virginia	31	34	31	96
Southern Virginia	34	35	22	91
North Carolina	0	0	17	17
Total	65	69	70	204

Drivers in each group were recruited from rural and urban/suburban locations. Originally, half of the sample was to be recruited from the Blacksburg/Roanoke region of Virginia, which included rural, suburban, and light urban roads. The remaining half was to be recruited from the Northern Virginia suburbs outside of Washington, DC. However, toward the end of the study, a third site was introduced – the Raleigh/Durham region of North Carolina – due to the difficulty of recruiting drivers of vehicles equipped with IHF cell phones. State laws in North Carolina were similar to Virginia with regard to cell phone use by drivers. One difference, however, is that North Carolina has a primary law banning text messaging (but not HH calls), while Virginia had a secondary law banning text messaging. Note: some drivers in Northern Virginia drove in Washington, DC, where there was a primary law banning text messaging and all other HH cell phone use. Some also drove in Maryland, where there is also a primary law banning text messaging. Table 5 summarizes the state laws in effect at the time of data collection. These laws are reviewed because they may have affected drivers' willingness to engage in cell phone use, and/or affected how they used the cell phone.

Table 5. Summary of State Cell Phone Laws

State/District	Cell Phone Laws
Virginia	▪ Ban on all cell phone use (HH and HF) for bus drivers (Primary law) ▪ Ban on all cell phone use (HH and HF) for novice drivers (Primary law) ▪ Ban on text messaging for all drivers (Secondary law; Primary law for bus drivers)
Washington, DC	▪ HH ban for all drivers (Primary law) ▪ Ban on all cell phone use (HH and HF) for bus drivers (Primary law) ▪ Ban on all cell phone use (HH and HF) for novice drivers (Primary law) ▪ Ban on text messaging for all drivers (Primary law)
Maryland	▪ HH ban for all drivers (Secondary law) ▪ Ban on all cell phone use (HH and HF) for novice drivers (Secondary law) ▪ Ban on text messaging for all drivers (Primary law)
North Carolina	▪ Ban on all cell phone use (HH and HF) for bus drivers (Primary law) ▪ Ban on all cell phone use (HH and HF) for novice drivers (Primary law) ▪ Ban on text messaging for all drivers (Primary law)

Source: NHTSA, 2012b

Participants were eligible for inclusion in the study if they met all of the following criteria:

- Lived in Virginia or North Carolina, had a valid driver's license, and were at least 18 years old;
- Owned an eligible vehicle – this included vehicle models that had a vehicle network that was compatible with the DAS;
- Were the primary driver of the vehicle (vehicle was seldom driven by anyone else);
- Reported using their cell phone at least once per day while driving (preference was given to those who reported more cell phone use);
- Reported that, while driving, they used their cell phone at least 50 percent of the time by one of the three types of cell phones;
- Reported driving at least 4-5 days per week;

- Reported driving at least 50-99 miles per week; and
- Indicated willingness to provide cell phone records for those calls completed during the study period.

Recruitment involved typical media outlets (e.g., newspapers, Craigslist). However, additional methods were used to target drivers who used IHF cell phones because their numbers were fewer than drivers of the other cell phone types. These additional methods included placing flyers on eligible vehicles in parking lots and word of mouth. All recruiting materials described the study as a driver safety study that used monitoring technology, but did not mention cell phones specifically. Interested individuals were screened for eligibility by phone.

All study protocols were approved by the Virginia Tech and Westat Institutional Review Boards. Participating drivers read and signed an informed consent form and received $300 for their participation. One hundred dollar payments were made three times during the study: (1) after the participant's vehicle was prepared for the study and the paperwork was completed, (2) after the equipment was removed from the participant's vehicle and a discussion on the driver's experiences with the system took place, and (3) once the participant's cell phone records for the weeks of participation were received. Participants that did not provide their cell phone records did not receive the final $100.

3.2 Data Collection

The DAS used in the study was based on the data collection platform used for naturalistic driving measurement in the Strategic Highway Research Program 2 (SHRP2) NDS overseen by the Transportation Research Board (, 2008). The platform had the same basic components and functionality, but with some additions and modifications to meet the needs of the current study. The following data elements were captured by the DAS.

- *Video* was captured using four in-vehicle cameras (Figure 1). One camera captured the driver's face and torso, with a partial view out the driver's side window. This view was used to identify cell phone subtasks (e.g., reaching, dialing, conversing, and text messaging) and the drivers' eye glance locations. A second camera captured a wide-angle view of the forward roadway. This view was used to identify the driving context (e.g., road type, traffic density, and weather) and observe SCEs. A third camera captured video of the vehicle's console and controls. This view was used to observe the driver's interaction with the vehicle controls, including IHF controls, whether the driver's hands were on the steering wheel, and cell phone subtasks performed near the driver's lap (e.g., text messaging or browsing). A fourth camera captured video of the rearward roadway. This view was used to identify tailgating and whether the trailing vehicle passed the subject vehicle.

Figure 1. Multiplexed image of the four camera views. Top left: view of the driver's face. Top right: view of the forward roadway. Bottom left: over-the-shoulder view of the driver. Bottom right: view of the rearward roadway. (Note: Driver shown is a VTTI researcher.)

- *Accelerometers* in the vehicle were used to detect large longitudinal and lateral forces that might indicate risky driving, as well as near-crash and crash events.
- *Global Positioning System* technology indicated the vehicle's location. The GPS device also recorded a standard time signal, which was used to synchronize the DAS data with the driver's cell phone records.
- *Forward Radar* was used to monitor the area in front of the SV and was used to determine the presence of other vehicles or objects. By comparing vehicle speed and changes in object distances, the RADAR was used to provide measures of unsafe headways, times-to-collision, and near-collisions.
- *Lane Tracker Machine Vision* was used to estimate the vehicle's distance to existing lane markings. Output from this sensor was used by reductionists to identify lane busts.
- *Illuminance Sensor* was used to monitor the ambient light. This sensor helped reductionists identify the prevalent illumination conditions.
- *Vehicle Network Data From the On-Board Diagnostics (OBD-II) Port* was used to monitor other vehicle measures such as vehicle speed, brake application, and steering wheel position.

Appendix A1 summarizes the data elements collected by the DAS and the associated dependent measures captured by these elements. It should be noted that audio data were not collected in this study.

DAS installation took approximately 3 to 4 hours, and was completed by trained vehicle technicians. After installation, participants were instructed to drive as they normally would for a period of four weeks. Past experience indicated that participants in vehicle monitoring studies tend to act naturally after an adjustment period of a few hours (Lee, Dingus, Klauer, Neale, & Sudweeks, 2005). No data was omitted from the analysis based on this adjustment period.

The project team monitored the recorded data to ensure that the systems were functioning properly. Other than to schedule a system removal date, the project team did not interact with participants during the monitoring period, unless there was a problem with the data collection equipment, which occurred infrequently. At the end of the monitoring period, the data collection system was removed from the participant's vehicle. Researchers then worked with participants to acquire their cell phone records encompassing their period of participation.

3.3 Data Reduction

The following sections provide an overview of the data reduction process. Additional details are contained in Appendixes A2 to A9.

3.3.1 Cell Phone Records

The cell phone records were manually entered into an electronic spreadsheet by data reductionists. The call records listed the date and start-time of the call, the duration of the call rounded up to the nearest minute, the direction of the call (sent /received), and the service provider. The text records listed the date and time the text message was exchanged, the direction of the text message, and the service provider. The data set was inspected for data entry errors. Corrections were made when they were found. Although rare, cases in which drivers simultaneously used two phones, or used a secondary phone whose records were not provided, did occur.

A total of 191 of the 204 drivers provided their cell phone records (94%). One driver had records that did not overlap driving, 3 drivers had calls that were prior to, or at the end of, driving, and 187 drivers (92%) had calls placed/received while driving. A total of 121 drivers (59%) provided text records; 109 drivers (53%) had text messages sent/received while driving. A total of 51,725 calls and 82,950 text messages were in the cell phone records. While available for some drivers, the cell phone data use records were not used in the study (e.g., to identify Internet browsing) because phones have applications that transmit data while running in the background without driver intervention.

Table 6 lists the cell phone providers with which participants had cell phone subscriptions, the number of drivers that subscribed to each cell phone provider, and the cell phone providers' billing policy. More information on the cell phone provider billing policies can be found in Appendix A2.

Table 6. Cell Phone Provider Billing Policies

Cell Phone Provider	Number of Participants Subscribed to Provider	Percent (%)	Billing Policy
VERIZON	111	54.4	Round up to the nearest minute
AT&T	38	18.6	Round up to the nearest minute
SPRINT	32	15.7	Round up to the nearest minute
US Cellular	10	4.9	Round up to the nearest minute
T-MOBILE	7	3.4	Rounds up and down to nearest minute
Ntelos	2	1.0	Round up to the nearest minute
BOOST M.	1	0.5	Round up to the nearest minute
Cricket	1	0.5	Round up to the nearest minute
Unspecified	2	1.0	
Total	204	100	

3.3.2 Driver Verification

Each file recorded by the DAS was reviewed by a reductionist to verify that the participant was indeed operating the vehicle. Data recorded from non-participating drivers were excluded from any further reduction or analysis.

3.3.3 Trip Summary

A trip summary file was prepared that listed each file recorded by the DAS, its start and end times, the date the file was recorded, the data-collection location where the file was recorded, and the de-identified driver ID. A total of 31,562 files were recorded.

3.3.4 Cell Phone Use While Driving

The cell phone records were merged with the trip summary data set to generate a data set of all files where:

- The call began after the start of the file, and ended before the end of the file.
- The call began after the start of the file, and ended after the end of the file.
- The call began before the start of the file, and ended before the end of the file.

A total of 14,754 calls and 8,610 text messages were exchanged while the vehicles were in operation (i.e., the ignition was turned on).

To identify how drivers were specifically using their cell phones while driving, 10 percent of the calls, with a minimum of four calls per driver, were randomly sampled. Likewise, 10 percent of the text messages, with a minimum of four text messages per driver, were randomly sampled. Since start time and duration of calls were rounded to the nearest minute, calls in the log that occurred at the same time were omitted from computations of the amount of time drivers conversed on the phone while operating their vehicle. Duplicate calls were not omitted from any frequency computations, however. The same approach was used for text messages. A total of 1,564 calls and 844 text messages that occurred when the vehicles were in operation were sampled. This comprised a total of 2,408 cell phone use samples.

Because the large majority of cell phone records were rounded up (one cell phone provider rounded down) to the nearest minute, the exact start and end time of each sampled call and text had to be identified by viewing the video data. Furthermore, since the records only listed the time and direction of the calls, the type of cell phone used to make the call also had to be visually determined (via video review). Each sample was reviewed in a customized data reduction software application by a team of data reductionists. Samples were omitted if: (1) the video was not available, (2) the wrong driver was present, (3) a passenger was the individual using the cell phone, (4) the video footage ended just before the cell phone interaction began, or (5) the video footage began just after the cell phone interaction ended. A total of 2,108 cell phone samples remained. Reductionists then recorded the exact start and end frame for every cell phone subtask pertaining to the sampled interaction. The following cell phone subtasks were recorded (Table 7). Operational definitions for each subtask are presented in Appendix A3.

Table 7. Subtasks Reduced

Subtask	Abbreviation
Hand-Held: Locate/Reach/Answer	HH: Locate/Answer
Hand-Held: Dialing	HH: Dial
Hand-Held: Talk/Listen/Voice Commands	HH: Talk/Listen
Hand-Held: Text Messaging	HH: Text
Hand-Held: Viewing/Browsing/Reading	HH: Browse/Read
Hand-Held: End Task	HH: End Task
Hand-Held: Holding	HH: Hold
Portable Hands-Free: Locate/Put-on Headset/Earpiece	PHF: Locate/Put on
Portable Hands-Free: Push Button to Begin/Answer	PHF: Begin/Answer
Portable Hands-Free: Talk/Listen/Voice Commands	PHF: Talk/Listen
Portable Hands-Free: Push Button to End	PHF: End Task
Portable Hands-Free: Holding/Wearing Headset/Earpiece	PHF: Hold/Wear
Integrated Hands-Free: Press Button to Begin/Answer	IHF: Begin/Answer
Integrated Hands-Free: Talk/Listen/Voice Commands	IHF: Talk/Listen
Integrated Hands-Free: Press Button to End	IHF: End Task
Cell Phone Navigation	Navigation
Other Cell Phone Task	Other

To clarify terminology used in this report, a cell phone *subtask* refers to a specific action the driver takes when using a cell phone (such as dialing), while a cell phone *interaction* refers to the series of subtasks that took place during the sampled call or text. The start and end points of the subtasks bounded the data reduction performed on them. However, because talking on a cell phone could be a lengthy subtask, only a random 6-second interval of the talking subtask was selected for further reduction. Care was taken to ensure that talking was the only cell phone subtask that took place in the sample. Furthermore, any holding of the cell phone or wearing of a PHF headset/earpiece that lasted longer than 5 s was treated as a separate subtask. Similarly to talking on a cell phone, a random 6-second interval was sampled since this subtask could also be quite long in duration. If the holding subtask lasted longer than 30 s, then the search for the beginning or end of the subtask was halted.

It was found that some cell phone interactions involved numerous combinations of cell phone subtasks. As such, only the first occurrence of each subtask combination was advanced for further data reduction. Therefore, if a cell phone interaction consisted of the driver: (1) pushing a button on his Bluetooth earpiece to begin a PHF cell phone call, (2) talking using the PHF earpiece, (3) browsing the HH cell phone during the PHF conversation, (4) putting the HH cell phone down and continuing to talk for another minute, (5) browsing the HH cell phone again during the conversation, (6) putting the HH phone down again and continuing to talk for another minute, and (7) pushing a button on the earpiece to end the call, then only the first browsing while talking subtask combination would be selected for reduction. For each sampled subtask, reductionists answered 49 questions pertaining to the driver, vehicle, and environmental factors present. These parameters are listed in Appendix A4. Reductionists also recorded the drivers' eye glance locations over the span of each subtask. Eye glance locations were recorded at 10 Hz (Appendix A5).

Kinematic data recorded at the time of each subtask were queried from the data set. The list of variables that were considered is presented in Appendix A6.

3.3.5 Cell Phone Use Baseline Periods

To investigate driver performance when using a cell phone, a 20-second baseline was sampled 30 s prior to the start of the first VM subtask that was contiguous to the sampled call. To be considered contiguous, the subtask had to occur within 30 s of the sampled call. For example, if the driver reached for the cell phone and dialed within 30 s of reaching, then the baseline was sampled 30 s prior to reaching for the cell phone. However, if the driver reached for the cell phone and held it for more than 30 s before dialing, then the baseline was sampled 30 s before the dialing subtask. It was important to select baseline periods that were close in time to the sampled cell phone use so that the environmental contexts remained similar. A higher degree of experimental control was gained as a result. It should be noted that, despite this sampling strategy, analyses in this study did not include baseline periods in which the driver used a cell phone (including holding a cell phone or PHF headset/earpiece). As such, some cell phone interactions could not be analyzed in the within-subject tests performed.

3.3.6 SCE Identification

SCEs were identified in this study as follows. First, algorithms developed and validated in previous NDSs (Blanco et al., in press; Dingus et al., 2006; Fitch et al., 2012; Hanowski et al., 2005; Simons-Morton, Ouimet, Zhang, Klauer, & Lee, 2011) were applied to the data set to trigger potential SCEs. An additional highway acceleration trigger was developed to identify less severe braking that took place at higher speeds. This was done because decelerations of less than -0.3 g performed above 64 km/h can still be indicative of unsafe driving. The algorithms' logic is presented in Table 8.

Table 8. Algorithm Logic Used to Trigger Potential SCEs

Trigger	Algorithm
Longitudinal Acceleration	Longitudinal Acceleration ≤ -0.65 g
Highway Acceleration	Longitudinal Acceleration ≤ -0.3 g and Subject Vehicle Traveling above 64 km/h 2 seconds beforehand
Lateral Acceleration	Lateral Acceleration ≥ |0.75| g
Forward Time-to-Collision (TTC)	Forward TTC < 2 s combined with criteria to ensure a stable radar target

Swerve	Angular acceleration ≥ 10 deg/s^2 or Yaw changes from at least ±8 deg/s to at least ±8 deg/s (opposite) within 0.75 seconds

These algorithms triggered 5,754 potential events. Reductionists then visually inspected each triggered event to verify whether it comprised an SCE. An experienced reductionist then verified each validated event. The experienced reductionist was selected because she had worked on numerous NDS data reductions, specifically SCE validation and conflict scenario reduction. Table 9 shows the number of triggered events generated by each trigger and the number of valid SCEs each one produced. SCEs that were observed upon video inspection, but were not triggered by any of the algorithms, were classified as "Analyst Identified." Reductionists were free to view as much video data around the events as needed in order to develop an understanding of the context. Triggered events were invalid if the algorithms returned a false alarm or lacked a conflict that required a rapid evasive maneuver to prevent a crash.

Table 9. Percentage of SCE Triggers That Were Valid

Trigger Type	Total Triggers	Total Valid	Percent Valid
Longitudinal Acceleration	257	167	65%
Highway Deceleration	5,160	235	5%
Swerve	71	0	0%
Lateral Acceleration	227	4	2%
TTC	28	18*	64%
Yaw	11	1	9%
User Identified		6	
Total	5,754	413	7%

**All valid TTCs were coupled with a valid longitudinal acceleration or highway acceleration trigger.*

The experienced reductionist then assigned a severity level to each SCE. The classification of the 413 SCEs is shown in Table 10. The operational definitions for crashes, near-crashes, and crash-relevant conflicts were the same as those used in previous NDSs (Blanco et al., in press; Dingus et al., 2006; Fitch et al., 2012; Hanowski et al., 2005; Simons-Morton et al., 2011). The examination of intersection violations was novel to this study.

Table 10. SCE Severity Classification

Severity	n	Operational Definition
Crash	4	Any contact with an object, either moving or fixed, at any speed in which kinetic energy is measurably transferred or dissipated, and includes other vehicles, roadside barriers, objects on or off of the roadway, pedestrians, pedalcyclists, or animals. All severe and minor crashes are included in this category.
Curb Strikes	2	Any crash that results from the subject vehicle (SV) making contact (intentional or unintentional) with a curb.
Near-Crash	72	Any circumstance requiring a rapid, evasive maneuver by the SV, or any other vehicle, pedestrian, pedalcyclist, or animal to avoid a crash. A rapid, evasive maneuver is defined as a steering, braking, accelerating, or any combination of control inputs that approaches the limits of the vehicle capabilities. As a guide: SV braking >0.5 g or steering input that results in a lateral acceleration >0.4 g to avoid a crash constitutes a rapid maneuver.

Severity	n	Operational Definition
Crash-Relevant Conflict	264	Any circumstance requiring a crash avoidance response on the part of the SV, any other vehicle, pedestrian, pedalcyclist, or animal that is less severe than a rapid evasive maneuver, but greater in severity than a "normal maneuver" to avoid a crash. The crash avoidance response can include braking, steering, accelerating, or any combination of control inputs. A crash avoidance response for the SV is defined as a control input that falls outside of the 99 percent confidence limit for control input as measured for the same subject.
Intersection Violation	71	Any stop at a controlled intersection where the SV either (1) stops past the stop bar and/or in the path of cross traffic, (2) performs a rolling stop at a stop sign or right-on-red with a minimum speed >=15mph regardless of relation to stop bar, or (3) passes through a red light in a straight crossing or left turn path.

The experienced reductionist then identified various parameters pertaining to the conflict scenario. The SCEs were then passed to the reduction team, who recorded the driver's eye glance locations in the 5 s prior to the onset of the SCE and 1 s afterwards. This time interval was selected to ensure that any driver behaviors recorded were proximal to the observed outcome and in order to match previous NDS methods. The reductionists also assessed the driver, vehicle, and environmental factors by answering the questions presented in Appendix A7. In particular, reductionists recorded whether specific cell phone subtasks took place in this 6-second interval. This reduction allowed the identification of those SCEs that occurred seconds after specific cell phone subtasks. The characteristics of the SCEs can be found in Appendix A8. The average SCE rate per 100 driving hours over all drivers was 5.97. The SCE rate per driver was computed across gender and two age groups (18 to 30 and 31 or older). The average SCE rate for females 18 to 30, males 18 to 30, females 31 or older, and males 31 or older was 6.16, 8.64, 5.71, and 5.53, respectively. The SCE rate per driver is displayed by gender and age group in Figure 8 in Appendix A8.

To support a case-control investigation of the SCE risk associated with cell phone use, baseline samples were randomly selected from the data set and reduced. The samples were 6 seconds long and were selected based on each driver's driving time in the study, which was calculated as follows. First, the total number of hours driven in the data set was computed. The number of baseline periods sampled from each driver was then based on each driver's percentage of the total driving time. The study's timeline facilitated the selection and reduction of 2,000 baseline periods. However, because the cell phone records indicated that approximately 10 percent would involve cell phone use, an additional 200 were included. Only the time the vehicle traveled above 8 km/h (specifically, 5 miles per hour) was considered (i.e., all SCE-baseline periods had a minimum speed of 8 km/h). As an example, if Driver 1's driving time comprised 10 percent of the total driving time, then 220 baseline periods (10% of 2,200) would be randomly selected from Driver 1's trips. A total of 2,308 baseline periods were reduced due to rounding up of the preset number of baseline periods to be reduced. This method was the same as that used in the investigation of driver distraction in commercial vehicle operations (Olson et al., 2009). An 8 km/h threshold was used to parallel previous light-vehicle NDSs (Klauer et al., 2006; Klauer, Guo, Sudweeks, & Dingus, 2010); it reflects the limit at which it becomes difficult to be certain the vehicle is in motion. Reductionists then identified the driver, vehicle, and environmental factors pertaining to each SCE-baseline by answering the questions in Appendix A9. Reductionists also recorded the driver's eye glance locations over a 6-second interval.

4 Investigation of Drivers' Cell Phone Use

The call and text records and sampled cell phone interactions (comprising sampled calls and text messages) were analyzed to investigate how drivers use their cell phones while driving. The key objective of this analysis was to determine how cell phone use behavior changes across cell phone types. The behaviors analyzed included: the frequency and duration of cell phone subtasks, the frequency and duration of non-cell-phone-related secondary tasks performed during phone use, the prevalence of removing both hands from wheel during phone use, drivers' emotional demeanor during cell phone interaction, where the cell phone was held during use, and cell phone use behavior in low and high driving task demand environments.

Sampled cell phone calls were classified as HH, PHF, or IHF if the talking/listening subtask was conducted using that cell phone type. Sampled text messages were classified separately as Text/Browse since the subtasks reduced pertained only to the text message, not the entire call (this was decided after attempts to reduce the entire call would not allow the reduction to be completed on schedule). A sampled phone call with multiple phone types used for the talking/listening subtask was considered "Mixed" and was not used in the analyses. Table 11 shows how the number of sampled phone calls and text messages were distributed across the cell phone classification.

Table 11. Frequency and Percentage of Sampled Cell Phone Interactions by Cell Phone Type

Cell Phone Type	N	Percent
Hand-Held	795	38%
Portable Hands-Free	218	10%
Integrated Hands-Free	344	16%
Text Message	648	31%
Mixed Use	103	5%
Total	2,108	100%

Many of the following analyses were conducted at two speed levels: driving at speeds at or above 8 km/h and driving at speeds below 8 km/h. The speed levels were abbreviated to "Above 8 km/h" and "Below 8 km/h." If a subtask was conducted in entirety above 8 km/h, then the subtask was considered "Above 8 km/h." If driving speeds fell below 8 km/h at any point during a subtask, the subtask was considered "Below 8 km/h." The driving speed during a subtask was found by overlaying the speed data with the subtask beginning and end frames. Of the 8,240 hours of driving, drivers were traveling above 8 km/h for 6,494 hours or 78.8 percent of total driving hours. Drivers traveled below 8 km/h for 1,746 hours or 21.2 percent of total driving hours.

4.1 Calls Analyzed According to the Cell Phone Records

By overlaying the cell phone records with the driving data, 14,754 calls and 8,610 text messages during driving were identified. The 14,754 calls consisted of 3,395 incoming calls, 10,064 outbound calls, 5 toll-free calls, and 1,290 calls of unknown direction. Of the 8,610 text messages during driving, 4,258 were received text messages, 3,994 were sent text messages, and 358 were of unknown direction. A total of 191 drivers (94%) provided call records; however, 4 drivers did not make calls while driving. Removing these drivers left 187 drivers (92%) in the call sample. Of the 121 drivers (59%) who provided text records, 12 did not have text messages that overlapped with driving. Removing these drivers left 109 drivers (53%) in the text sample. Note: a debriefing was not held to determine why some of the drivers did not make any calls while operating a vehicle in the study. Previous experience with NDSs would suggest that drivers did not adjust their calling behavior when being recorded.

Phone calls accounted for 871 hours of the 8,240 hours of driving (10.6% of driving time). When driving at speeds above 8 km/h, drivers were on the phone 10.4 percent of the time and received or sent 0.9 text messages per hour. At speeds below 8 km/h, drivers were on the phone 13.0 percent of the time and received or sent 1.5 text messages per hour. Drivers made an average of 77.26 phone calls during their participation (*M* = 31 days) and the average phone call while driving was 4.02 minutes long. The distribution of number of calls per driver is displayed in Figure 2. The average call rate per driver was 2.00 calls per driving hour. The minimum and maximum call rates per driver were 0.28 calls per driving hour and 7.06 calls per driving hour, respectively. The distribution of the call rate (calls while driving per driving hour) per driver is displayed in Figure 3.

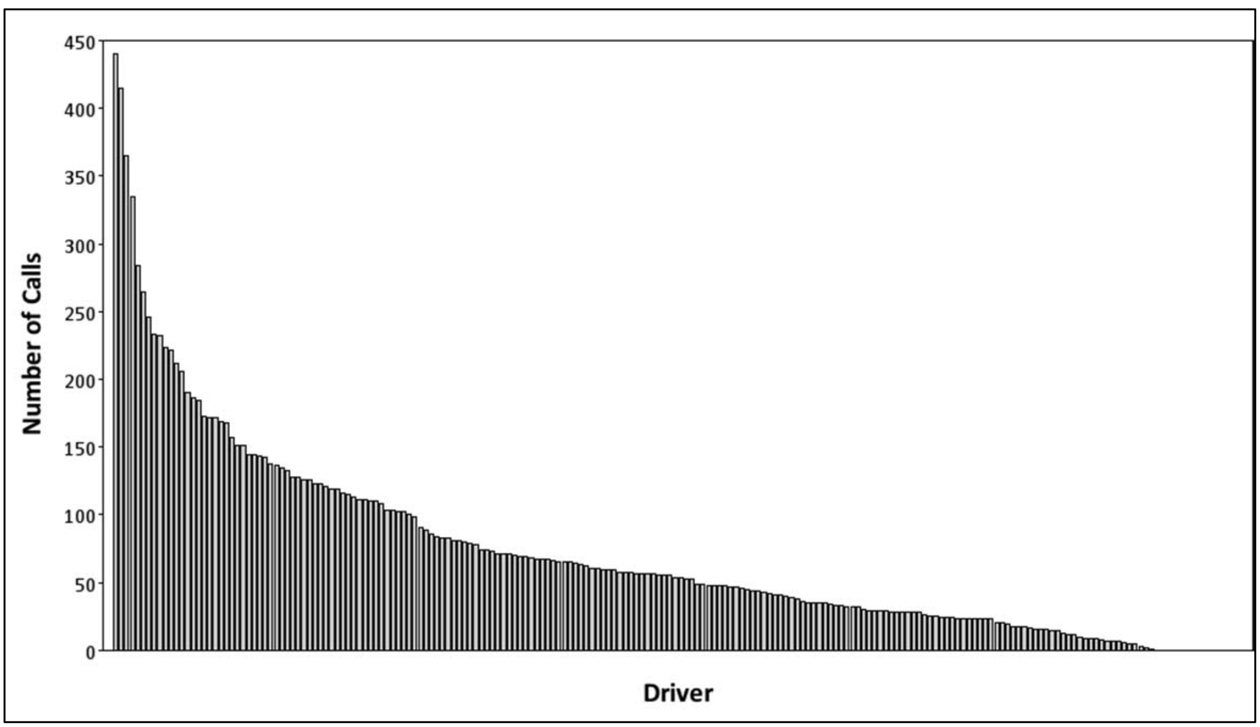

Figure 2. Number of Calls During Driving per Driver

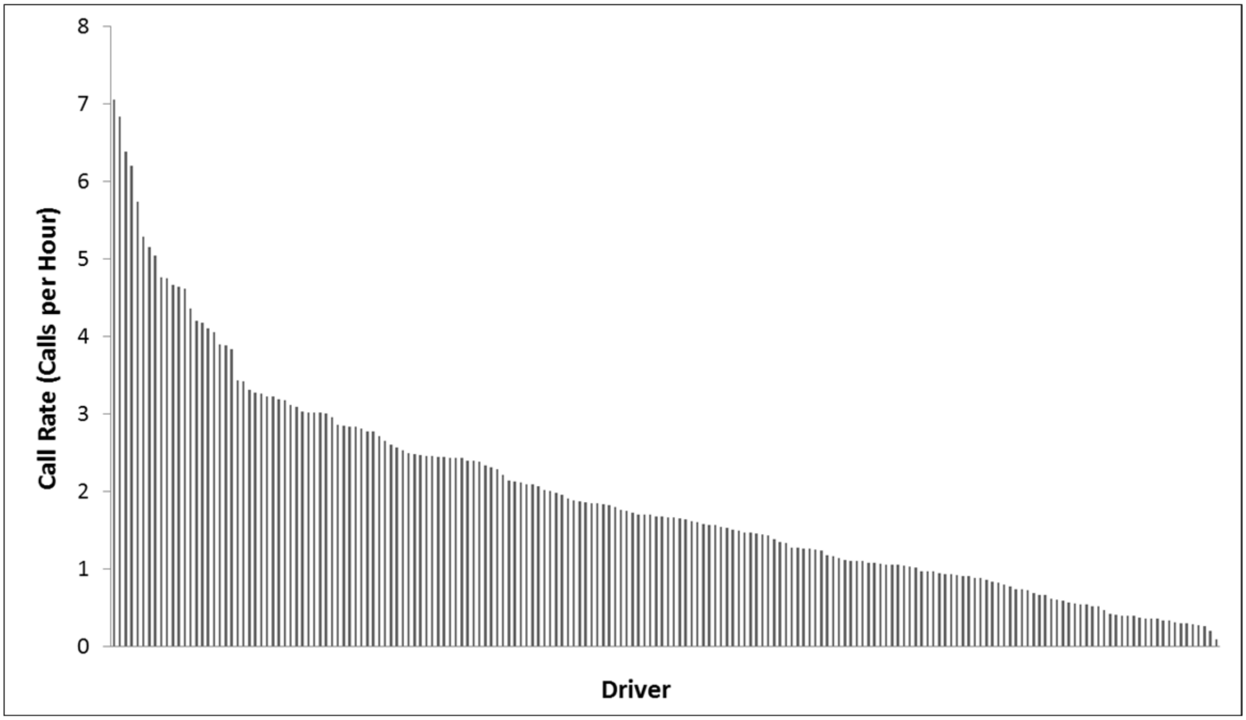

Figure 3. Number of Calls Made per Hour of Driving Above 8 km/h

4.2 Calls Analyzed According to the Cell Phone Reduction

As described in the methods chapter, video inspection was required to verify the type of cell phone used by the driver when a call was made. This section presents the results of analyses that were performed using the sampled cell phone interactions.

4.2.1 Distribution of Calls Across Groups Assigned During Recruitment

Drivers in the study were assigned to one of three cell phone groups (HH, PHF, or IHF) if they reported using that cell phone type at least 50 percent of the time. However, sampled calls were classified as HH, PHF, or IHF if the talking/listening subtask was conducted using that cell phone type, without considering the driver's group assigned during recruitment. The number of sampled calls for each cell phone type was calculated for all three groups. These frequency counts, and the corresponding percentage of all calls made by drivers in the group, are listed in Table 12. Drivers in the HH group used an HH phone for 93.6 percent of calls. Drivers in the IHF group used an IHF system for 63.7 percent of calls and an HH cell phone in 29.7 percent of the calls. Drivers in the PHF group used a PHF cell phone for 32.2 percent of calls and an HH cell phone for 58.5 percent of calls.

Table 12. Frequency and Percentage of Call Interactions by Cell Phone Type Across Groups Assigned During Recruitment

Group Assigned During Recruitment	Hand-Held Interactions	Portable Hands-Free Interactions	Integrated Hands-Free Interactions
Hand-Held Group	353 (93.6%)	19 (5.0%)	5 (1.3%)
Portable Hands-Free Group	307 (58.5%)	169 (32.2%)	49 (9.3%)
Integrated Hands-Free Group	135 (29.7%)	30 (6.6%)	290 (63.7%)

4.2.2 Call and Text Rate by Cell Phone Type

Although the cell phone records and driving data were used to determine when a call was made while the vehicle was in operation, the data could not specify the type of cell phone used. To assess whether more calls were made with a given cell phone type over the others using the cell phone records, the following data step was taken. Using the sampled cell phone interactions, those drivers who were observed using a PHF system to talk/listen in any sampled call were classified as PHF users (even though they could have made HH calls; this was done because they had access to a PHF cell phone). Likewise, drivers who were observed to use an IHF system to talk/listen in any sampled calls were classified as IHF users. Drivers who were observed to just use an HH device to talk/listen in sampled calls were classified as HH users. A total of 12 drivers made both PHF and IHF cell phones and were excluded in the following analysis. Please note that this classification method was only used for the current analysis. The classification method described earlier that assigned a sampled cell phone interaction to a cell phone type based on the interface used during the conversation was utilized for the remaining analyses across cell phone types.

The number of phone calls or text messages made per minute of driving was computed for each driver in the assigned groups. The mean call and text rates were tested across the three groups using an analysis of variance (ANOVA) and follow-up Tukey's t-tests. Drivers who made PHF calls were found to make significantly more calls per minute of driving ($M = 0.0409$ calls per minute) than drivers that made just HH calls ($M = 0.0262$ calls per minute, $p = .0007$) and drivers that made IHF calls ($M = 0.0296$ calls per minute, $p = .0215$). The text rate, however, was not found to significantly differ. (Note: Hands-free texting was rare and was not considered in this study.)

4.2.3 Duration of Cell Phone Use by Cell Phone Type

Based on the reduction of the cell phone interactions, the average cell phone interaction, comprising VM subtasks and conversing, was 3.73 minutes long. At each speed level, a Kruskal-Wallis test was conducted to compare duration of phone interaction across cell phone types before proceeding with any follow-up tests. The results of the overall Kruskal-Wallis test at both speed levels were significant (above 8 km/h: $\chi^2 = 288.5$, df = 3, $p < .0001$; below 8 km/h: $\chi^2 = 309.4$, df = 3, $p < .0001$). Counts, average durations, and standard errors are listed in Table 13 for driving above 8 km/h and Table 14 for driving below 8 km/h. Descriptive statistics for the duration of the cell phone interactions are listed in Table 13 for driving above 8 km/h and Table 14 for driving below 8 km/h. Table 13 and Table 14 also list the results of Kruskal-Wallis comparisons of two phone types at a time, indicated by the superscript letter next to each phone type. At speeds above and below 8 km/h, text/browse interactions were significantly shorter than call interactions regardless of phone type ($p < .0001$, for all phone types and speed levels). PHF and IHF interactions were significantly longer than HH interactions (above 8 km/h: $p < .0001$, $p = .0453$; below 8 km/h: $p = .0028$, $p = .0084$). PHF interactions were not found to be significantly different than IHF interactions when driving below 8 km/h.

Table 13. Phone Interaction Descriptive Statistics With Kruskal-Wallis Test Results for Duration – Above 8 km/h

Cell Phone Type	N	Mean Duration (Min)	SE	25th Percentile	75th Percentile	85th Percentile
Hand-Held^{A}	527	3.4	0.2	0.9	3.4	6.1
Portable Hands-Free^{B}	158	5.5	0.5	1.5	7.4	10.8
Integrated Hands-Free^{C}	237	4.0	0.4	1.1	4.5	7.0
Text/Browse^{D}	339	1.0	0.1	0.3	1.3	1.8

The superscript letter for each cell phone type indicates significant differences found in the Kruskal-Wallis test for duration; if two entries have different superscript letters, they were found to be significantly different.

Table 14. Phone Interaction Descriptive Statistics With Kruskal-Wallis Test Results For Duration – Below 8 km/h

Cell Phone Type	N	Mean Duration (Min)	SE	25th Percentile	75th Percentile	85th Percentile
Hand-Held^{A}	260	2.5	0.2	0.8	2.7	4.7
Portable Hands-Free^{B}	60	6.0	1.0	0.9	9.7	14.1
Integrated Hands-Free^{B}	97	4.7	1.0	1.0	5.4	7.0
Text/Browse^{C}	283	1.2	0.1	0.3	1.4	1.9

The superscript letter for each cell phone type indicates significant differences found in the Kruskal-Wallis test for duration; if two entries have different superscript letters, they were found to be significantly different.

4.2.4 Frequency and Duration of Cell Phone Subtasks

The list of cell phone subtasks, with frequency counts and summary statistics for the duration in seconds, is displayed in Table 15. The subtasks are grouped by the cell phone type used for the talking/listening or texting portion of the cell phone interaction and are listed in descending order by the average duration.

Table 15. Cell Phone Subtask Frequency and Duration With Summary Statistics

Cell Phone Type	Cell Phone Subtask	N	Mean (s)	SE	Max (s)	Min (s)	25th Percentile (s)	50th Percentile (s)	75th Percentile (s)	85th Percentile (s)
Hand-Held	HH: Talk/Listen	525	178.7	12.1	2045	0.9	35.3	68.5	184.9	328.1
Hand-Held	HH: Dial	309	12.4	0.5	64.8	0.6	6.5	10.3	16.1	19.9
Hand-Held	HH: Browse/Read, HH: Talk/Listen	133	4.4	0.8	68	0.3	1	1.6	2.9	5.4
Hand-Held	HH: Locate/Answer	331	4.3	0.2	20.3	0.5	2.3	3.5	5.3	6.5
Hand-Held	HH: End Task	461	4	0.1	21.2	0.1	1.9	3.3	5.1	6.2
Portable Hands-Free	PHF: Talk/Listen	156	297.7	27	1733.5	0.8	59.8	173.6	387.9	609.5
Portable Hands-Free	PHF: Locate/Put On	15	12	2.8	39.8	0.1	6.3	8.7	12.7	26.4
Portable Hands-Free	HH: Dial	29	10.4	1.2	27.8	2.3	5.6	8.5	14.5	16.9
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	35	4.1	0.8	17.4	0.5	1	2.7	5.5	9.1
Portable Hands-Free	HH: Locate/Answer	43	3.6	0.5	21.1	0.1	1.7	2.7	4.4	5.1
Portable Hands-Free	PHF: End Task	33	3	0.5	16.4	0.6	1.6	2.2	3.2	4.3
Portable Hands-Free	PHF: Begin/Answer	13	2.9	1.1	15.3	0.4	0.9	1.2	3.1	5.1
Integrated Hands-Free	IHF: Talk/Listen	237	226.8	21.6	2425.6	2.9	47.4	87.0	241.7	410.1
Integrated Hands-Free	HH: Dial	67	12.9	1.3	47.4	1.5	5.5	9.5	18.1	22.6
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	31	6.8	1	28.8	0.5	4	4.8	9.2	10.6
Integrated Hands-Free	IHF: Begin/Answer	120	4.6	0.6	37.6	0.5	1.6	2.6	4.6	7.5
Integrated Hands-Free	HH: Locate/Answer	72	3.9	0.4	15.3	0.1	2	2.7	4.8	7.5
Integrated Hands-Free	IHF: End Task	154	2.9	0.2	10	0.1	1.3	2.3	4	5.1
Text/Browse	HH: Text	207	34.6	2.5	302.2	0.7	11.8	23.7	44.7	63.9
Text/Browse	HH: Browse/Read	286	13.7	0.9	87.4	0.7	4.7	9.4	15.5	22.5
Text/Browse	HH: Locate/Answer	301	3.1	0.1	19.5	0.1	1.8	2.5	3.5	4.4
Text/Browse	HH: End Task	352	2	0.1	24.2	0.1	0.9	1.4	2.5	3.4

Figure 4 and Figure 5 show the frequencies (displayed above each bar) and duration of all cell phone subtasks across cell phone types when driving above 8 km/h and below 8 km/h, respectively. Of the 218 sampled PHF interactions, 97 (44.5%) did not have an HH subtask during the interaction. Of the 344 IHF interactions, 161 (46.8%) did not have an HH subtask during the interaction.

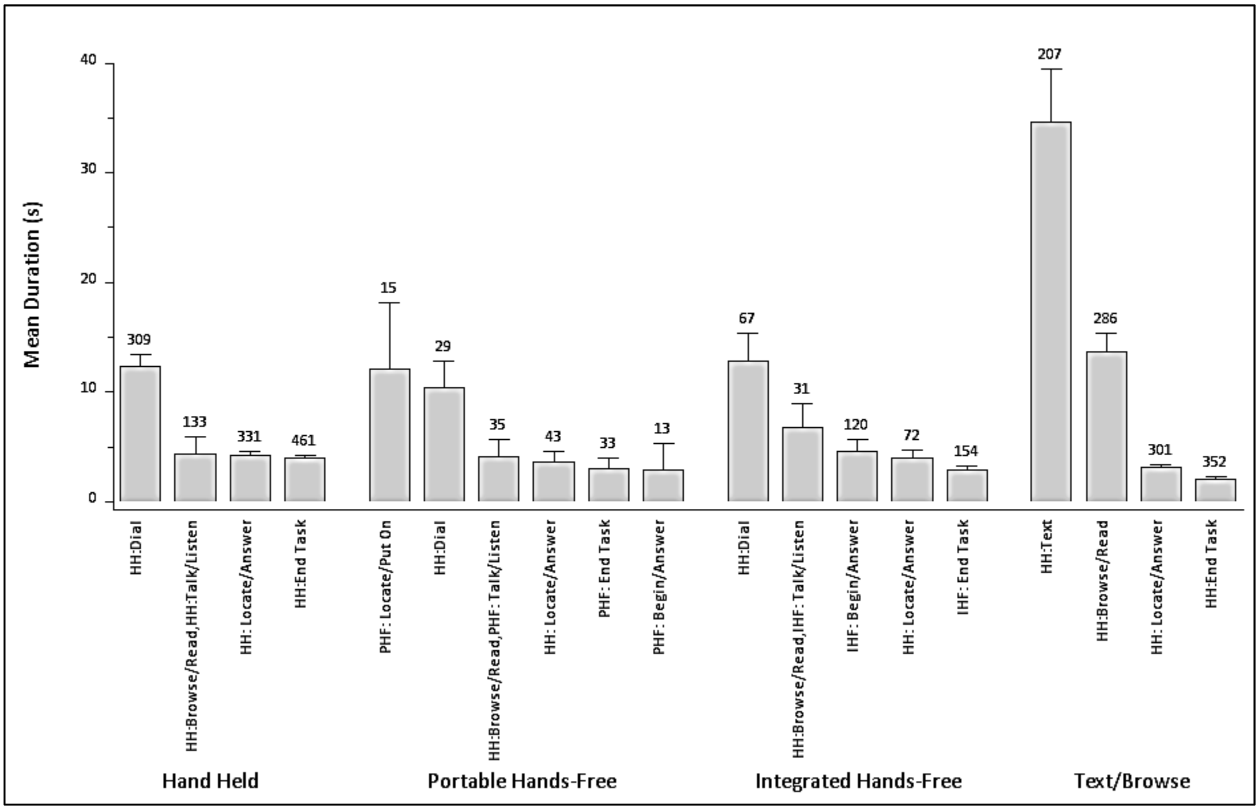

Figure 4. Frequency and Duration for Cell Phone Subtasks When Driving Above 8 km/h

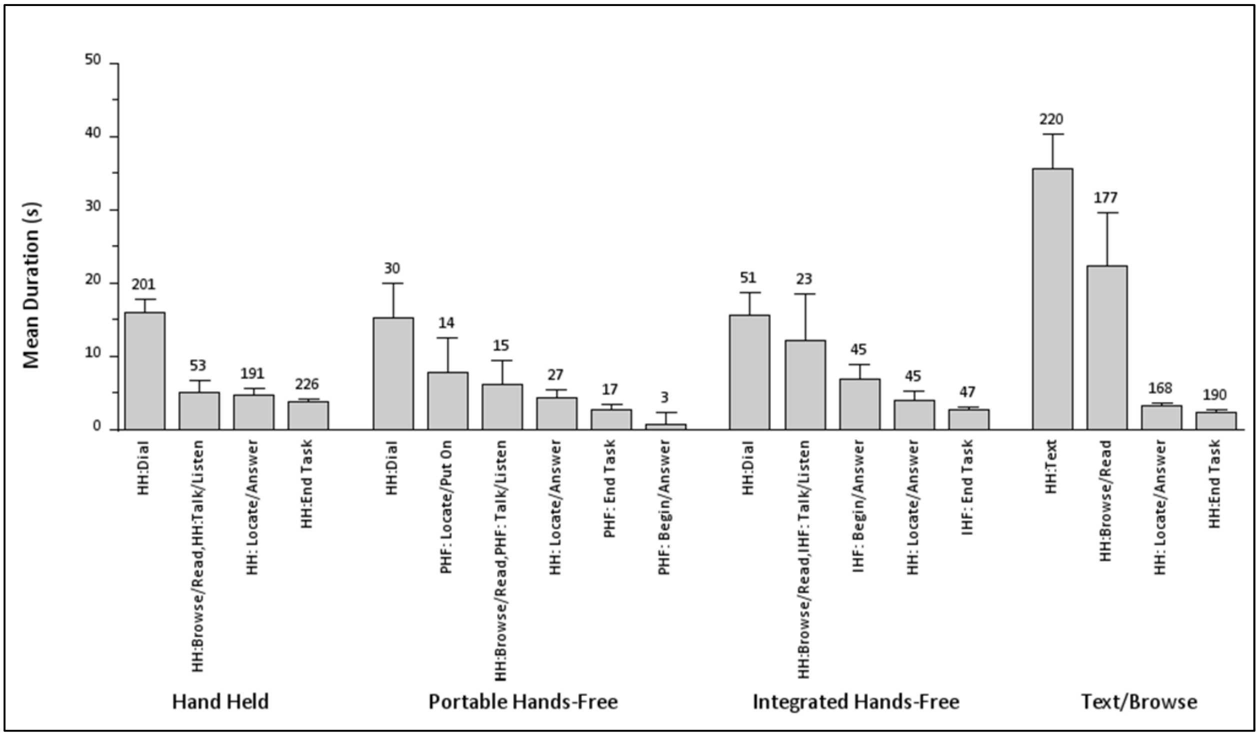

Figure 5. Frequency and Duration for Cell Phone Subtasks When Driving Below 8 km/h

The following cell phone subtasks were analyzed for changes in duration across cell phone types: talking/listening, locate/answer or locate/put on (a PHF subtask only), dialing or begin/answer, browse/read while talking or listening, and end task. These subtasks were observed to occur in some form in each cell phone type. The data were transformed using a log transformation. The analysis was conducted using ANOVA and post hoc Tukey's tests with 95-percent confidence intervals; results will be discussed here and shown in Appendix A10.

The cell phone subtask talk/listen, plotted in Figure 6 with frequency counts for each bar, was tested for significant differences in duration across the three cell phone types. The results of the ANOVA at both speed levels were significant (above 8 km/h: $F = 16.2$, $p < .0001$; below 8 km/h: $F = 8.34$, $p = 0.0003$). Counts, average durations, and standard errors are listed in Table 16 for driving above 8 km/h and Table 17 for driving below 8 km/h. The significant differences in duration by cell phone type are indicated by the superscript letter next to each phone type. Talking/listening on a PHF phone or an IHF phone was significantly longer at both speed levels than talking/listening on an HH phone. When driving at speeds above 8 km/h, talking/listening on a PHF phone was significantly longer than talking/listening on an IHF phone. The CIs for the difference in log duration for HH versus PHF, listed for above 8 km/h and below 8 km/h, respectively, are (-0.8953, -0.3622) and (-0.8925, -0.0786). The CIs for the difference in log duration for HH versus IHF, listed for above 8 km/h and below 8 km/h, respectively, are (-0.4980, -0.0405) and (-0.8444, -0.1683). The CIs for the difference in log duration for PHF versus IHF, listed for above 8 km/h and below 8 km/h, respectively, are (0.0581, 0.6608) and (-0.4875, 0.4459).

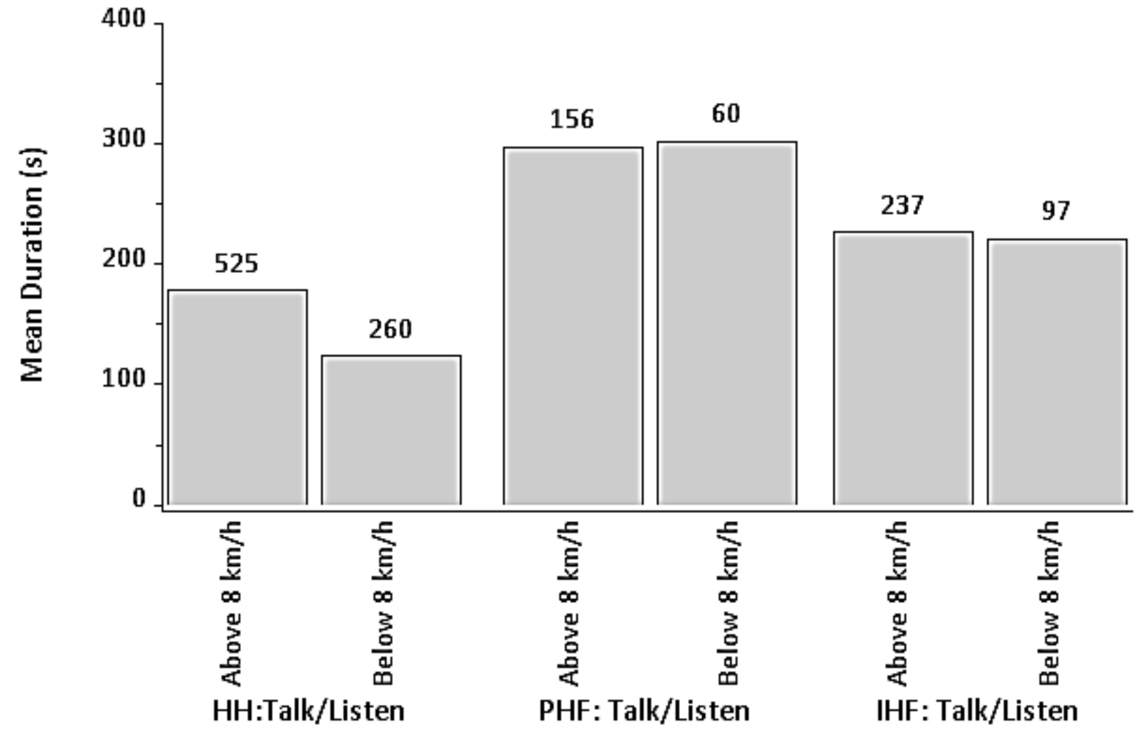

Figure 6. Frequency and Duration of Talk/Listen Cell Phone Subtask Across Speed Level

Table 16. Talk/Listen Subtask Descriptive Statistics With Tukey Test Results for Duration – Above 8 km/h

Cell Phone Type	N	Mean Duration (s)	SE	25th Percentile	50th Percentile	75th Percentile	85th Percentile
Hand-Held[A]	525	178.7	12.1	35.3	68.5	184.9	328.1
Portable Hands-Free[B]	156	297.7	27.0	59.8	173.6	387.9	609.5
Integrated Hands-Free[C]	237	226.8	21.6	47.4	87.0	241.7	410.1

The superscript letter for each cell phone type indicates significant differences found in the Kruskal-Wallis test for duration; if two entries have different superscript letters, they were found to be significantly different.

Table 17. Talk/Listen Subtask Descriptive Statistics With Tukey Test Results for Duration – Below 8 km/h

Cell Phone Type	N	Mean Duration (s)	SE	25th Percentile	50th Percentile	75th Percentile	85th Percentile
Hand-Held[A]	260	124.0	10.4	32.1	60.1	136.0	229.2
Portable Hands-Free[B]	60	302.6	56.8	38.0	99.0	432.2	683.5
Integrated Hands-Free[B]	97	221.3	32.4	49.0	100.2	258.6	394.8

The superscript letter for each cell phone type indicates significant differences found in the Kruskal-Wallis test for duration; if two entries have different superscript letters, they were found to be significantly different.

The duration of subtasks "locate/answer" and "locate/put on" were significantly longer for HH phone calls (above 8 km/h M = 4.3 s; below 8 km/h M = 4.7 s) than for text/browse samples (above 8 km/h *M* = 3.1 s; below 8 km/h *M* = 3.2 s) at both speed levels [above 8 km/h CI of the log difference=(0.1698, 0.4374); below 8 km/h CI of the log difference=(0.0573, 0.4647)]. When driving above 8 km/h, the "locate/answer" or "locate/put on" subtask duration was significantly shorter for PHF phone calls (*M* = 3.6 s) than for HH samples (*M* = 4.3 s) [CI of the log difference = (-0.5574, -0.0128)].

The subtasks "dialing" and "begin/answer" were compared across cell phone types used for the subtask, regardless of the phone type used for talking/listening. At both speed levels, HH dialing was significantly longer in duration (above 8 km/h *M* = 12.4 s; below 8 km/h *M* = 15.9 s) than were PHF (above 8 km/h *M* = 2.9 s; below 8 km/h *M* = 0.7 s) or IHF begin/answer tasks (above 8 km/h *M* = 4.8 s; below 8 km/h *M* = 6.8 s). This was because drivers would frequently pause during the dialing subtask to look back at the forward roadway. The mean subtask duration was also longer because some subtasks involved 10-digit dialing. The CIs for the difference in log duration for HH versus PHF, listed for above 8 km/h and below 8 km/h, respectively, are (1.2413, 2.2900) and (2.2527, 4.4884). The CIs for the difference in log duration for HH versus IHF, listed for above 8 km/h and below 8 km/h, respectively, are (0.9906, 1.3890) and (0.6874, 1.3213). The CIs for the difference in log duration for PHF versus IHF, listed for above 8 km/h and below 8 km/h, respectively, are (-1.1166, -0.0351) and (-3.5122, -1.2202).

The duration of the subtask browse/read while talking/listening was significantly longer for IHF phone calls than for HH phone calls at both speed levels [above 8 km/h: IHF *M* = 6.8 s, HH *M* = 4.4s, CI of the log difference= (0.0760, 1.2949); below 8 km/h: IHF *M* = 12.2s, HH *M* = 5.0s, CI of the log difference= (0.2268, 1.4486)]. When driving above 8 km/h, the subtask was significantly longer for IHF phone calls (M= 6.8 s) than for PHF phone calls (M= 4.1 s) [CI of the log difference= (0.0760, 1.2949)]. The task was not significantly longer during HH phone calls compared to PHF phone calls at either speed level.

The duration of the subtask "end task" was significantly longer for HH (*M* = 4.0 s), PHF (M= 3.0 s), or IHF phone calls (*M* = 2.9 s) than for text/browse samples (*M* = 2.0 s) when driving above 8 km/h [CI for the log difference for HH, PHF, and IHF, respectively: (0.6602, 0.9707), (0.1546, 0.9532), (0.2536, 0.6774)]. When driving below 8 km/h, the "end task" subtask duration was significantly longer for HH phone calls (*M* = 3.7 s) than for text/browse samples (*M* = 2.3 s) [CI for the log difference= (0.2908, 0.7091)]. The "end task" subtask duration was significantly longer for HH phone calls than for IHF phone calls when driving above 8 km/h [CI for the log difference=(0.1459, 0.5542)].

4.2.5 Frequency of Non-Cell-Phone Secondary Tasks

Drivers also engaged in non-cell-phone-related secondary tasks during driving. The list of all secondary tasks is provided in Appendix A10. Reductionists noted up to three secondary tasks occurring during each cell phone subtask. The number of cell phone subtasks associated with and including a talk/listen subtask with a secondary task present was tallied for each cell phone type. The differences in proportions of the following secondary tasks were tested with Fisher's tests across cell phone types: adjusting radio or heat, ventilation, and air-conditioning (HVAC); adjusting/monitoring other devices integral to vehicle; eating or drinking; and reading or writing. The distribution of the proportions of cell phone subtasks with the above secondary tasks is displayed in Figure 7. For this analysis, no distinction was made for different speed levels.

Adjusting the radio/HVAC did not occur significantly more often during HH, PHF, IHF, or Text/Browse subtasks (p=0.1694). Eating or drinking did occur significantly more often in IHF subtasks (0.58%) than in HH subtasks (0.15%) (p=0.0311); however, the difference is less than 0.5 percent. The secondary tasks of reading or writing and adjusting/monitoring other devices integral to vehicle were not found to occur significantly more often among any of the cell phone types or text messaging/browsing samples.

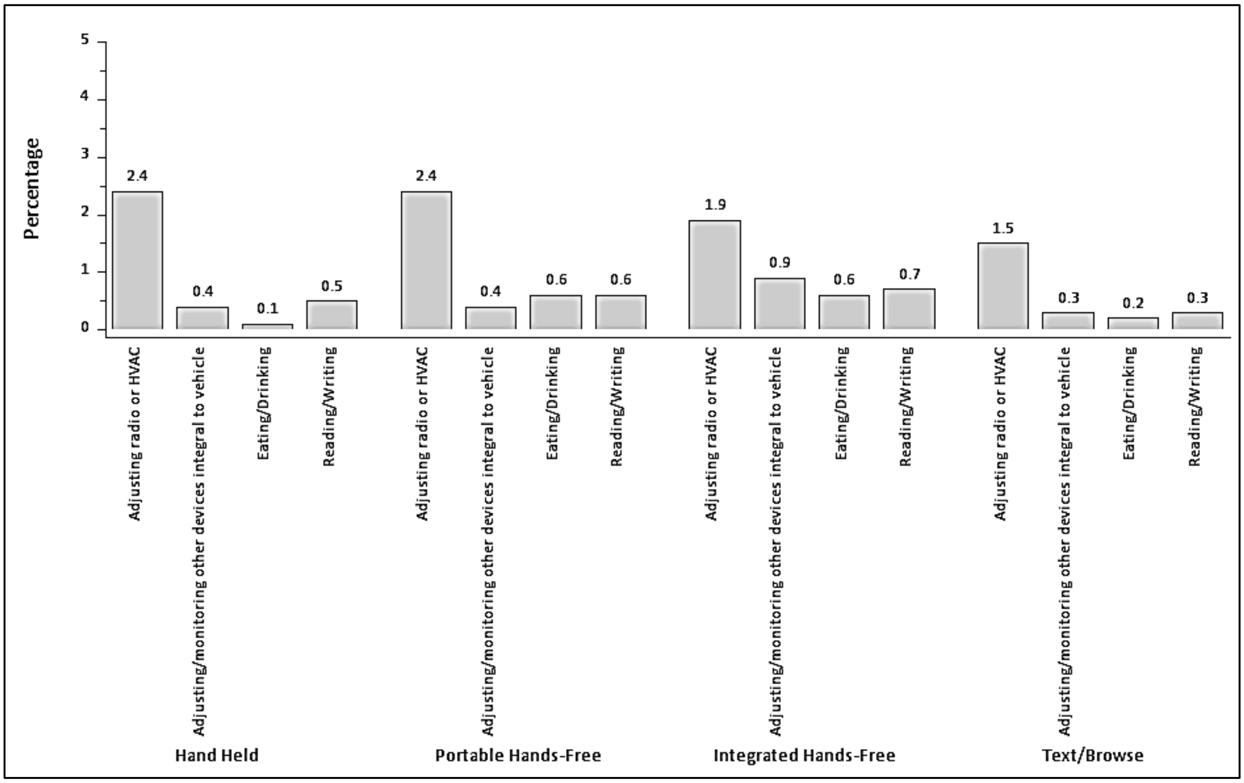

Figure 7. Percentage of Cell Phone Subtasks With Non-Cell-Phone-Related Secondary Task by Cell Phone Type

4.2.6 Comparison of Actual Call Duration to Cell Phone Records

The reduced talk/listen duration was compared to the cell phone record duration for each sampled phone call. The cell phone records overestimated the talk/listen subtask by 0.46 minutes on average (SE = 0.01 minutes). The difference between the cell phone records and reduction duration was found to be significant using a paired t-test ($t = 39.7$, $p < .0001$).

4.2.7 Percentage of Subtasks With Both Hands Removed From Steering Wheel

For each cell phone subtask, reductionists recorded whether drivers removed one or both hands from the steering wheel. For each cell phone type, the number of subtasks with both hands removed from the steering wheel (no hands on wheel during subtask) was counted, as well as the number of subtasks with one or no hands removed from the steering wheel. Displayed in Table

18 is the percentage of subtasks with both hands removed for each cell phone type (calculated as the number of subtasks with both hands removed divided by the total number of subtasks for the cell phone type). The Fisher's test results for cell phone type comparisons are in Appendix A10. Follow-up analyses for individual subtasks are also found in Appendix A10. At both speed levels, HH cell phone interactions had a significantly lower percentage of subtasks performed with both hands off the steering wheel than was the case for IHF cell phone interactions and text/browse interactions. PHF cell phone interactions had a significantly lower percentage of subtasks performed with both hands off the steering wheel than did IHF cell phone interactions, and text/browse interactions, when traveling below 8 km/h.

Table 18. Percentage of Subtasks With Both Hands Removed From Steering Wheel by Cell Phone Type

Cell Phone Type	Percentage of Subtasks With Both Hands Removed (Above 8 km/h)	Percentage of Subtasks With Both Hands Removed (Below 8 km/h)
HH	1.6%	16.1%
PHF	4.6%	22.2%
IHF	7.1%	42.7%
Text/Browse	7.1%	54.2%

4.2.8 Emotional Demeanor During Calls

During the reduction of cell phone subtasks, reductionists rated the emotion expressed by the driver as well as the emotional intensity. The rating scales used were adopted from the Facial Action Coding System (FACS) and other research on emotion (Ekman & Rosenberg, 1997; Hsieh, 2012; Zinck & Newen, 2008). The rating scales used are shown in Appendix A4. Using just the randomly chosen 6-second talking/listening samples, samples where the driver was rated to show any pronounced or severe emotion were classified as emotional conversation. Samples where the driver was rated to be neutral, or have any emotion slightly shown, were combined (to correct for any inconsistencies reductionists may have had when coding "slight" emotion). It was found that drivers were neutral during 96.2 percent of talking subtasks performed above 8 km/h, and 96.8 percent of talking subtasks performed below 8 km/h. The emotions displayed included happy (11.4%, 8.8%) and angry/frustrated/impatient (2.1%, 3.2%) during driving above 8 km/h and below 8 km/h, respectively. "Sad" and "Surprised" emotions were observed in less than 0.5 percent of phone interactions.

4.2.9 Where Phone Is Held During Subtask

For each HH cell phone subtask, reductionists recorded where the driver held the cell phone during the majority of the subtask. Appendix A4 shows the locations that the reductionists were instructed to code. An analysis of where drivers held the cell phone was performed by examining the first HH subtask for each interaction. The various locations were also grouped into three classifications of visibility to a passing car: high, moderate, and low visibility. High visibility locations consisted of those above the steering wheel or driver-side window. Moderate visibility locations consisted of those at mid-steering wheel or at the driver-side window. Low visibility locations consisted of those low on the steering wheel or below the steering wheel.

Table 19 lists the observed percentage of interactions by visibility classification and driver location. The most commonly observed phone use locations, during driving above and below 8 km/h, were of moderate visibility (69.2% and 66.6% of interactions, respectively). Drivers in the southern Virginia location had the highest percentages of high visibility locations when driving below 8 km/h compared to drivers in North Carolina or Northern Virginia. Drivers in the Northern Virginia location had the highest percentages of low visibility locations at both driving speeds.

Table 19. Where Phone Was Held During Subtask by Driver Location and Speed

Speed Level	Driver Location	Low Visibility	Moderate Visibility	High Visibility	Not in hand-Other
Above 8 km/h	North Carolina	4.2%	75.0%	20.8%	0.0%
Above 8 km/h	Northern Virginia	6.7%	67.4%	23.9%	2.0%
Above 8 km/h	Southern Virginia	5.8%	70.1%	22.7%	1.4%
Above 8 km/h	Overall	6.1%	69.2%	23.1%	1.6%
Below 8 km/h	North Carolina	9.4%	69.8%	17.0%	9.1%
Below 8 km/h	Northern Virginia	13.2%	66.3%	16.7%	3.7%
Below 8 km/h	Southern Virginia	12.2%	65.9%	20.2%	1.7%
Below 8 km/h	Overall	12.6%	66.6%	18.1%	2.7%

4.2.10 Type of Cell Phone Used

Touch screen cell phones were observed most often during HH subtasks (60% of subtasks performed both above 8 km/h and below 8 km/h). All phone types observed are listed with counts and proportions in Table 20 below.

Table 20. Type of Phone Used During Hand-Held Subtask

Type of Phone	Above 8 km/h (N)	Above 8 km/h Percentage (%)	Below 8 km/h (N)	Below 8 km/h Percentage (%)
Touch Screen	669	61.7	404	59.1
BlackBerry/QWERTY on Front	172	15.9	103	15.1
Vertical Flip-Phone	111	10.2	60	8.3
Standard Keys on Front of Phone	87	8.0	57	8.8
Horizontal Flip-Phone/Slide Keyboard	42	3.9	49	7.2
Unable to Determine	4	0.4	11	1.6

4.2.11 Where Phone Was Kept Prior to Reaching

Drivers who were observed to reach for their cell phone mostly kept their cell phone in the cup holder (36.3%) or in their seat or lap (29.0% of interactions). Other locations within arm's reach of the driver included center console storage (2.2%), in cradle (1.2%), on dashboard (1.1%), or in the gear shift/under the emergency brake (0.6%). Observed locations that may require drivers to move out of position included the passenger seat (14.2%), their purse (5.6%), in the driver door cubby (1.2%), and pants or shirt pocket (5.9%). Very few observations were made of drivers reaching onto the floor, to the instrument panel, or retrieving the phone from their visor. A plot of all the observed locations with percentage of observations is in Appendix A10.

4.2.12 Cell Phone Use in Low and High Driving Task Demands

During video reduction, reductionists recorded driving and environmental conditions during each subtask (see Appendix A4). These factors were used to formulate low and high driving task demand subsets. The driving task demands were classified as low if the road was level, straight, dry, did not have a junction, had a LOS (level of service) A, and when it was daylight and there was no adverse weather. The driving task demands were considered high when the road was near an interchange area, intersection, and traffic density was at a LOS C or greater. These were the classifications used in Fitch and Hanowski (2011). Please see Appendix A4 for operational definitions for each level of service.

The duration of cell phone subtasks was tested for differences between low and high driving task demands using Kruskal-Wallis tests. The significant results are listed in Table 21. Additional results are presented in Appendix A10. For all calls made on the three cell phone types, the duration of the talk/listen subtask during high driving task demands was not significantly different from its duration in low driving task demands. However, the browsing subtask in the sampled text messages was significantly longer in low driving task demands than in high driving task demands (p = 0.0303). The text messaging subtask was also significantly longer in low driving task demands than in high driving task demands (p = 0.0439). For HH interactions, ending the task was significantly longer in high driving task demands than in low driving task demands (p = 0.0185). In both PHF and IHF interactions, ending the task was significantly longer in low driving task demands than in high driving task demands (p = 0.0360, p = 0.0407). The difference in duration of length for HH, PHF, and IHF end task subtasks could be due to HH users' reluctance to look away from the forward roadway, perhaps using short glances to accomplish a task (and therefore increasing the time it takes to complete the task). All other subtasks were not significantly different in duration between low and high driving task demands.

Table 21. Significant Results of Chi-Square Tests on the Duration of Cell Phone Subtasks Across Driving Task Demands

Subtask	Low Task Demand Mean (s)	Low Task Demand SE	High Task Demand Mean (s)	High Task Demand SE	χ^2	*p*-value
Text/Browse: Browsing	17.3	2.2	12.3	2.2	4.69	0.0303
HH: End Task	2.8	0.2	3.5	0.2	5.55	0.0185
PHF: End Task	4.2	1.1	2.3	0.2	4.4	0.036
IHF: End Task	3.1	0.3	2.4	0.2	4.19	0.0407

5 Investigation of the Risk of an SCE Associated With Cell Phone Use

Two approaches were used to investigate the SCE risk associated with cell phone use. The first is called the risk rate approach and leveraged the cell phone records provided by participants. It was used to estimate the risk of cell phone use relative to general driving. Non-cell-phone secondary tasks could be performed by drivers during "general driving." The second approach was a case-control experimental design that was performed to compare the risk of cell phone use relative to "just driving" (which excludes the performance of any secondary tasks, cell-phone-related or not). Although each risk assessment approach has its own characteristics and interpretation, both approaches considered the SV to be "at-risk" only when it was moving above 8 km/h.

5.1 Risk Rate Approach

A key component in assessing the SCE risk associated with cell phone use is knowledge of how often the cell phones were used while driving. This is referred to as the exposure of drivers to cell phone use. The risk rate approach took full advantage of the cell phone records to determine cell phone use, as opposed to case-control and case-crossover approaches that estimate cell phone use by sampling baseline driving periods. The risk rate approach also leveraged the detailed data reduction of the cell phone samples to estimate subtask durations. Overall, the approach is a highly efficient method for estimating the SCE risk associated with talking on a cell phone, talking on specific types of cell phones, performing VM cell phone subtasks, and overall cell phone use. However, it must be noted that the SCE risk estimated from the risk rate approach was relative to general driving, where other non-driving secondary tasks (e.g., eating) could occur. The risk rate approach does not consider other non-cell-phone-use secondary tasks across driving with and without using a cell phone.

5.1.1 SCE Rate

The risk of cell phone use relative to general driving was efficiently estimated using the acquired cell phone records and the reduced data set of cell phone interactions. The basic formulation for the SCE rate was as follows:

$$Rate_{Cell\ Phone\ Use} = \frac{\#SCEs\ when\ driver\ was\ using\ a\ cell\ phone\ (driving\ speed > 8\ km/h)}{Total\ duration\ of\ cell\ phone\ use\ while\ driving\ (driving\ speed > 8\ km/h)}$$

$$Rate_{Driving} = \frac{\#SCEs\ when\ driver\ was\ not\ using\ a\ cell\ phone\ (driving\ speed > 8\ km/h)}{Total\ duration\ of\ driving\ without\ cell\ phone\ use\ (driving\ speed > 8\ km/h)}$$

Cell phone use was considered a risk if $Rate_{Cell\ Phone\ Use} > Rate_{Driving}$

Note that $Rate_{Driving}$ refers to the SCE rate when the driver was *not* engaged in cell phone subtasks. This reference level was used when assessing the risk rate for overall cell phone use as well as the risk rate for subtask categories, such as conversing on a cell phone, performing call-related VM cell phone subtasks, and text-messaging-related VM cell phone subtasks. For example, the SCE rate of call-related VM subtasks was calculated as follows:

$$Rate_{Call-Related\ VM} = \frac{\#SCEs\ when\ driver\ performed\ call-related\ VM\ subtasks\ (driving\ speed > 8\ km/h)}{Total\ duration\ of\ call-related\ VM\ subtasks\ (driving\ speed > 8\ km/h)}$$

Call-related VM subtasks were considered to be associated with an increased SCE risk if $Rate_{Call-Related\ VM} > Rate_{Driving}$

The risk rate approach did not investigate the risk of specific cell phone VM subtasks because some of the VM subtasks were infrequently observed in the obtained sample. A reliable estimate for the duration of these subtasks could not be generated. VM subtasks were thus aggregated into overall call-related VM subtasks and text-messaging-related VM subtasks when evaluating their SCE risk.

5.1.2 Data Processing

The risk rate approach required the following two parameters:

1. The number of SCEs associated with each cell phone subtask
2. The duration of each cell phone subtask

The specific cell phone subtasks observed in the 6-second window surrounding each SCE were identified. The SCEs were then classified as either cell-phone-related or not cell-phone-related. The cell phone records and the reduced cell phone subtasks were used to estimate the duration of the subtasks. The cell phone records and the cell phone use reduction were also used to estimate the duration of general driving. The estimation procedures are described below. The combination of the cell phone records and the reduced cell phone subtasks provided an unprecedented level of cell phone exposure information.

5.1.3 Estimation Procedure

The subtask durations were estimated for the following categories: (1) cell phone use – collapsed, (2) call-related VM, (3) text-messaging-related VM, (4) talking/listening, (5) talking/listening HH, (6) talking/listening PHF, (7) talking/listening IHF, (8) HH cell phone use (collapsed), (9) PHF cell phone use (collapsed), and(10) IHF cell phone use (collapsed). The estimation procedure details are provided in Appendix A.11.

5.1.3.1 Estimating the Duration of Cell Phone Talking

Among all cell phone subtasks, talking was the easiest to estimate. The starting time and duration of cell phone talking was directly available from cell phone records. By overlaying the cell phone record with the vehicle's speed data, the total duration of talking/listening while driving above 8 km/h was computed. Note: the cell phone records rounded each call up to the nearest minute, which could overestimate the talking time. This round-up bias was assessed by comparing the duration of the reduced cell phone interactions to the cell phone records. The round-up bias was estimated by each cell phone user group and the direction of the cell phone calls. The duration of cell phone talking calculated from the cell phone records was then adjusted based on this information.

The reduced cell phone samples revealed that many drivers used multiple types of cell phones (HH, PHF, or IHF) during their participation in the study, regardless of what they reported during study recruitment. After calculating the talking time for each driver, an estimate of how much of their talking time was spent on each of the three cell phones types was generated. The durations were then estimated using the reduced cell phone samples. For each driver, the proportion of their sampled talking time spent on each of the three cell phone types was estimated. These proportions were then multiplied by the driver's total talking time as calculated from the cell phone records.

5.1.3.2 Estimating the Total Duration of Cell Phone VM Subtasks

The VM cell phone subtasks were not directly available from the cell phone records. VM subtask durations were thus estimated using the reduced cell phone samples. The average duration of VM subtasks per call/text was calculated by stratifying across call/text messaging direction and drivers' assigned cell phone type group. These averages were then multiplied by the number of calls/text messages in the cell phone records to estimate the total VM time. Two VM subcategories were also created: (1) call-related VM subtasks, and (2) text-messaging-related VM subtasks.

Call-related VM subtasks were subtasks that were VM in nature and were performed to initiate or end a cell phone conversation. Push to begin a PHF call and Push to begin an IHF call were included in this category. The call-related VM subtask duration was estimated as follows. First, the amount of time spent performing VM subtasks for a given HH, PHF, or IHF interaction was computed by subtracting the reduced talk time from the overall length of the reduced cell phone interaction. Because it was hypothesized that the VM subtask duration would differ based on call direction and the originally assigned cell phone group, the average VM subtask time per call was calculated by user group and call direction. This average was then multiplied by the number of calls to estimate the total call-related VM time.

Subtasks observed during sampled text messages were classified as text-messaging-related VM subtasks (e.g., locating a cell phone, text messaging, browsing/reading, and ending cell phone use). The durations of these subtasks were summed for each text message. The average VM subtask time per text message was calculated by user group and text direction. This average was then multiplied by the number of text messages to estimate the total text-messaging-related VM time. One complication in doing so was that text records were only available for 121 of the 204 drivers. To make maximum use of information from all drivers, the research team estimated the VM subtask duration for the 83 drivers with missing text records by assuming they had the same text usage patterns as the 121 drivers with text records. The average text messaging duration per hour of driving was computed using the 121 drivers and was applied to the remaining 83 drivers to estimate the total duration of text messaging.

5.1.3.3 Estimating the Duration of Overall Cell Phone Use

The total cell phone use time was computed by summing the total estimated talking time with the total estimated call-related VM time and the total estimated text-messaging-related VM time. A similar procedure was used to compute how much time was spent using the three types of cell phones. The total HH cell phone use time was computed by summing the total estimated HH cell phone talking time with the total estimated HH cell phone call-related VM subtask time and the total estimated text-messaging-related VM subtask time. Note: all text messaging-related VM subtasks were strictly assigned to HH cell phone use. The total PHF cell phone use time was computed by summing the total estimated PHF cell phone talking time with the total estimated PHF cell phone call-related VM subtask time. The total IHF cell phone use time was computed by summing the total estimated IHF cell phone talking time with the total estimated IHF cell phone call-related VM subtask time.

5.1.3.4 Estimating the Total General Driving Time

The total time spent not using a cell phone – referred to as general driving – was computed by subtracting the total estimated cell phone use time from the total driving time.

5.1.4 Analysis

A mixed effect Poisson model was used to assess the SCE risk associated with cell phone subtasks. The model formulation is shown below:

$$Y_{ij} \sim Poisson(E_{ij}\lambda_{ij})$$

where

- Y_{ij} is the observed SCE frequency for driver *i* and cell phone use stratification *j,* as measured by the number of SCEs; cell phone use stratification indicator *j* =0 indicates reference level (no cell phone use) and *j=1* indicates cell phone use;
- E_{ij} is the duration traveled by driver *i* above 8 km/h under cell phone use stratification *j*;
- λ_{ij} is the corresponding expected SCE rate, as measured by the number of SCEs per unit time of driving.

A log link function connects λ_{ij} with a set of covariates,

$$\log(\lambda_{ij}) = \beta_0 + X_{ij}\beta + \alpha_i$$

where α_i is a random effect term for driver i and α_i follows a normal distribution; X_{ij} is an indicator variable for driver i and cell phone use stratification j

$$x_{ij} = \begin{cases} 0 & driving\ without\ cell\ phone\ use\ (reference\ level) \\ 1 & driving\ while\ using\ a\ cell\ phone \end{cases}$$

and β is a regression parameter. A significant β indicates a statistically significant difference in the SCE rate between cell phone use and non-cell-phone use while driving.

5.1.5 Results

Table 22 presents the risk rate ratios and 95-percent confidence limits for the cell phone subtasks. The risk rate ratios were investigated using crashes, near-crashes, and crash-relevant conflicts. The risk rates were also investigated by including intersection violations (i.e., stops past the stop bar). However, intersection violations were relatively noisy. Caution should thus be used when interpreting the results that included intersection violations.

The risk rate approach found that talking on any kind of cell phone was not associated with an increased SCE risk. Cell phone VM subtasks (collapsed together) were found to be associated with an increased SCE risk (Risk Rate Ratio = 2.93). This was found for both call-related VM subtasks (Risk Rate Ratio = 3.34) and text messaging-related VM subtasks (Risk Rate Ratio = 2.12). As such, when the risk of HH cell phone use (collapsed across VM and talking/listening subtasks) was computed, it was also found to be associated with an increased SCE risk (Risk Rate Ratio = 1.73).

Table 22. Risk Rate Ratios for Cell Phone Use Subtasks and Aggregate Use While Driving

Subtask	Rate Ratios for Crashes, Near-Crashes, and Crash-Relevant Conflicts	Rate Ratios for Crashes, Near-Crashes, Crash-Relevant Conflicts, and Intersection Violations	LCLs for Crashes, Near-Crashes, and Crash-Relevant Conflicts	LCLs for Crashes, Near-Crashes, Crash-Relevant Conflicts, and Intersection Violations	UCLs for Crashes, Near-Crashes, and Crash-Relevant Conflicts	UCLs for Crashes, Near-Crashes, Crash-Relevant Conflicts, and Intersection Violations	p-values for Crashes, Near-Crashes, and Crash-Relevant Conflicts	p-values for Crashes, Near-Crashes, Crash-Relevant Conflicts, and Intersection Violations
Cell Phone Use – Collapsed	1.32	1.29	0.96	0.96	1.81	1.72	.0917	.0894
Visual-Manual	**2.93***	**2.60***	1.90	1.72	4.51	3.92	< .0001	< .0001
Call-Related Visual-Manual	**3.34***	**3.23***	1.76	1.80	6.35	5.79	.0003	.0001
Text-Related Visual-Manual	**2.12***	1.76	1.14	0.95	3.96	3.27	.0184	.0737
Talking/Listening	0.84	0.90	0.55	0.62	1.29	1.31	.4217	.5746
Talking/Listening HH	0.84	1.03	0.47	0.63	1.53	1.68	.5764	.9099
Talking/Listening PHF	1.19	0.98	0.55	0.46	2.57	2.12	.6581	.9645
Talking/Listening IHF	0.61	0.62	0.27	0.29	1.41	1.35	.2447	.2275
HH Cell Phone Use (Collapsed)	**1.73***	**1.71***	1.20	1.23	2.49	2.38	.0034	.0014
PHF Cell Phone Use (Collapsed)	1.06	0.88	0.49	0.41	2.30	1.89	.8780	.7335
IHF Cell Phone Use (Collapsed)	0.57	0.58	0.25	0.27	1.31	1.26	.1859	.1674

** Indicates significant effect at the .05 level of significance.*

5.2 Case-Control Approach

To estimate the risk of cell phone subtasks relative to "just driving," where all non-driving secondary tasks are excluded, a case-control experimental design was used. Drivers' exposure to cell phone use was estimated based on how often cell phone subtasks were observed in the 2,308 baseline samples. Because reductionists identified what secondary tasks took place in the 6-second baseline and SCE samples, samples where "just driving" was observed could be selected. However, it should be noted that many samples were excluded in doing so; only 46 percent of the samples constituted "just driving."

5.2.1 Equations

ORs were calculated to estimate the SCE risk associated with cell phone subtasks relative to "just driving." The setup of the 2x2 contingency table and the OR formula are shown below (Table 23).

Table 23. 2x2 Contingency Table for Cell Phone Use and SCE Outcome

	Just Driving	Cell Phone Subtask	
Baseline	n_{11}	n_{12}	$n_{1.}$
SCE	n_{21}	n_{22}	$n_{2.}$
	$n_{.1}$	$n_{.2}$	$n_{..}$

$$\textit{Odds Ratio} = (n_{11})(n_{22})/(n_{21})(n_{12})$$

As an example, the OR for investigating the association between talking on a cell phone and being involved in an SCE was computed as follows (the data used are shown in Table 24):

Table 24. Contingency Table for Talking on a Cell Phone and SCE Outcome

	Just Driving	HH: Talk/Listen	
Baseline	1,068 (A)	259 (B)	1,327
SCE	154 (C)	28 (D)	182
	1,222	287	1,509

$$OR = \frac{A \times D}{B \times C} \qquad OR = \frac{1{,}068 \times 28}{259 \times 154} \qquad OR = 0.7497$$

The 95-percent confidence interval for talking on a cell phone was calculated to determine if the OR of 0.75 was significant. The formulas to calculate the 95th percentile lower confidence limit (LCL) and upper confidence limit (UCL) are shown below:

$$UCL = OR \times e^{1.96 \times \sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}} \qquad UCL = 0.7497 \times e^{1.96 \times \sqrt{\frac{1}{1068}+\frac{1}{259}+\frac{1}{154}+\frac{1}{28}}}$$

$$UCL = 1.1467$$

$$LCL = OR \times e^{-1.96 \times \sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}} \qquad LCL = 0.7497 \times e^{-1.96 \times \sqrt{\frac{1}{1068}+\frac{1}{259}+\frac{1}{154}+\frac{1}{28}}}$$

$$LCL = 0.4902$$

Since the 95-percent confidence interval included "1.0," there is no evidence that just talking on a cell phone is associated with an increased SCE risk.

5.2.2 Results

The SCE risk of cell phone subtasks relative to "just driving" is shown in Table 25. The SCEs used to compute the ORs excluded intersection violations since analyses that included them found fewer significant effects, suggesting that the violations added noise to the data without a commensurate increase in the predictive ability of the statistical model. It can be seen that the case-control approach found VM subtasks to be associated with an increased SCE risk (OR = 1.73), while talking on a cell phone, regardless of type of interface, was not found to be associated with an increased SCE risk. In further isolating the VM subtasks, locating/answering an HH cell phone was found to be associated with an increased SCE risk (OR = 3.65). This may be related to the inherent urgency in answering a call before it transfers to voice mail.

Table 25. Odds Ratios for Cell Phone Use Subtasks and Aggregate Use While Driving

Subtask	OR	LCL	UCL	#SCE	#BL	SCE Total	BL Total	Total
Cell Phone Use (Collapsed)	1.10	0.80	1.53	57	358	211	1426	1637
Visual-Manual Subtasks	**1.73***	1.12	2.69	29	116	183	1184	1367
Text Messaging/Browsing	1.73	0.98	3.08	16	64	170	1132	1302
Locate/Answer	**3.65***	1.67	8	10	19	164	1087	1251
Dial	0.99	0.12	8.11	1	7	155	1075	1230
Push to Begin/End Use	0.63	0.08	4.92	1	11	155	1079	1234
End HH Phone Use	1.26	0.43	3.71	4	22	158	1090	1248
Talking on Cell Phone	0.75	0.49	1.15	28	259	182	1327	1509
HH Talking	0.79	0.43	1.44	13	114	167	1182	1349
PHF Talking	0.73	0.36	1.47	9	86	163	1154	1317
IHF Talking	0.71	0.30	1.66	6	59	160	1127	1287
HH Cell Phone Use (Collapsed)	1.39	0.96	2.03	41	204	195	1272	1467
PHF Cell Phone Use (Collapsed)	0.79	0.40	1.55	10	88	164	1156	1320
IHF Cell Phone Use (Collapsed)	0.62	0.26	1.46	6	67	160	1135	1295

** Indicates significant effect at the .05 level of significance.*

6 Investigation of Driver Performance When Using a Cell Phone

The effects of using a cell phone on driver performance were investigated by comparing driver performance on multiple dimensions when executing specific cell phone subtasks to their performance 30 s prior to executing the first subtask in the interaction. Measures were taken to investigate whether drivers' vehicle control degraded due to distraction (Table 26), as well as whether drivers purposefully changed their driving style to compensate for the increased workload (Table 27). Finally, measures were taken to investigate whether executing the subtasks had an effect on downstream traffic (Table 28).

Table 26. Driver Performance Degradation Measures

Measure	Operational Definition	Subtask Interval	Subtask-Baseline Interval
Percentage of Total Eyes Off Road Time (TEORT)	A measure of visual behavior to the forward roadway. Computed as the number of frames the driver's eyes were off the forward roadway divided by the total number of frames in the sample interval. EORT included glances to the mirrors and side windows.	Interval spanned the duration of the subtask. However, only one randomly selected 6-s interval was selected for talking, as well as holding, because these subtasks could take minutes to perform. These intervals are referred to as sample intervals in this column.	Sample interval spanned 20 s starting 30 s back from the first cell phone interaction. This interval is referred to as sample interval in this column.
Speed Standard Deviation	A measure of vehicle longitudinal control. It consists of the SV's speed standard deviation computed over the sample interval.	20 s beginning from start of the subtask. For example, if reaching for a cell phone took 4 s, then speed standard deviation was measured over 20 s beginning at the start of the reaching subtask. Note: this interval could overlap with subsequent subtasks, like dialing.	20-s baseline sample.
Headway Standard Deviation	A measure of vehicle longitudinal control. Computed as the standard deviation of the SV's headway to a lead vehicle over the sample interval. Reductionists visually verified the lead vehicle's radar target ID. These data were used when computing the headway standard deviation.	20 s beginning from start of sample.	20-s baseline sample.

Measure	Operational Definition	Subtask Interval	Subtask-Baseline Interval
Unintentional Lane Bust Rate	A measure of vehicle lateral control. Reductionists used a lane tracker tool to identify unintentional lane busts that occurred over the sampled interval. This count was then divided by the sample duration to compute the unintentional lane bust rate.	Subtask interval.	20-s baseline interval.
Delayed Reaction to an External Event	A qualitative measure of long reaction time. Reductionists assessed whether the driver had a delayed reaction to an unexpected external event within 6 s of the start of the sample. An unexpected external event was anything unexpected or out of the ordinary that presented a safety hazard (e.g., vehicle, pedestrian, or animal unexpectedly entering roadway. This could also have included a delayed reaction to a red light). Driver reaction was assessed as either: (1) fully prepared, driver reacts in a timely manner, (2) somewhat caught off guard, (3) very much caught off guard, and (4) extremely caught off guard.	6 s beginning from start of the subtask.	First 6 s of the baseline sample.
Peak Deceleration	A measure of vehicle longitudinal control. Refers to the peak deceleration of the SV over a 10-second interval.	10 s beginning from start of the subtask.	First 10 s of the baseline sample.
If Driver Crosses an Intersection, Does Driver Scan (Providing He/She Should)	If the driver crossed an intersection within 10 s from the start of the sample, reductions indicated whether the driver scanned the intersection prior to entering it. If the vehicle crossed a four-way intersection, the driver was considered to have scanned if he looked left and right. The sequence of locations was not considered. If the driver crossed a right junction, then he was considered to have scanned if he looked right. The same was true when crossing left junctions.	10 s beginning from start of the subtask.	First 10 s of the baseline sample.
If Driver Crosses an Intersection, Does Driver Violate the Intersection	If the driver had to stop at an intersection encountered within 10 s of the sample, reductions marked a violation if the driver stopped past the stop bar, had a rolling stop less than 15 mph, or had a rolling stop greater than 15 mph.	10 s beginning from start of the subtask.	First 10 s of the baseline sample.
If the SV Changes Lanes, Does Driver Use the Turn Signal	If the driver started, or was in the process of, changing lanes within a 10-second interval spanning 5 s before the start of the sample up to 5 s after the start of the sample, then a measure of whether the turn signal was activated in this interval was taken from the vehicle network.	10 s (± 5s centered on the start of the subtask)	10 s (± 5s centered on start of baseline sample)

*Note: the sample intervals were chosen such that, if needed, they could be combined with the SCE-baseline periods in future analyses. This was not done in the current study, however.

Table 27. Driver Adaptation Measures

Measure	Operational Definition	Subtask Interval	Subtask-Baseline Interval
Speed	Refers to the vehicle speed at the start of the sample interval.	Recorded at the first frame of the subtask.	Recorded at first frame of the baseline sample.
Headway	Refers to the SV's headway to a lead vehicle at the start of the sample interval. Reductionists visually verified the lead vehicle's radar target ID prior to computing the headway.	Recorded at the first frame of the subtask.	Recorded at first frame of the baseline sample.
Time-to-Collision (TTC)	Refers to the SV TTC to a lead vehicle at the start of the sample interval. TTC was computed as the range to the lead vehicle divided by the range rate to the lead vehicle. Reductionists visually verified the lead vehicle's radar target ID prior to computing the TTC.	Recorded at the first frame of the subtask.	Recorded at first frame of the baseline sample.
Lane Change	Reductionists indicated whether the driver started, or was in the process of, changing lanes within a 10-second interval spanning 5 s before the start of the sample up to 5 s after the start of the sample. The lane change could be in any direction.	10 s (± 5s centered on the start of the subtask)	10 s (± 5s centered on start of baseline sample)
Lane Position	Reductionists indicated the lane position of the SV at the start of the sample interval. A score of "1" was assigned to the leftmost lane. Reductionists also indicated the number of lanes available for travel so that the rightmost lane could be identified.	Recorded at the first frame of the subtask.	Recorded at first frame of the baseline sample.

Table 28. Measures of Effects on Downstream Traffic

Measure	Operational Definition	Subtask Interval	Subtask-Baseline Interval
Range to Rear Vehicle (RV)	A measure of whether the RV was tailgating the SV. Subject's vehicles were not equipped with a rear facing radar unit. However, reductionists rated the range to the RV using the video image of the rearward roadway. Appendix A4 describes how these ratings were made.	Recorded at the first frame of the subtask.	Recorded at first frame of the baseline sample.
Lane Change	A measure of whether the RV passed the SV. Reductionists indicated whether the RV started, or was in the process of, changing lanes within 10 s of the start of the sample. The lane change could be in any direction.	10 s beginning from start of subtask.	10 s beginning from start of baseline sample.

6.1 Performance Degradation When Using a Cell Phone

The performance measures analyzed were selected to investigate drivers' visual behavior, longitudinal vehicle control, lateral vehicle control, and degraded reaction time to unexpected events when using a cell phone. All inferential tests were conducted at the .05 level of significance.

6.1.1 Percent Total-Eyes-Off-Road Time

The mean percent TEORT when drivers performed various cell phone subtasks above 8 km/h was investigated. Percent TEORT was computed as the total number of samples where the driver's eyes were off the forward roadway divided by the total number of samples in the subtask or baseline sample. Percent TEORT is a normalized measure that allows the comparison of driver visual behavior across subtasks of varying durations. To perform a controlled comparison of percent TEORT, inferential statistics were only performed when eye glance data were available for both the subtask and its matched baseline sample. For each subtask, a one-way within-subject ANOVA was performed to investigate whether the mean percent TEORT when performing the subtask differed from the mean percent TEORT during its matched baseline sample. Similar to cell phone use analyses, only interactions that were categorized as one of the three cell phone types, or were a sampled text message, were analyzed. Table 29 presents the ANOVA summary results.

Table 29. ANOVA Results for Within-Subject Comparisons of Mean Percent TEORT Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean (%)	SE (%)	Subtask Mean (%)	SE (%)	n	df_1	df_2	F Stat	*p*-value
HH	HH: Locate/Answer	15.2	1.0	33.1	1.6	201	1	87	105.18	< .0001
HH	HH: Dial	16.1	1.4	59.5	1.4	131	1	64	498.36	< .0001
HH	HH: Talk/Listen	14.6	0.9	9.5	0.9	207	1	91	14.80	.0002
HH	HH: Browse/Read, HH: Talk/Listen	12.3	1.7	71.5	2.7	56	1	34	357.38	< .0001
HH	HH: End Task	14.8	1.0	44.1	2.0	179	1	84	120.07	< .0001
PHF	PHF: Locate/Put On	14.6	8.8	25.5	3.8	4	-	-	-	-
PHF	PHF: Begin/Answer	13.6	1.8	24.1	12.1	8	1	5	0.90	.3852
PHF	HH: Locate/Answer	16.7	3.1	46.3	5.9	23	1	12	19.71	.0008
PHF	HH: Dial	19.3	3.4	63.3	3.2	13	1	7	50.11	.0002
PHF	PHF: Talk/Listen	16.4	1.9	16.0	2.1	49	1	22	0.02	.8776
PHF	PHF: End Task	13.0	5.3	21.6	9.1	9	1	6	0.44	.5316
PHF	HH: Browse/Read, PHF: Talk/Listen	15.9	3.3	72.8	6.3	15	1	11	117.34	< .0001
IHF	IHF: Begin/Answer	11.7	1.2	52.7	2.9	69	1	36	117.58	< .0001
IHF	HH: Locate/Answer	15.0	2.2	43.4	4.3	39	1	25	32.13	< .0001
IHF	HH: Dial	15.9	2.6	64.5	2.7	31	1	21	189.12	< .0001
IHF	IHF: Talk/Listen	12.4	1.0	15.6	1.7	108	1	49	1.32	.2560
IHF	IHF: End Task	11.7	1.1	45.4	3.4	74	1	42	64.62	< .0001
IHF	HH: Browse/Read, IHF: Talk/Listen	14.6	2.6	58.1	5.3	14	1	11	56.51	< .0001
Text/Browse	HH: Locate/Answer	15.5	0.9	33.2	1.6	192	1	55	28.42	< .0001
Text/Browse	HH: Browse/Read	16.0	1.0	62.9	1.3	157	1	47	294.37	< .0001
Text/Browse	HH: Text	16.1	1.3	67.6	1.2	112	1	26	263.32	< .0001
Text/Browse	HH: End Task	15.8	0.9	29.6	1.9	178	1	49	19.69	< .0001

With respect to HH cell phone use, locating the cell phone, dialing, browsing, text messaging, simultaneously browsing and conversing, and ending cell phone use were all found to significantly increase the percentage of time drivers took their eyes off the forward roadway. Drivers' mean percent TEORT during baseline samples ranged from 12.3 to 16.1 percent, while their mean TEORT during these cell phone subtasks ranged from 33.1 to 71.5 percent. Conversing on an HH cell phone, however, was found to significantly lower drivers' mean percent TEORT from 14.6 to 9.5 percent.

With respect to PHF cell phone use, locating the HH cell phone, dialing on an HH cell phone, and simultaneously browsing and conversing on the PHF cell phone were all found to significantly increase the percentage of time drivers took their eyes off the forward roadway. Drivers' mean percent TEORT during baseline samples ranged from 15.9 to 19.3 percent, while their mean percent TEORT during these subtasks ranged from 46.2.4 to 72.8 percent. Conversing on a PHF cell phone did not have a significant effect on mean percent TEORT. The same was true for pressing a button to begin/answer a PHF call and pressing a button to end a PHF call; however, this was most likely because of a small sample size (n = 8 for pressing a button to begin/answer a PHF call and n = 9 for pressing a button to end a PHF call). Note, there was an insufficient amount of data to test for differences in TEORT when locating a PHF device (n = 4). The paucity of matched samples could be because these subtasks and/or baseline periods occurred when the vehicle was stopped or because drivers initiated or ended the call before or after their trip.

With respect to IHF cell phone use, locating the HH cell phone, pressing a button to begin/answer an IHF call, dialing on an HH cell phone, simultaneously browsing and conversing on the IHF cell phone, and pressing a button to end an IHF call were all found to significantly increase the percentage of time drivers took their eyes off the forward roadway. Drivers' mean percent TEORT during baseline samples ranged from 11.7 to 15.9 percent, while their mean percent TEORT during these cell phone subtasks ranged from 43.4 to 64.5 percent. Conversing on an IHF cell phone did not have a significant effect on mean percent TEORT.

An objective of this study was to assess whether certain types of cell phones resulted in a greater amount of visual distraction than others. To answer this research question, changes in mean percent TEORT when performing a subtask were compared across cell phone types. Percent TEORT difference scores were created by subtracting the matched baseline percent TEORT from the subtask percent TEORT. Functionally similar subtasks were then compared across cell phone types using a one-way between-subjects ANOVA. Table 30 presents the mean percent TEORT differences for the subtasks and their respective test statistics.

Table 30. Mean Percent TEORT Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p*-value
Locate Device	HH: Locate/Answer	17.9	1.7	201	2	127	1.03	.3611
Locate Device	HH: Locate/Answer for PHF	26.8	5.9	27	2	127	1.03	.3611
Locate Device	HH: Locate/Answer for IHF	28.4	4.4	39	2	127	1.03	.3611
Initiate Call	HH: Dial	43.4	1.8	131	4	133	4.07	.0038
Initiate Call	HH: Dial for PHF	44.0	4.7	13	4	133	4.07	.0038
Initiate Call	HH: Dial for IHF	48.6	3.1	31	4	133	4.07	.0038
Initiate Call	PHF: Begin/Answer	10.6	12.1	8	4	133	4.07	.0038
Initiate Call	IHF: Begin/Answer	41.0	3.0	69	4	133	4.07	.0038
Talk/Listen	HH: Talk/Listen	-5.1	1.2	207	2	162	4.77	.0097
Talk/Listen	PHF: Talk/Listen	-0.4	2.5	49	2	162	4.77	.0097
Talk/Listen	IHF: Talk/Listen	3.2	1.8	108	2	162	4.77	.0097
Browse While Conversing	HH: Browse/Read, HH: Talk/Listen	59.2	2.8	56	2	56	3.77	.0292
Browse While Conversing	HH: Browse/Read, PHF: Talk/Listen	56.2	6.4	15	2	56	3.77	.0292
Browse While Conversing	HH: Browse/Read, IHF: Talk/Listen	43.5	5.1	14	2	56	3.77	.0292
End Use	HH: End Task	29.3	2.0	179	2	132	3.05	.0507
End Use	PHF: End Task	8.6	7.8	9	2	132	3.05	.0507
End Use	IHF: End Task	33.6	3.5	74	2	132	3.05	.0507

The method used to initiate a call was found to significantly affect the mean change in percent TEORT, $F(4,133) = 4.07$, $p = .0038$. A Tukey-Kramer test revealed that pressing a button to begin/answer a PHF call yielded an increase in mean percent TEORT (10.6%) that was significantly less than the increases in mean percent TEORT from dialing an HH cell phone (43.4% when making HH calls, 44.0% when making PHF calls, and 48.6% when making IHF calls), and pressing a button to begin/answer an IHF call (41.0%). Reasons why this was found could be that: (1) drivers looked at the HH cell phone when dialing, (2) pressing a button to begin an IHF call included cases when the driver dialed using the integrated keyboard, and (3) some drivers were observed to interact with the vehicle's center stack when beginning/answering an IHF call (e.g., to lower the HVAC fan, or increase the volume), and (4) drivers could continue to look forward when pressing a button on their headset or earpiece to begin/answer a PHF call. Note, drivers using PHF headsets or earpieces may not need to lower the HVAC fan or music volume when beginning a call because of the proximity of the microphone and earpiece to the driver.

The method used to converse was found to significantly affect the change in mean percent TEORT, $F(2,162) = 4.77$, $p = .0097$. A Tukey-Kramer test revealed that conversing on an HH cell phone yielded a decrease in mean percent TEORT (5.1%) that was significantly different than the change in mean percent TEORT from conversing on a PHF or IHF cell phone (-0.4 and 3.2% TEORT, respectively). One reason why this was found could be that drivers have hands available to perform other secondary tasks when conversing on PHF and IHF cell phones, while their hands are occupied when conversing on an HH cell phone. Perhaps drivers were more constrained in performing other secondary tasks that demanded visual attention when conversing on an HH cell phone.

The method used to simultaneously browse while conversing on the cell phone was found to significantly affect the change in mean percent TEORT, $F(2,56) = 3.77$, $p = .0292$. A Tukey-Kramer test revealed that browsing and conversing on an HH cell phone yielded an increase in mean percent TEORT (59.2%) that was significantly greater than the increase in mean percent TEORT from browsing and conversing on an IHF cell phone (43.5%). Note that the duration of these subtasks is equally important and is reported in the next section.

6.1.2 TEORT Duration

The mean TEORT durations for similar subtasks were grouped and compared using a one-way between-subjects ANOVA. A significant effect was found, $F(9, 651) = 48.99$, $p < .0001$. A Tukey-Kramer test revealed that the mean TEORT duration when text messaging (M = 23.3 s) was significantly longer than any other subtask (Table 31). Browsing and dialing had TEORT durations of 8.2 s and 7.8 s, respectively, which were also found to be significantly longer than simpler VM subtasks such as pressing a button to begin an IHF call or ending an HH call. Note, the TEORT durations for the conversing subtasks, including simultaneously browsing and conversing, were excluded since their sample durations were limited to 6 s.

Table 31. Mean TEORT Durations Collapsed Across Cell Phone Types

Subtask	Mean TEORT (s)	Standard Error	N
HH: Text	23.3^{A}	1.7	207
HH: Browse/Read	$8.2^{B, D}$	0.5	286
HH: Dial	7.8^{B}	0.3	405
PHF: Locate/Put On	$2.7^{B, C, D}$	0.9	15
IHF: Begin/Answer	$2.5^{C, D}$	0.4	120
HH: Locate/Answer	$1.3^{C, D}$	0.1	746
HH: End Task	$1.3^{C, D}$	0.1	813
IHF: End Task	$1.3^{C, D}$	0.1	154
PHF: End Task	$0.5^{C, D}$	0.1	33
PHF: Begin/Answer	$0.5^{C, D}$	0.2	13

Tukey-Kramer significant differences denoted by capital letters.

Mean TEORT durations for ungrouped cell phone subtasks were also compared across cell phone types using a one-way between-subjects ANOVA. Appendix A12 presents the mean

TEORT durations for the subtasks that were compared and their respective test statistics. No significant differences between the same subtasks were found when comparing across cell phone types.

6.1.3 Speed Standard Deviation

The mean speed standard deviation of the vehicle when drivers initiated various cell phone subtasks above 8 km/h was investigated. Speed standard deviation was computed over the first 20 s from the start of the subtask. Because this measure could overlap subsequent subtasks, it is reported with the intention of investigating the association of specific cell phone subtasks and subsequent speed variability. For each subtask and matched baseline sample that had a valid speed measure, a one-way within-subject ANOVA was performed to investigate whether the mean speed standard deviation when initiating the subtask differed from the mean speed standard deviation during the baseline sample. Appendix A12 presents the ANOVA summary results for each test. Ending an HH cell phone interaction had a significant effect on the speed standard deviation, $F(1, 84) = 4.50$, $p = .0368$. The mean speed standard deviation was higher when ending an HH cell phone interaction ($M = 6.32$ km/h, $SE = 0.46$ km/h, $n = 179$) than it was during the matched baseline sample ($M = 4.96$ km/h, $SE = 0.31$ km/h, $n = 179$). Ending an IHF cell phone interaction also had a significant effect on the speed standard deviation, $F(1, 43) = 4.39$, $p = .0422$. The mean speed standard deviation was higher when ending an IHF cell phone interaction ($M = 5.19$ km/h, $SE = 0.72$ km/h, $n = 77$) than it was during the matched baseline sample ($M = 3.95$ km/h, $SE = 0.41$ km/h, $n = 77$).

To investigate whether changes in speed standard deviation when performing a subtask differed across cell phone types, speed difference scores were created by subtracting the matched baseline speed standard deviation from the subtask speed standard deviation. The difference scores were grouped by cell phone type and compared using a one-way between-subjects ANOVA. Appendix A12 presents the mean speed standard deviation differences for the subtasks and their respective test statistics. No significant differences were found.

6.1.4 Headway Standard Deviation

The mean headway standard deviation of the vehicle when drivers initiated various cell phone subtasks above 8 km/h was investigated. Similarly to speed standard deviation, headway standard deviation was computed over the first 20 s from the start of the subtask. For each subtask and matched baseline sample that had a valid headway measure, a one-way within-subject ANOVA was performed to investigate whether the mean headway standard deviation when initiating the subtask differed from the mean headway standard deviation during the baseline sample. Note that the number of samples available for this analysis was greatly reduced when requiring a valid headway measure for both the baseline and subtask samples. For instance, a headway measure would not exist if a lead vehicle was not present. Appendix A12 presents the ANOVA summary results for each test. No significant differences were found.

Similarly to speed standard deviation, headway standard deviation difference scores were compared across cell phone types using a one-way between-subjects ANOVA. Appendix A12 presents the mean headway standard deviation differences for the subtasks and their respective test statistics. No significant differences were found.

6.1.5 Unintentional Lane Bust Rate

Unintentional lane busts were analyzed to investigate drivers' lateral vehicle control. The unintentional lane bust rate was computed as the number of unintentional lane busts that occurred during the sample interval divided by the duration of the sample interval. Similarly to speed standard deviation, a one-way within-subject ANOVA was performed to investigate whether the mean unintentional lane bust rate when performing the subtask differed from the mean unintentional lane bust rate during the baseline sample. Appendix A12 presents the ANOVA summary results. The mean unintentional lane bust rate was significantly lower when talking on an HH cell phone (M = 0.001, SE = 0.000, n = 207) compared to baseline (M = 0.003, SE = 0.001, n = 207), $F(1, 91) = 5.90$, $p = .0171$.

Unintentional lane bust rate difference scores were compared across cell phone types using a one-way between-subjects ANOVA. Appendix A12 presents the mean unintentional lane bust rate differences for the subtasks and their respective test statistics. No significant differences were found.

6.1.6 Delayed Reaction to Unexpected External Event

Table 32 presents the number of samples above 8 km/h in which drivers had a delayed reaction to an unexpected external event within 6 s from the start of the sample. An unexpected external event was anything unexpected or out of the ordinary that presented a safety hazard (e.g., vehicle, pedestrian, or animal unexpectedly entering roadway; this could also have included a delayed reaction to a red light). It can be seen that unexpected external events were infrequent (only 12 were observed in this study). Consequently, inferential statistics were not performed. Table 33 shows which subtasks and baseline periods took place when the unexpected external event occurred. Note that baseline periods that had cell phone use take place at some point in the 20-second interval are included in this table.

Table 32. Frequency of Driver Delayed Reaction to Unexpected External Event

Reaction	Frequency	Percentage
No external event occurs	6,134	99.80
Fully prepared, drives appropriately/reacts in a timely manner	9	0.15
Somewhat caught off guard, but quickly reacts in appropriate manner	3	0.05
Very much caught off guard, has a delayed reaction (~ > 0.75 s or 750 timestamps)	0	0
Extremely caught off guard, does not react at all	0	0

Table 33. Frequency of Driver Delayed Reaction to Unexpected External Event by Subtask

Subtask	Driver Somewhat Caught Off Guard	Driver Fully Prepared	No Event Occurs
Baseline - HH	--	2	254
Baseline - PHF (Complex Subtask Performed at Some Point)	--	1	34
Baseline - Text	1	1	265
Baseline - Text (Complex Subtask Performed at Some Point)	1	--	108
HH: Holding	--	2	250
HH: Locate/Answer	--	1	778
HH: Locate/Answer, IHF: Talk/Listen	--	1	40
HH: End Task	1	--	938
HH: Talk/Listen	--	1	541
Total	3	9	--

6.1.7 Peak Deceleration

The mean peak deceleration of the vehicle within 10 s of the driver initiating a cell phone subtask above 8 km/h was investigated. For each subtask and matched baseline sample that had a valid acceleration measure, a one-way within-subject ANOVA was performed to investigate whether the mean peak deceleration when initiating the subtask differed from the mean peak deceleration during the first 10 s of the baseline sample. Appendix A12 presents the ANOVA summary results for each test. The mean peak deceleration was significantly higher when ending an HH cell phone interaction (M = 0.105 g, SE = 0.008 g, n = 179) compared to baseline (M = 0.078, SE = 0.007, n = 179), $F(1, 84) = 5.51$, $p = .0212$.

Peak deceleration difference scores were compared across cell phone types using a one-way between-subjects ANOVA. Appendix A12 presents the mean peak deceleration differences for the subtasks and their respective test statistics. No significant differences were found.

6.1.8 Driver Performance When Using a Cell Phone near Intersections

A total of 520 of the 2,108 sampled cell phone interactions consisted of the SV crossing an intersection within 10 s from the start of any one of the inherent subtasks. Recall that multiple subtasks took place in one cell phone interaction. This equates to 24.7 percent of cell phone interactions taking place just prior to crossing an intersection. An intersection was defined here as any signalized junction, or junction where the driver's lane was controlled by a stop or yield sign. As a side note, if holding a cell phone or PHF headset/earpiece is included as a subtask, this number increases to 553 interactions (26.2%).

More important, however, is how often drivers use a cell phone near an intersection while the vehicle is in motion. A total of 352 (20.1%) of the 1,748 cell phone interactions made when traveling above 8 km/h were performed prior to crossing an intersection. When including holding as a subtask, this number increases to 379 interactions (21.7%).

To investigate how using a cell phone affects driver performance near intersections, analyses of driver visual behavior and stopping performance were performed using only the cell phone interactions that classified into one of the three cell phone types, or were sampled text messages.

The percentage of subtasks in which the driver scanned before entering the intersection was investigated. Scanning was defined as gazing to roadway junctions, but not driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right was required; for a right 3-way intersection, a glance to the right was required; for a left 3-way intersection, a glance to the left was required. These glances were required regardless of traffic control status (traffic light color, etc.). Since there were only 455 samples where the vehicle was moving near an intersection, all VM subtasks were grouped together, while talking/listening alone was categorized separately. It was found that drivers scanned during 37.6 percent of the grouped baseline samples (n = 85), 36.1 percent of the grouped VM cell phone subtasks (n = 269), and 34.6 percent of the grouped talking/listening cell phone subtasks (n = 101). A chi-squared test did not find these percentages to significantly differ, $\chi^2(2) = 0.1795$, $p = .9142$.

When considering cases where drivers were required to stop at an intersection within 10 s of initiating a subtask, the percentage of subtasks in which the drivers violated the intersection was investigated. It was found that drivers had a rolling stop in 86.4 percent of the grouped baseline samples (n = 22), 69.7 percent of the grouped VM cell phone subtasks (n = 89), and 68.6 percent of the grouped talking/listening cell phone subtasks (n = 35). A chi-squared test did not find these percentages to significantly differ, $\chi^2(2) = 2.6913$, $p = .2604$.

6.1.9 Drivers' Turn Signal Use When Changing Lanes

There were 232 eligible samples where the SV executed a lane change within 5 s prior to the sample and 5 s after the start of the sample. Drivers used their turn signal during this interval of time for 51.7 percent of the maneuvers. To explore whether cell phone use affected drivers' turn signal use, the subtasks were grouped into VM subtasks and talking/listening only.

It was found that drivers used their turn signal during 59.3 percent of the grouped baseline samples (n = 59), 52.3 percent of the grouped VM cell phone subtasks (n = 149), and 46.9 percent of the grouped talking/listening cell phone subtasks (n = 49). A chi-squared test did not find these percentages to significantly differ, $\chi^2(2) = 1.6937$, $p = .4288$.

6.2 Driver Adaptation When Using a Cell Phone

6.2.1 Speed

The mean speed of the vehicle when drivers initiated various cell phone subtasks above 8 km/h was investigated. For each subtask and matched baseline sample that had a valid speed measure, a one-way within-subject ANOVA was performed to investigate whether the mean speed when initiating the subtask differed from the mean speed at the start of the baseline. Appendix A13 presents the ANOVA summary results for each test. Browsing while conversing on an IHF cell phone had a significant effect on the vehicle's speed, $F(1, 11) = 12.64$, $p = .0045$. The mean speed was lower when browsing and conversing on an IHF cell phone (M = 77.5 km/h, SE = 7.1 km/h, n = 14) than it was during the matched baseline sample (M = 91.5 km/h, SE = 6.2 km/h, n = 14). It should be noted that the sample size used in these investigations was small.

Speed difference scores were compared across cell phone types using one-way between-subject ANOVAs. Appendix A13 presents the mean speed differences for the subtasks and their respective test statistics. The method used to converse had a significant effect on the change in speed from baseline, $F(2, 162) = 3.09$, $p = .0481$. Although it appears as though drivers decreased their speed more when conversing on a PHF cell phone (M = -6.7 km/h, SE = 4.2 km/h) compared to the other types of cell phones (M = -1.5 km/h, SE = 1.6 km/h, and M = 0.2 km/h, SE = 2.1 km/h for conversing on HH and IHF cell phones, respectively), a Tukey-Kramer multiple comparisons test could not identify where the significant difference existed. It should be noted that the observed speed differences may be from drivers choosing to engage in a cell phone subtask as they approach a stop.

6.2.2 Headway

The mean headway of the vehicle when drivers initiated various cell phone subtasks above 8 km/h was investigated. For each subtask and matched baseline sample that had a valid headway measure, a one-way within-subject ANOVA was performed to investigate whether the mean headway when initiating the subtask differed from the mean headway at the start of the baseline. Appendix A13 presents the ANOVA summary results for each test. Text messaging had a significant effect on the vehicle's headway, $F(1, 27) = 5.03$, $p = .0405$. The mean headway was greater when text messaging (M = 0.6 s, SE = 0.1 s, n = 29) than it was during the matched baseline sample (M = 0.4 s, SE = 0.1 s, n = 29). It should be noted that the sample size used in these investigations was small. At the same time, not having a valid radar measure could be the result of engaging in cell phone use when not following a vehicle (i.e., in order for a range value to be recorded, there must be a lead vehicle).

Headway difference scores were compared across cell phone types using one-way between-subject ANOVAs. Appendix A13 presents the mean headway differences for the subtasks and their respective test statistics. No significant results were found.

6.2.3 TTC

The mean TTC of the vehicle when drivers initiated various cell phone subtasks above 8 km/h was investigated. For each subtask and matched baseline sample that had a valid TTC measure, a one-way within-subject ANOVA was performed to investigate whether the mean TTC when initiating the subtask differed from the mean TTC at the start of the baseline. Appendix A13 presents the ANOVA summary results for each test. No significant TTC differences were found.

6.2.4 SV Lane Change Behavior

The percentage of subtasks performed above 8 km/h where the SV was observed to change lanes (in any direction) in the 10-second interval spanning from 5 s prior to the start of the subtask up to 5 s after the start of the subtask was investigated. For each subtask and matched baseline sample, a McNemar change test was performed to investigate whether the proportion of subtasks in which the SV changed lanes differed from the proportion of baseline periods in which the SV changed lanes. A lane change could be made in either direction for this analysis. Appendix A13 presents the summary results for each test. Locating/answering an HH cell phone had a significant effect on the driver's likelihood of changing lanes, $\chi^2(1) = 6.0000$, $p = .0227$. Drivers changed lanes 9.90 percent of the time when locating/answering an HH cell phone ($n = 202$) compared to 3.96 percent of the time during the matched baseline sample ($n = 202$). Perhaps drivers changed lanes when locating the cell phone because they knew they were getting ready to make a call and wanted to be in the right lane.

It was found that drivers changed lanes during 5.1 percent of the grouped baseline samples ($n = 700$), 4.5 percent of the grouped VM cell phone subtasks ($n = 2992$), and 5.2 percent of the grouped talking/listening cell phone subtasks ($n = 922$). A chi-squared test did not find these percentages to significantly differ, $\chi^2(2) = 1.0378$, $p = .5952$.

To investigate whether changes in SV lane change behavior when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. SV changed lanes during subtask, but not during baseline
2. SV changed lanes in both baseline and subtask, or SV did not change lanes in both baseline and subtask
3. SV changed lanes during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Appendix A13 presents the percentage of samples for each of the three categories and the respective *p*-value. The method used to end the cell phone use was found to be significantly related to the SV lane change behavior (Table 34).

Table 34. Results for Between-Subjects Comparisons of SV Lane Change Behavior When Ending Cell Phone Use Across Cell Phone Types

Subtask	SV LC During Subtask, but Not During Baseline (%)	Same LC Behavior During Baseline and Subtask (%)	SV LC During Baseline, but Not During Subtask (%)	n	*df*	χ^2	*p*-value
HH: End Task	1.40	96.65	1.96	358	4	11.7721	.01913
PHF: End Task	0.00	88.89	11.11	9	4	11.7721	.01913
IHF: End Task	3.95	88.16	7.89	76	4	11.7721	.01913

LC – lane change

6.2.5 SV Lane Position

The percentage of subtasks performed above 8 km/h where the SV was traveling in the right-most lane when initiating the subtask was investigated. For each subtask and matched baseline sample, a McNemar change test was performed to investigate whether the proportion of subtasks in which the SV traveled in the right-most lane differed from the proportion of baseline periods in which the SV traveled in the right-most lane. Appendix A13 presents the summary results for each test. No significant differences were found.

It was found that the SV traveled in the right-most lane during 39.6 percent of the grouped baseline samples (n = 477), 38.6 percent of the grouped VM cell phone subtasks (n = 1850), and 39.9 percent of the grouped talking/listening cell phone subtasks (n = 554). A chi-squared test did not find these percentages to significantly differ, $\chi^2(2) = 0.3558$, $p = .8370$.

To investigate whether changes in SV lane position behavior when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. SV in right-most lane during subtask, but not during baseline
2. SV in right-most lane for both baseline and subtask, or SV not in right-most lane for both baseline and subtask
3. SV in right-most lane during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Appendix A13 presents the percentage of samples for each of the three categories and the respective p-value. No significant differences were found.

6.3 Downstream Effects From Drivers Using Cell Phones

6.3.1 Range to Rear Vehicle

The percentage of subtasks performed above 8 km/h where the Rear Vehicle (RV) was rated to be traveling closely behind the SV (less than 20 m) at the start of the subtask was investigated. For each subtask and matched baseline sample, a McNemar change test was performed to investigate whether the proportion of subtasks in which the RV was close differed from the proportion of baseline periods in which the RV was close. Appendix A14 presents the summary results for each test. No significant differences were found.

It was found, however, that an RV was close to the SV during 6.2 percent of the grouped baseline samples (n = 338), 9.8 percent of the grouped VM cell phone subtasks (n = 1,387), and 12.3 percent of the grouped talking/listening cell phone subtasks (n = 454). A chi-squared test found these percentages to significantly differ, $\chi^2(2) = 8.2123$, $p = .0165$. It should be noted that this result could be a downstream effect from drivers using a cell phone, or it could be a reflection of the types of conditions during which drivers use a cell phone.

To investigate whether the likelihood of the RV traveling close to the SV when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. RV traveling close to SV during subtask, but not during baseline

2. RV traveling close to SV for both baseline and subtask, or RV not traveling close to SV for both baseline and subtask
3. RV traveling close to SV during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Appendix A14 presents the percentage of samples for each of the three categories and the respective chi-square p-value. No significant differences were found.

6.3.2 Rear Vehicle Lane Change Behavior

The percentage of subtasks performed above 8 km/h where the RV executed a lane change to pass the SV within 5 s prior to the start of the subtask up to 5 s after initiating the subtask was investigated. For each subtask and matched baseline sample, a McNemar change test was performed to investigate whether the proportion of subtasks in which the RV passed the SV differed from the proportion of baseline periods in which the RV passed the SV. Appendix A14 presents the summary results for each test. No significant differences were found.

It was found that an RV passed the SV during 3.9 percent of the grouped baseline samples (n = 337), 3.2 percent of the grouped VM cell phone subtasks (n = 1,386), and 2.2 percent of the grouped talking/listening cell phone subtasks (n = 453). A chi-squared test did not find these percentages to significantly differ, $\chi^2(2) = 1.8799$, $p = .3907$.

To investigate whether the likelihood of the RV passing the SV when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. RV passed the SV during subtask, but not during baseline
2. RV passed the SV for both baseline and subtask, or RV did not pass the SV for both baseline and subtask
3. RV passed the SV during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Appendix A14 presents the percentage of samples for each of the three categories and the respective chi-square p-value. No significant differences were found.

7 Discussion

This study was performed to generate information on drivers' cell phone use, the SCE risk associated with cell phone use, and driver performance when using a cell phone. In addition to generating updated statistics on drivers' HH cell phone use based on naturalistic driving data, drivers' use – and the associated SCE risk – of PHF and IHF cell phones was also investigated. A key aspect of this study was the incorporation of drivers' cell phone records, and the detailed reduction of cell phone subtasks while driving, in the investigations.

7.1 Drivers' Cell Phone Use

By overlaying the cell phone records with the collected naturalistic driving data, drivers were found to have talked on a cell phone 10.6 percent of the time the vehicle was operated. Although this estimate is based on drivers who reported substantial cell phone use while driving (at least one call while driving per day), and call records that rounded up to the nearest minute, it provides a generally robust estimate.

To help put this finding into perspective, Table 35 summarizes cell phone use estimates presented in earlier studies. The 100-Car Study estimates in the table are those reported in this report's introductory section on drivers' cell phone use. They, in addition to the use statistics reported in the Olson et al. (2009) investigation of commercial driver distraction, were generated through an analysis performed in the current study that examined the percentage of baseline and SCE samples that had specific cell phone subtasks observed in the 6-second interval (note: the cell phone use statistics are not the percentage of "just driving" samples, but rather the percentage of all samples). Since the current study sampled 2,308 baseline periods and 342 SCEs in a similar manner to the earlier NDSs (based on drivers' time in study) the percentage of samples in which the cell phone subtasks were observed can be compared (Table 35). Key patterns that emerge include the following. First, drivers in the current study were estimated to talk on any type of cell phone 10.8 percent of the time through the case-control sampling methodology, and 10.6 percent of the time using the call records (risk rate approach). This indicates that the case-control sampling methodology was relatively accurate. Second, compared to the 100-Car Study, drivers in the current study appear to have talked less on an HH cell phone, talked more on hands-free cell phones, dialed less on an HH cell phone, but texted more on HH cell phones. Third, the current study's estimates for talking on an HH cell phone are generally in line with the NOPUS estimates. Finally, it is important to note that text messaging was observed in the current study, despite it being illegal to do so in the states where drivers were observed.

Table 35. Estimates of Drivers' Cell Phone Use (Dashes Indicate Unavailable Data)

<table>
<tr><th>Study</th><th>Year Data Collected</th><th>Cell Phone Use (Collapsed)</th><th>Text</th><th>Dial</th><th>HH Talk/Listen</th><th>HF Talk/Listen</th></tr>
<tr><td rowspan="2">100-Car Study
(Klauer et al., 2006)</td><td rowspan="2">2003-2004</td><td rowspan="2">8.3%</td><td rowspan="2">-</td><td rowspan="2">1%</td><td colspan="2">7.6%</td></tr>
<tr><td>6.2%</td><td>1.3%</td></tr>
<tr><td rowspan="2">Two-Truck NDS
(Olson et al., 2009)</td><td rowspan="2">2004-2005
2005-2007</td><td rowspan="2">9.2%</td><td rowspan="2">0.1%</td><td rowspan="2">1%</td><td colspan="2">8.3%</td></tr>
<tr><td>4.2%</td><td>4.1%</td></tr>
<tr><td>IVBSS
(Funkhouser & Sayer, 2012)</td><td>2006</td><td>6.7%
(Includes stopped vehicles)</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>NOPUS (National Highway Traffic Safety Administration, 2011)</td><td>2010</td><td>9%*</td><td>0.9%</td><td>0.9%</td><td>5%</td><td>4%*</td></tr>
<tr><td>Current Study
(Based on Cell Phone Records)</td><td>2011</td><td>-</td><td>-</td><td>-</td><td colspan="2">10.6% overall
10.4% > 8 km/h
13.0% < 8 km/h</td></tr>
<tr><td rowspan="2">Current Study
(Based on SCE-Baseline Samples)</td><td rowspan="2">2011</td><td rowspan="2">15.7%</td><td rowspan="2">3.0%</td><td rowspan="2">0.3%</td><td colspan="2">10.8%</td></tr>
<tr><td>4.8%</td><td>3.6% PHF
2.45% IHF</td></tr>
</table>

** Estimated using NHTSA's 2007 Motor Vehicle Occupant Safety Survey (MVOSS) data (National Highway Traffic Safety Administration, 2011)*

This study found that drivers who had access to PHF cell phones made more calls per driving minute than did drivers who had access to IHF cell phones or who only made calls on HH cell phones. It is unclear whether drivers purchased PHF cell phones because they recognized that they frequently made calls and required an HF technology to meet this need, or whether drivers made more calls with PHF cell phones because the interface made it easier to do so. PHF cell phones allow drivers to initiate calls with one button press and/or a voice-command, which requires significantly less VM attention than does locating and dialing on an HH cell phone.

In line with this thinking, it was also found that calls made on PHF cell phones lasted significantly longer (M = 5.0 minutes) than calls made on IHF cell phones (M = 3.8 minutes) and HH cell phones (M = 3.0 minutes). The HF technology not only makes it easier to initiate calls, but also easier to continue a conversation. Drivers can keep their hands on the wheel, and do not get fatigued from holding a cell phone to their ear. Again, it is to be determined whether PHF usage was greater because of the type of drivers that made the calls, or because the interface simplified cell phone interaction. Although PHF and IHF both allow hands-free conversation, the duration of PHF calls may have been longer because of the types of drivers that purchase this technology.

Despite the benefits that HF cell phones offer (from minimizing the need to reach for, dial, and hold a cell phone while driving), the data show that drivers still used an HH cell phone during PHF and IHF calls. For instance, PHF drivers used an HH phone for at least one subtask in 55.5

percent of PHF phone interactions. IHF drivers used an HH phone for at least one subtask in 53.2 percent of IHF phone interactions. This clearly indicates that the technology has not eliminated the visual distraction imposed from HH cell phone use. Reasons why drivers continued to use HH cell phones during use could be: (1) the HF technology did not reliably comprehend the drivers' voice commands and thus necessitated manual dialing, (2) the technology did not automatically pair with the drivers' cell phone and thus required manual interaction to pair the cell phone, and (3) drivers could not remember the name of the contact (as entered in their address book) and thus had to manually locate the contact in their address book. A fourth reason, and most concerning, is that the HF cell phones allowed drivers to browse and text during a conversation. However, this feature is not limited to HF cell phones. Drivers were observed to browse and talk using HH cell phones (either using a speaker-phone feature, or simply disengaging the phone from their ear to browse). Nevertheless, it was found that drivers browsed on an HH cell phone while conversing on an IHF cell phone significantly longer than they browsed and conversed on an HH cell phone. This could be due to the ease with which the technology makes dual tasking possible.

The non-cell-phone-related secondary task "eating/drinking" did occur significantly more often in IHF subtasks (0.58%) than in HH subtasks (0.15%) ($p = 0.0311$); however, the difference is marginal at 0.43 percentage points. No significant differences were found in the prevalence of non-cell-phone-related secondary tasks across the cell phone types. It was believed that drivers might have engaged in other activities more frequently when using the HF cell phones, but this was not found to be the case.

The average amount of time drivers took to text/browse when traveling above 8 km/h was 1.3 minutes. This included the time taken to locate the HH cell phone, browse to the text messaging interface, text (i.e., input the text message, which was – on average –34.6 s), and end the task by placing the cell phone down. This represents a substantial amount of time spent performing consecutive VM subtasks. Despite the fact that text messaging is illegal in the states where the study was performed, the data suggest that drivers continue to text for extended durations.

Drivers' cell phone use was compared across low and high driving task demands to explore how cell phone use may be affected by the driving context. There were subtasks that were significantly shorter during high driving task demands than in low driving task demands. These included browsing, text messaging, ending an IHF call, and ending a PHF call. This may be evidence of drivers curtailing cell phone use when driving demands more of their attention.

7.2 SCE Risk Associated With Cell Phone Use

Talking on any type of cell phone was not found to be associated with an increased SCE risk. This was the case when assessing SCE risk relative to general driving using a risk rate approach, and when assessing SCE risk relative to "just driving" using a case-control approach. However, VM subtasks were associated with an increased SCE risk. The risk rate approach estimated VM subtasks (collapsed across all VM subtasks) to be associated with a significantly increased SCE risk relative to general driving (OR = 2.93), and the case-control approach estimated that they were associated with a significantly increased SCE risk relative to "just driving" (OR = 1.73). These findings are in alignment with previous NDS investigations of SCE risk related to cell phone subtasks (Fitch & Hanowski, 2011; Hickman, Hanowski, & Bocanegra, 2010; Klauer et al., 2006; Klauer et al., 2010; Olson et al., 2009).

The SCE risks associated with the three types of cell phone interfaces were also investigated. Here, the SCE risk associated with HH cell phone use (collapsed across subtasks) was found to significantly increase using the risk rate approach (OR = 1.73). This was because the SCE risk related to the VM subtasks outweighed the SCE risk related to conversing on an HH cell phone. Both call-related VM subtasks and text-messaging were associated with a significantly increased SCE risk (ORs = 3.34 and 2.12, respectively). These findings reinforce the dangers of drivers taking their eyes off the road to interact with a cell phone.

The SCE risks associated with PHF and IHF cell phone use (when all HH VM cell phone subtasks were excluded) were not found to significantly increase. It must be recognized, however, that pure PHF and IHF cell phone use did not always take place: 55.5 percent of the 218 sampled PHF interactions and 53.2 percent of the 344 sampled IHF interactions involved VM HH subtasks. VM HH cell phone interactions could include pairing the cell phone with the device, manually dialing when a voice command was not successful, and text messaging/browsing during the call.

7.3 Driver Performance While Using a Cell Phone

Driver performance when using a cell phone was investigated in terms of visual behavior, longitudinal vehicle control, lateral vehicle control, and reaction to unexpected external events. Drivers' lane change performance, performance when near intersections, and the effect that drivers using cell phones have on downstream traffic were also investigated. Overall, the results complement the SCE risk findings in that VM subtasks performed on an HH cell phone affected drivers' visual behavior and vehicle control, while talking on a cell phone did not degrade driving performance.

The root of driving performance lies in how well drivers visually attend to the road in order to perceive events when they occur. Drivers' visual attention to the forward roadway was substantially affected by VM subtasks performed on an HH cell phone. Locating, dialing, text messaging, browsing, and ending an HH call all increased the percentage of TEORT compared to baseline. Furthermore, text messaging (M = 23.3 s), browsing (M = 8.2 s), and dialing (M = 7.8 s) all led to substantially longer TEORT durations than when drivers performed PHF and IHF cell phone subtasks. To compare, the largest mean TEORT was 2.7 s when locating a PHF device. Long TEORT durations are a concern as they can degrade drivers' ability to quickly perceive events in the roadway.

It is interesting that locating an HH cell phone was found to increase SCE risk through the case-control analysis because drivers had a relatively short mean TEORT duration (M = 1.3 s) when performing this subtask. This suggests that drivers may have been selective in terms of when they took their eyes off the road to text, browse, and dial, while they may have used less discretion when locating an HH cell phone. This is particularly plausible when considering that locating a cell phone to answer an incoming call has an inherent urgency.

When crossing an intersection, drivers properly scanned the intersection 38 percent of the time when not using a cell phone. Their likelihood of scanning the intersection did not change when performing either VM or talking/listening subtasks. When stopped at an intersection, however, drivers that used a cell phone were less likely to scan the intersection prior to advancing. It must be noted, however, that this later finding was produced using 23 observations of drivers stopped at an intersection. As such, there are insufficient data for it to be generalized and a more robust investigation based on a sufficiently large sample size is warranted.

The effects of cell phone use on vehicle control were, in contrast to visual behavior, much less pronounced. Ending both HH and IHF cell phone use was associated with a significantly higher speed standard deviation compared to baseline (as computed over 20 s from the start of subtask). Ending HH cell phone use was also associated with a significantly higher peak deceleration compared to baseline. Although it is possible that drivers braked harder because they were distracted by their cell phone use, it is also possible that drivers chose to end their cell phone conversations when coming to a stop (e.g., in their driveway) or when nearing their destination (e.g., in a parking lot). Another finding was that locating an HH cell phone was performed more frequently when the SV changed lanes. Performing this subtask while changing lanes may be another reason why locating an HH cell phone was found to be associated with an increased SCE risk.

There were two findings that could be construed as evidence of compensatory behavior when using a cell phone. First, browsing was performed at significantly lower speeds than the speeds recorded during baseline. Second, text messaging was performed at significantly greater headways than the headways recorded during baseline. It must be noted, however, that the sample size pertaining to these findings was quite small, making it difficult to generalize the findings. For the most part, drivers did not decrease their speed when performing VM or talking/listening cell phone subtasks. Similar results were found when analyzing commercial motor vehicle speed when drivers engaged in mobile device use (Fitch & Hanowski, 2012).

With respect to assessing whether cell phone use affected downstream traffic behavior, the data indicate that a trailing vehicle was more likely to be traveling close (less than 14 m) to the SV when the driver was performing either VM or talking/listening subtasks on a cell phone. Although a first thought might be that drivers using a cell phone were not keeping pace with lead vehicles, the analyses of vehicle speed and headway did not overwhelmingly indicate that this was the case. What may be more likely to have taken place was that drivers used their cell phones in situations where vehicles traveled closer together (e.g., in stop-and-go traffic). Further analysis should be performed to better understand the contexts in which drivers used their cell phones to properly interpret this finding.

A goal of this study was to investigate the effects of distraction from “just talking” on a cell phone. It was found that talking on an HH cell phone increased drivers’ visual attention to the forward roadway and improved their lane keeping performance. Talking on a PHF or IHF cell phone was not found to impact any of the driver performance measures investigated. An exploratory analysis did not find drivers’ scanning behavior when crossing an intersection, their tendency to have a rolling stop at an intersection, or their tendency to signal during lane change maneuvers to change when talking on cell phone. Albeit, these latter investigations precluded performing matched comparisons due to a small sample size. Finally, emotional conversation was qualified using FACS to explore the potential impact of intense emotional conversation on driving. Emotional conversation took place in 3.6 percent of the samples. Although an investigation of SCE risk from emotional conversation did not find an effect, the analysis was limited to the small sample size available. Overall, none of the analyses performed in this study found talking on a cell phone to lead to a driving performance decrement.

7.4 Summary

The results from this study present a clear finding: VM subtasks performed on HH cell phones degrade driver performance and increase SCE risk. Talking on a cell phone, regardless of the type of interface, was not associated with an increased SCE risk. Pure PHF and IHF cell phone use – where VM HH cell phone subtasks are excluded – were also not associated with an increased SCE risk. Although current HF interfaces allow drivers to communicate with their voice, there is a concern that they still allow, and sometimes require, VM HH cell phone subtasks. Drivers can, and frequently do, initiate HF calls, text/browse during HF calls, and end HF calls with an HH cell phone. HF interfaces also require that drivers enable a Bluetooth connection, pair their cell phone, and manually dial if their voice commands are not recognized. Approximately half of the hands-free cell phone interactions in this study were found to involve a VM HH cell phone subtask. Such VM HH cell phone subtasks detract from the goal of true HF cell phone use. Furthermore, there is a segment of the driving population which primarily uses a cell phone to exchange text messages. Various HF interfaces do not address this type of cell phone use.

8 Limitations

The following limitations could have potentially impacted the study's ability to answer the research questions. First, the cell phone records only documented sent and received calls and text messages. Time when the driver was browsing on the cell phone, or simply holding the cell phone, could not be identified without a video reduction. Although it may have been possible to use the data transfer records to estimate when browsing took place, such records would be inaccurate because of cell phone applications operating in the background when the phone was not being used. This limitation may have affected the risk rate approach's estimate of general driving. Second, not all drivers provided call and text records. Out of the 204 drivers in the study, call records were available for 187 drivers and text records were available for 109 drivers. As such, the cell phone use reduction was used to estimate how the drivers that did not provide text records performed text messaging subtasks in the risk rate approach. Third, this study estimated driver performance when talking on a cell phone using randomly selected 6-second samples in which talking was the only cell phone subtask that took place. A reduction of the entire talking subtask was not performed because the study timeline made this infeasible. Although the majority of dependent measures were used to investigate instantaneous driving performance, this limitation may have affected the study's ability to assess driver performance when talking on a cell phone. Fourth, this study reported the percentage of cell phone use near an intersection. To truly understand cell phone use near intersections, however, would require knowing how frequently drivers were near an intersection when not using a cell phone. Finally, there were very few samples of drivers engaging in emotional conversation, or interacting with a cell phone while stopped at an intersection, to perform robust inferential tests. Further sampling is required to investigate these aspects.

9 Acknowledgements

The following people are greatly thanked for their support in data acquisition installation and data collection: Laura Tollin, Kelly McGowan, Logan Donnelly, Todd Smith, David Mellichamp, Scott Stone, Scott Aust, Stephen Tucker, Alexander Bier, Tammy Russell, Carl Cospel, Julie Jermeland, Jared Bryson, Andrew Petersen, Sally Waldon, and Doug McGraw. The authors also wish to acknowledge Jim Jenness, Neil Lerner, and other individuals who are a part of the Westat team for providing commendable assistance with data collection. The following individuals provided invaluable assistance with data reduction: Rebecca Olson, Megan Moore, Sarah Terrell, Holland Vasquez, Heather Poole, Laura Meadows, Brandy Puryear, William Johnson, April Thompson, Jessica Maitland, Danielle Dougherty, Lora Howard, Carrie Boucher, Arielle Brassard, Ben Boucher, Lama Hasan, Rebecca Rader, Caitlin Johnson, Esther Jung, Anne Dumadag, Richard Walton, Collin Lester, Diana Trump, Timothy Walker, Evan Tatarka, Erem Memisyazici, Lauren Cupp, Adam Thompson, Matthew Frazier, Heather Calhoon, Boon Teck Ong, Jessica Chesnakas, Karine Johnson, Tameka Byrd, Hannah Miller, Wesley Hill, Ryan Knight, Padma Carstens, Rachel Harris, Erem Memisyazici, and Spencer Henry. Kim Shelton and Spencer Joslin are thanked for their project management assistance. Vikki Fitchett's technical editing of final deliverables was also greatly appreciated.

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APPENDICES

A.1 Data Elements and Dependent Measures

Table 36. Data Elements and Dependent Measures

Data Element	Dependent Measures Captured	Units	Sampling Frequency
Camera: Driver head and torso	▪ Cell phone use/subtask ▪ Eye glance location ▪ Eyes-off-road ▪ Seat belt use ▪ Other in-vehicle secondary tasks ▪ Partial view out driver side window	N/A	15 Hz
Camera: View of forward roadway	• Driving context • Safety-critical events	N/A	15 Hz
Camera: View of vehicle console, steering wheel, and driver lap	• Cell phone use/task • Hands on steering wheel • Other vehicle feature interactions	N/A	15 Hz
Camera: View of rearward roadway	• Safety-critical events • Rear vehicle behavior	N/A	15 Hz
Accelerometers	• Aggressive driving • Safety-critical events	g	10 Hz
GPS	• Clock time • Vehicle location, elevation	ms, deg, m	1 Hz
Forward radar	• Forward object identification • Object range • Object range rate • Safety-critical events	m, m\s	12.5 Hz
Lane tracker	• Vehicle's distance to the lane markings • Lane busts	cm	15 Hz
Illuminance sensor	• Ambient light level	lux	10 Hz
Vehicle network data from OBD-II port	▪ Vehicle speed ▪ Brake application ▪ Steering wheel position ▪ Other measures as available depending on vehicle model	Varies	Varies

A.2 Cell Phone Provider Billing Policies

Question	Verizon	AT&T	Boost Mobile	T-Mobile	Sprint	US Cellular	NTelos	Cricket
When determining call length, do you round to the nearest minute?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unlimited – not rounded Not unlimited – rounded
Do you round up, or down?	Up	Up	Up	0.5 rounded up, below rounded down	Up	Up	Up	Up
If I make a call and the call is not answered, will those minutes appear on my call log?	Yes	Yes	No	Yes	No	No	No – unless 60s ringing	Yes
If I make a call and their voice mail picks up, will those minutes appear on my call log?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
If I receive a call but do not answer it, will those minutes appear on my call log?	No	Yes - missed call	No	Yes	No	No	No – unless 60s ringing	Yes – missed call
If I miss a call and the person calling leaves me a voice message, will those minutes appear on my call log?	No	Yes	Yes	Yes	Yes	No	Yes	Yes
If I check my voicemail, will those minutes appear on my call log?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of participants with cell phone provider	106	38	1	7	28	8	2	

A.3 Operational Definitions for Cell Phone Subtasks

In the first step of the Cell Pilot Analysis, suspected cell phone interactions were identified within the driving data based on a review of sampled cell phone records provided by participants. Reductionists reviewed these suspected cell phone interactions to identify the true beginning and ending of the each interaction. This protocol describes the individual cell phone subtasks coded within these interactions (e.g., reaching, dialing, talking, browsing) through a video reduction interface. These subtasks then provided structure for the remaining analyses required by the project.

Multiple tasks often occurred simultaneously, and any simultaneous tasks were coded together (i.e., all simultaneous tasks were captured in the coding). Before coding subtasks for any given event, reductionists determined the high level tasks being performed (e.g., text sent or received, call made or received) from the phone records to provide context for the subtasks.
Also, time periods where both of the driver's hands were off the wheel were coded as well, although this may or may not be related to the cell phone task being performed at the same time.

Cell Phone Subtask List
Hand-Held: Locate/Reach/Answer
Hand-Held: Talk/Listen/Voice Commands
Hand-Held: Dialing
Hand-Held: Text Messaging
Hand-Held: Viewing/Browsing/Reading
Hand-Held: Holding
Hand-Held: End Task
Integrated Hands-Free: Press Button to Begin/Answer
Integrated Hands-Free: Talk/Listen/Voice Commands
Integrated Hands-Free: Press Button to End
Portable Hands-Free: Locate/Put-on Headset/Earpiece
Portable Hands-Free: Holding/Wearing Headset/Earpiece
Portable Hands-Free: Push Button to Begin/Answer
Portable Hands-Free: Talk/Listen/Voice Commands
Portable Hands-Free: Push Button to End
Cell Phone Navigation
Other Cell Phone Task
Both Hands off Steering Wheel

Cell Phone Use Subtask Definitions

Hand-held: Locate/reach/answer- When the driver looks for or reaches towards his/her hand-held cell phone. If more than one step occurs (i.e., driver looks for phone, reaches for it, then answers it), the first frame number coded would be the start of the first task (i.e., looking before reaching for the phone) and the last frame number coded would be the end of the last task (i.e., answering phone).

NOTE: If the subject must remove a hand-held cell phone from the case before using it, codes as "HH: locating/reaching/answering."

- Event Start - when the driver starts to move his/her hand in the direction of the hand-held phone in order to retrieve the phone OR first glances in the direction of the hand-held phone followed by immediately reaching for it, whichever comes first. If the driver adjusts radio or HVAC prior to initiating the cell phone task, then the first movement or glance toward the HVAC/radio should be coded as Event Begin.
- Event End - when the driver does one of the following (or whichever comes last):
  1. For answering the hand-held cell phone, the last frame coded is when the driver finishes moving the phone to his/her ear.
  2. For locating and reaching for the hand-held cell phone, the last frame coded is when one of the other categories begins (i.e., "HH: dialing," "HH: talk/listen/voice commands"). So if reaching is followed by dialing, then reaching would end when the phone is first flipped/slid open, or for non-flip phones, when the first button is depressed. And lastly, it could be when the driver's hand becomes stationary again. If the driver picked up a hand-held phone, but then rests the phone in lap, no cell phone task would follow. If the driver picks up the phone and just holds the phone in hand without further visual or manual interaction for 5 or more seconds, "HH: Holding" would follow. In this last case, "HH: Locate/Reach/Answer" would end and "HH: Holding" would begin at the beginning of the 5-second rule. (See HH: Holding section for complete definition.)
  3. For locating cell phone and not picking it up, the last frame number coded would be the first frame number where the subject has shifted his/her gaze AND hands to something else (i.e., forward roadway/steering wheel) after having glanced at or reached for the cell phone for the last time.

Hand-Held: Talk/Listen/Voice Commands- When a driver is talking on a hand-held phone or has the phone up to his/her ear as if listening to a phone conversation or waiting for the person being called to pick up the phone.

NOTE: If the driver uses the speaker phone function on a hand-held cell phone, code as "HH: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function. Code as "PHF: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.

- Event Start - when the phone is at the driver's ear OR (in cases of hand-held speaker phone) when the driver begins talking repeatedly with no obvious passenger interaction
- Event End - when the driver:
  1. moves the phone away from his/her ear to end a call (coded as "HH: End Task " until the phone fully leaves the driver's hand(s)),

2. OR once the driver moves the phone away from his/her ear, and continues to hold the phone in his/her hand(s) without further visual or manual interaction for 5 consecutive seconds. This should be coded as "HH: Holding" until the driver begins another task with the phone or the phone fully leaves the driver's hand(s). "HH: Talk/Listen" would end and "HH: Hold" would begin at the start of this 5-second rule. (See HH: Holding section for complete definition.)

Hand-held: Dialing - When the driver is pressing buttons or interacting with a touch screen on a hand-held cell phone in order to dial a phone number to make a call. This can include dialing, searching for a contact's number, entering a voice mail password, etc.

> **NOTE**: This option was only used when the cell records indicate that the driver had made an outgoing phone call.
>
> **NOTE**: This does NOT include pressing a button to answer a call (coded as "HH: Locating/Reaching/Answering") or pressing a button to end a call (coded as "HH: End Task").
>
> **NOTE**: Additionally, "HH: Dialing" does NOT include pressing buttons or interacting with a touch screen in order to type/read a text message (which should be coded as "HH: Text messaging" if driver types or "HH: Viewing/Browsing/Reading" if driver reads) or browse the Internet/use phone applications (which should be coded as "HH: Viewing/Browsing/Reading").

- Event Start - For flip/slider phones it begins when driver flips/slides open the phone OR first glances at the phone immediately before flipping it open in order to dial, whichever comes first. For non-flip phones, it begins when the driver first depresses a button on the keypad or touchscreen OR first glances at cell phone followed immediately by pushing a button, whichever comes first. If the driver reads a number off a paper, the task begins when he/she reaches for paper OR first glances at it/looks for it. If the driver adjusts radio or HVAC prior to initiating the cell phone task, then the first movement or glance toward the HVAC/radio should be coded as Event Begin.
- Event End – After the last button is depressed and the driver starts a new task (e.g., "HH: Talking/Listening/Voice commands" or "PHF: Talking/Listening/Voice Commands"), OR when the driver closes the phone and/or lets it go, OR the driver last glances at the phone before moving on to a new task, whichever comes last.

Hand-held: Text messaging- When a driver is pushing buttons or interacting with a touch screen on a hand-held cell phone in order to type a text message.

NOTE: This option was only used when the cell records indicate that the driver has sent a text message on a hand-held phone.

NOTE: This does not include reading a text message, which should be coded as “HH: Viewing/Browsing/Reading.”

NOTE: If the cell records indicated that the driver has received a text message, and the driver is seen checking then replying to this text message in the video, event is coded as follows: If the driver replies to the text message within 10 seconds after reading the text message, then the reply should be considered part of the same task, and was coded as “HH:Text” (the initial reading of the received text message was coded as “HH:View/Browse”). If the driver does NOT reply to the text message within 10 seconds and simply holds the phone (coded as “HH:Hold”) for 10+ seconds or puts the phone down (coded as “HH:End Task”), then the sent text should be considered a separate, non-sampled task and was not coded.

- Event Start – For flip/slider phones, it begins when the driver flips/slides open the phone OR first glances at the phone immediately before flipping it open in order to begin a text message, whichever comes first. For non-flip phones, it begins when the first button on the keypad/touchscreen is depressed to begin a text message OR when the driver first glances at the cell phone followed immediately by pushing a button, whichever comes first.
- Event End - After the last button is depressed and the driver moves on to a new task (e.g., “HH: End Task,” etc.), OR the driver last glances at the phone as if checking that the message was sent before moving on to a new task, whichever is last (Note: the lowering/closing of the phone and putting it down if contiguous to this should be coded as “HH: End Task”).

Hand-Held: Viewing/Browsing/Reading – When the driver views the hand-held cell phone display with or without pressing buttons or manipulating the touch screen for a purpose other than making/receiving a call or sending a text message. Examples include: when the driver uses the cell phone to check time, read a received text message, browse the Internet or email, or use the phone’s other applications.

NOTE: If any viewing and/or button manipulation is seen and there is NO record of a call being made/received/ended or a text being sent, then use this category. Reading a received text messages was coded using this category.

NOTE: Exceptions to this rule: #1) When a call is ending, it was coded as “HH: End Task” if the driver looks at the phone and/or presses a button to end a call. #2) When a call is being answered, any glances or associated button presses were coded as “HH: Locate/Reach/Answer.”

NOTE: If the cell records indicate that the driver has received a text message, and the driver is seen checking then replying to this text message in the video, it was coded as follows: If the driver replies to the text message within 10 seconds after reading the text message, then the reply should be considered part of the same task, and was coded as "HH:Text" (the initial reading of the received text message should still be coded as "HH:View/Browse"). If the driver does NOT reply to the text message within 10 seconds and simply holds the phone (coded as "HH:Hold") for 10+ seconds or puts the phone down (coded as "HH:End Task"), then the sent text should be considered a separate, non-sampled task and was NOT coded.

- Event Start – For flip/slider phones, if the event is preceded by "HH: Locating/Reaching," the event begins when the driver flips/slides open the phone OR first glances at the phone immediately before flipping it open in order to begin viewing/browsing/reading, whichever comes first. For non-flip phones, it begins when the first button on the keypad/touchscreen is depressed to begin viewing/browsing/reading OR when the driver first glances at the cell phone to begin viewing/reading, whichever comes first. If preceded by holding or talking, the event begins with the first glance to the phone prior to viewing/browsing/reading.
- Event End –When the driver finished browsing/reading/viewing and begins moving to close the phone or put it down, OR moves onto another task with the phone (e.g., "HH: Holding", "HH: Dialing"). Closing the phone, putting it down, or lowering it to a holding position should be coded as "HH: End Task."

Hand-Held: Holding – When the driver holds a hand-held cell phone in his/her hand but does not interact with it. It does NOT count as holding if the phone is resting on the driver's seat (next to or between legs), or on the driver's lap (both of which would end the cell phone interaction and were coded as no cell phone task).

NOTE (The 5-Second Rule): If the subject is viewing, dialing, or performing another task with a hand-held phone, then holds the phone without visually or manually interacting with it for at least 5 consecutive seconds, this "break" period was coded as "HH: Holding", starting at the beginning of the 5-second time period. If the driver resumes another (or the same) subtask before the 5-consecutive-second period ends, it was not coded "HH: Holding." Rather, we continued to code as the initial task until a new task begins. This is known as the "5-second rule" and is referred to frequently in these definitions.

NOTE: Holding is assumed in all other hand-held subtasks ("HH:…") and was not coded simultaneously with any other hand-held task. However, if the phone is being held during any PHF or IHF tasks, then "HH: Holding" was simultaneously coded.

- Event Start –when other hand-held cell phone tasks (e.g., "HH: Reaching/Locating" or "HH: Talking/Listening") have ended and driver continues to hold the phone in his/her hand(s) without further visual or manual interactions for at least 5 consecutive seconds.

- Event End –when the driver last touches the phone or when another hand-held cell phone task begins (e.g., "HH: Talking/Listening" or "HH: Dialing").

Hand-Held: End Task- When the driver completes a specific cell phone objective by either pressing a button to end the call, putting the phone down after ending a call or text, or flipping/sliding the phone closed after ending a call or text.

- Event Start –when the driver (whichever comes first):
    1. First moves to press a button on a hand-held phone in order to end a call, OR first glances at the phone prior to pressing a button to end the call,
    2. OR for flip/slider phones, when the driver first moves to flip or slide the phone closed if no button is pressed to end the call,
    3. OR first moves to put the phone down or lower it to a holding position if no obvious button presses or phone manipulations to end the call/text occur
    4. OR the driver first glances at the phone to put it down or lower it to a holding position.
- Event End – (whichever comes last):
    1. When the phone leaves the driver's hand after ending the call/text,
    2. OR the driver last glances at the phone before moving on to a new task,
    3. OR another task begins (e.g., dialing a new number, or Holding for 5 or more seconds).

Integrated Hands-Free: Press Button to Begin/Answer- When the driver presses a button on the steering wheel or center stack in order to begin a cell phone interaction. This can include pushing to answer a call, pushing to voice dial, or pushing to enter a voice command.

- Event Start - when the driver begins to reach for the button on the steering wheel or center stack in order to answer/make a call, OR first glances toward the button on the steering wheel or center stack followed immediately by reaching for it, whichever comes first. If the driver adjusts radio or HVAC prior to initiating the cell phone task, then the first movement or glance toward the HVAC/radio should be coded as Event Begin.
- Event End – when the driver's hand moves away from the buttons on the steering wheel or center stack following the last button press/adjustment.

Integrated Hands-Free: Talk/Listen/Voice Commands- When a driver talks, listens, or gives voice commands on an integrated device. Driver must be observed talking repeatedly with no obvious passenger interaction. Additionally, this option should only be used when the cell records indicate that the driver has made or received a call on an integrated hands-free device.

- Event Start - when the driver begins talking as if giving commands or having a conversation with no obvious passenger interaction, generally after pressing the button(s) on the steering wheel or center stack.

- Event End – when the driver stops talking repeatedly, often (but not always) followed by glancing and/or reaching for the button on the steering wheel or center stack in order to end the call.

Integrated Hands-Free: Press Button to End Task- When the driver presses the button on the steering wheel or center stack in order to end the cell phone interaction.

- Event Start - when driver begins to reach for the button on the steering wheel or center stack in order to end call, OR first glances toward the button on the steering wheel or center stack followed immediately by reaching for it to end a call, whichever comes first.
- Event End – when the driver's hand moves away from the button on the steering wheel or center stack following the button press OR the driver's glance leaves the button location for the last time, whichever comes last.

Portable Hands-Free: Locate/Put-on Headset/Earpiece- When the driver looks for or reaches towards a headset or earpiece. If more than one task occurs (i.e., driver looks for earpiece, reaches for it and then puts it in his ear), the first frame number would be the start of the first task (reaching for earpiece) and the last frame number coded would be the end of the last task (i.e., placing earpiece in ear.)

- Event Start - when the driver starts to move his/her hand in the direction of the headset/earpiece to retrieve it OR first glances as if looking for the headset/earpiece followed immediately by reaching for it, whichever comes first.
- Event End - when the driver does one of the following (whichever comes last):
  1. For putting on a headset/earpiece, the last frame is when the driver finishes moving the earpiece into his/her ear and his/her hand begins to move away from the earpiece.
  2. For locating and reaching for the headset/earpiece, the event ends when one of the other categories begins (i.e., "HH: Dialing," "PHF: Begin/Answer," "PHF: Talking/Listening," "HH: Talking/Listening," etc.).
  3. For locating the headset/earpiece and not picking it up, the last frame number coded would be the first frame number once the subject has shifted his/her gaze to something else (i.e., forward roadway) having glanced at the headset/earpiece for the last time.

Portable Hands-Free: Talk/Listen/Voice Commands- When a driver is talking on a headset, earpiece, or other aftermarket device, OR listening to a phone conversation, OR waiting for a person they are calling to pick up the phone. Driver must be observed talking repeatedly with no obvious passenger interaction to conclude that the headset/earpiece is in use.

> **NOTE:** This subtask should be coded if the talking subtask is performed on a portable hands-free device, even if the dialing, answering, or call ending subtask are performed using a hand-held phone.

NOTE: If the driver uses the speaker phone function on a hand-held cell phone, code as "Hand-Held: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function. Code as "Portable Hands-free: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.

- Event Start - when the last button is pressed on the headset/earpiece before conversation begins. (i.e., when "PHF: Begin/Answer" has ended)
- Event End - when the driver stops talking repeatedly, or first moves to press the button on the headset/earpiece in order to end the call (which would then be coded as "PHF: Press button to end").

Portable Hands-Free: Press Button to Begin/Answer - When the driver presses a button on the headset/earpiece in order to begin a cell phone interaction. This can include pushing to answer a call or pushing to give a voice command to make a call. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone.

NOTE: If instead of pushing a button on the headset/earpiece to answer or make a call, the driver pushes a button or dials on a hand-held phone, this would be coded as "HH: Dialing" or "HH: Locate/Reach/Answer," even if the subsequent conversation takes place via a Portable Hands Free device.

- Event Start - when driver begins to reach for the button on the headset/earpiece, OR first glances toward the button on a wire connected to a headset/earpiece followed immediately by reaching for it, whichever comes first. If the driver adjusts radio or HVAC prior to initiating the cell phone task, then the first movement or glance toward the HVAC/radio should be coded as Event Begin.
- Event End – when the driver's hand moves away from the button on the headset/earpiece following the button press that initiates the interaction.

Portable Hands-Free: Hold/Wear Headset/Earpiece- When a driver is holding a headset/earpiece in his/her hand or wearing it on his/her head but not interacting with it (and not involved in a phone conversation). Also code as "PHF: Hold/Wearing" if the driver has been holding the earpiece/headset in his/her hand(s) for some time and finally moves to put it on. It does NOT count as holding if the headset/earpiece is resting on the driver's seat (next to or between legs), or on the driver's lap.

NOTE: If the subject is talking/listening on a portable hands-free device or performing another task with a hand-held phone or portable hands-free device, then holds the headset/earpiece in hand or on his/her head without interacting for at least five consecutive seconds, this "break" period should be coded as "PHF: hold/wear headset/earpiece." If the driver resumes another task before the 5-consecutive-second period ends, do NOT code "PHF: Hold/Wear headset/earpiece."

NOTE: While coding PHF: Talk/Listen, do NOT intersperse PHF: Hold/Wear unless it is clear that a phone call has ended. The driver may stop talking for periods of time (including breaks longer than 5 seconds) to listen to the conversation. This should be coded straight through as PHF: Talk/Listen.

NOTE: Holding/wearing headset or earpiece is assumed in all other Portable Hands-Free ("PHF:…") subtasks and does not need to be coded simultaneously with any other PHF task. <u>However, if a headset/earpiece is being held or worn during any HH or IHF tasks, then "PHF: Holding/Wearing" would need to be simultaneously coded.</u>

- <u>Event Start</u> –when other PHF cell phone tasks (e.g., reaching/locating or talking) have ended and driver continues to hold headset/earpiece in hand or on his/her head without further visual or manual PHF interactions.
- <u>Event End</u> –when the driver moves to put the headset/earpiece down and last touches it OR when another cell phone task begins (e.g., talking/listening or dialing).

Portable Hands-Free: Press Button to End- When the driver presses the button on the headset/ear piece in order to end the cell phone interaction. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone.

NOTE: If instead of pushing a button on the headset/earpiece to end a call, the driver pushes a button on a hand-held phone, this would be coded as "HH: End Task," even if the conversation took place via a Portable Hands-Free device.

- <u>Event Start</u> - when driver begins to reach for the button on the headset/earpiece/wire, OR first glances toward the button on the headset/earpiece/wire followed immediately by reaching for it, <u>whichever comes first</u>.
- <u>Event End</u> – when the driver's hand moves away from the button on the headset/earpiece/wire following the button press that ends the call AND the driver has completed the last glance toward the button, <u>whichever comes last</u>.

Cell Phone Navigation- When the driver is using the navigation feature of a hand-held cell phone. We do not entirely know what this will look like, but it may occur when the phone is in a cradle on the dash, or when the driver is clearly using the phone for turn-by-turn navigation purposes.

NOTE: Please note this interaction in the Comments section of Excel log so that a closer examination can be performed.

- Event Start –when the driver begins reaching for the cell phone, OR when the driver begins to look at the phone for purposes of navigation, whichever comes first.
- Event End – when the driver reaches his/her destination, OR manually deactivates the navigation feature, whichever comes last.

Other Cell Phone Tasks - When a driver is interacting with a hand-held cell phone, portable hands-free device, or integrated hands-free device in some manner not described in previous categories. This includes, but is not limited to, the following:

1. When the driver plugs a hand-held phone into a power charger.
2. When the subject is playing with a hand-held phone or portable hands-free device, or fiddling with them without any purposeful manipulation.
3. When the subject puts a hand-held cell phone into a case after holding it in his/her hand for 5 or more consecutive seconds after other HH tasks have ended. Includes reaching for the separate case, maneuvering phone into the case, and then putting it down or holding it (coded as holding if longer than 5 seconds).

NOTE: If subject must remove a hand-held cell phone from the case before using it, code as "HH: locating/reaching/answering." If the subject is putting the phone back INTO case immediately following a call or text, code it as "HH: End Task." If the subject is putting the phone back INTO a case after "HH: Holding," code as "Other Cell Phone Task."

NOTE: Define the observed behaviors in the Comments section of Excel log.

- Event Start –when other identifiable cell phone tasks have ended, OR if isolated from other tasks, the event begins when a cell phone task that does not fit into other categories begins.
- Event End - when subject puts hand-held phone or portable hands-free device down or begins another identifiable subtask (i.e., "HH: dialing," "PHF: talking/listening," etc.).

Both Hands off Steering Wheel – Anytime the driver removes both hands from the steering wheel for a non-driving-related reason while the vehicle is in motion (speed >0). This does NOT have to be related to the cell phone task in order to be coded (e.g., it could be to adjust the radio), but DOES need to be non-driving related (i.e., crossing hands to turn steering wheel does not count).

NOTE: Both hands off the wheel should ONLY be coded when the vehicle is in motion and the speed is greater than 0 as witnessed from the video. When the vehicle is stationary, both hands off the wheel can be ignored.

NOTE: If both hands are off the wheel for a driving-related reason, do NOT code. If one hand is off the wheel due to phone use, and the second hand is needed off the wheel for driving-related reasons (e.g., to shift gears), then this would be related to cell phone use and should be coded. If the driver is on a hands-free device and removes both hands from the wheel to gesture during conversation or perform other non-driving related tasks (e.g., eating and radio adjustments), then also code. When in doubt, code as Both Hands off Steering Wheel.

- Event Start – when the driver first has no hands on the steering wheel
- Event End – when the driver returns at least one hand to the steering wheel

Recap of Special Scenarios

1. Viewing While Answering a Hand-Held phone: At the beginning of a call, code as "HH: Reaching/Locating/Answering" straight through even if the driver looks at a hand-held phone or presses a button to answer a call. "HH: Locating/Reaching/Answering" has an implied "viewing" component, so it is not needed to call it out separately. If the driver has to open a flip phone, pull antenna up, or remove the phone from a case before answering a call, also code as "HH: locating/reaching/answering."

2. Cell Phone Cases: If subject must remove a hand-held cell phone from the case before using it, this should be included as "HH: Locating/Reaching/Answering." But if subject is putting it back INTO case immediately after using it, include as "HH: End Task." If subject puts phone back into case after a period of "HH: Holding," then code it as Other Cell Task.

3. Speaker Phone Talking: If the driver uses the speaker phone function on a hand-held cell phone to have a cell phone conversation:
   a. Code as "HH: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function.
   b. Code as "PHF: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.

4. Text Messages: If the cell records indicate that the driver has received a text message, and the driver is seen checking then replying to this text message in the video, code as follows:
   a. If the driver replies to the text message within 10 seconds after reading the text message, then the reply should be considered part of the same task, and should be coded as "HH: Text" (the initial reading of the received text message should still be coded as "HH: View/Browse").
   b. If the driver does NOT reply to the text message within 10 seconds and simply holds the phone (coded as "HH: Hold") for 10+ seconds or puts the phone down

(coded as “HH: End Task”), then the sent text should be considered a separate, non-sampled task and should NOT be coded.

A.4 Driver, Vehicle, and Environmental Factors Coded for Cell Phone Subtasks

The first two steps of the Cell Phone Pilot Analysis reduction work were (1) to identify the start and end points of sampled cell phone interactions while driving based on records of calls and text messages provided by the cell phone company via the study participants, and (2) within those interactions, code the duration of cell phone subtasks (e.g., reaching for phone, dialing, talking). This step in the reduction involved a close examination of those subtasks for a variety of vehicle, environmental, and driver-related factors.

Separate events were created for each unique cell phone subtask associated with each sampled call and text message. A randomly selected 6-second clip of one talking, one holding a handheld phone, and one wearing a portable hands-free device (where applicable) were reduced for each interaction. All other subtasks and subtask combinations were reduced in their entirety.

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1. InteractionEventID (text): **Interaction Event ID:** Enter the INTERACTION Event ID from the reduction log. (This number will be used to tie this subtask back to the whole cell phone interaction.)

2. Seatbelt: **Driver seatbelt use at START of event:**
   a. <u>Yes, belt worn</u>
   b. <u>No, belt NOT worn</u>
   c. <u>Unable to determine</u>

3. HHPhoneType: **Type of hand-held phone the driver uses for the majority of the event:**
   a. <u>NA Subtask Baseline Event (Skip to Page 2)</u>
   b. <u>No hand-held phone used (Skip to Page 2)</u>
   c. <u>Standard keys on front of phone</u>
   d. <u>Vertical flip-phone</u>
   e. <u>Horizontal flip-phone/Slide keyboard</u>
   f. <u>Touch screen</u>
   g. <u>BlackBerry/QWERTY on Front</u>
   h. <u>Unable to determine</u>

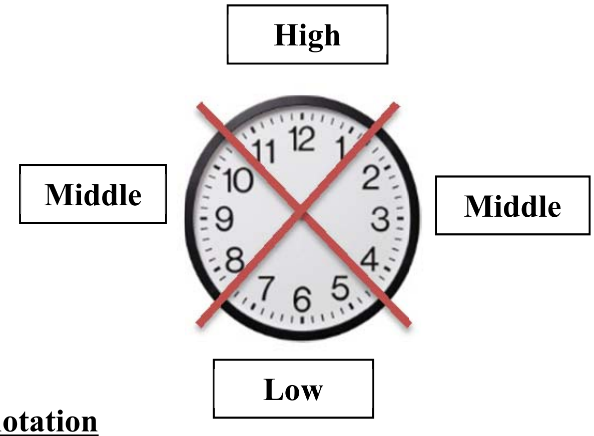
4. PhonePriorLocation: **Location of hand-held phone prior to being reached for (Reaching subtasks only)**: applies only to "HH: Locate/Reach/Answer" subtasks
   a. <u>Reaching for phone does not occur</u> – choose this option if the subtask being coded is an HH task other than "HH: Locate/Reach/Answer" (such as, "HH: Talk/Listen," "HH: Text," etc.)
   b. <u>Shirt/Jacket Pocket</u>
   c. <u>Pants Pocket</u>
   d. <u>Cup Holder</u>
   e. <u>On Dash (not in cradle)</u>
   f. <u>Purse (if seen)</u>

g. Passenger Seat
h. In Cradle – usually found attached to dash or windshield
i. Glove Box
j. Center Console Storage
k. Other
l. Unable to Determine
m. No Hand-Held Phone Used
n. N/A (Baseline)

5. PhoneUseLocation: **Location of hand-held phone during majority of event (not for reaching or ending subtasks):** applies only to "HH: Dial," "HH: View/Browse," "HH: Talk/Listen," "HH: Text," and "HH: Hold" subtasks.

a. N/A, Reaching or ending HH call – choose this option if the subtask being coded is "HH: Locate/Reach/Answer" or "HH: End Task."
b. In right hand against right ear
c. In left hand against left ear
d. In one hand on steering wheel (low) – 5:00-7:00 on a clock.
e. In both hands resting on steering wheel (low)
f. In one hand resting on steering wheel (middle) – 2:00-4:00 or 8:00-10:00 on a clock.
g. In both hands resting on steering wheel (middle)
h. In one hand resting on steering wheel (high) – 11:00-1:00 on a clock.
i. In both hands resting on steering wheel (high)
j. In one hand raised out in front of forward view
k. In both hands raised out in front of forward window
l. In one hand to side of/in front of steering wheel
m. In both hands to side of/in front of steering wheel
n. In one hand below steering wheel
o. In both hands below steering wheel
p. In one hand placed in front of mouth
q. In both hands placed in front of mouth
r. In right hand against left ear (cross body)
s. In left hand against right ear (cross body)
t. Not in hand – Other
u. No hand-held phone used
v. N/A (Baseline)

Hand placement on steering wheel diagram



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6. AmbientLighting: **Ambient Lighting at the START of the event:**
    a. <u>Daylight</u>
    b. <u>Dusk</u> – use if the ambient lighting is mostly dark and continues to darken throughout the file. Do not use if it the ambient lighting is daylight, but it is cloudy.
    c. <u>Darkness, lighted</u> – It is nighttime during the subtask, but the roadway is lighted
    d. <u>Darkness, not lighted</u> – It is nighttime during the subtask, and the roadway is NOT lighted
    e. <u>Dawn</u> – use if the ambient lighting is mostly dark and lightens throughout the file. Do not use if it the ambient lighting is daylight, but it is cloudy.
    f. <u>Task is not Started Outside</u>
    g. <u>Unable to determine</u>

7. Weather: **Weather conditions at the START of the event:**
    a. <u>No Adverse Conditions</u> – includes cloudy/overcast skies with no visible falling precipitation
    b. <u>Light Rain/Mist</u>
    c. <u>Heavy Rain</u>
    d. <u>Snowing/Sleeting</u>
    e. <u>Fog</u>
    f. <u>Rain + Fog</u>
    g. <u>Snow + Fog</u>
    h. <u>Smoke, dust</u> - There is smoke and/or dust, either stagnant or blowing, in the air
    i. <u>Other</u> - There is some type of adverse atmospheric condition present, not described in other categories
    j. <u>Unable to determine</u>

8. RoadSurface: **Road surface condition at the START of the event:**
    a. <u>Dry</u> - There is no foreign material (rain, snow, oil, etc.) on the roadway in the area of the event (nothing on the road to affect the driving task)
    b. <u>Wet</u> - Roadway is completely or partially wet in the area of the event (not snowy, icy, muddy, or oily)

c. Snowy - There is some amount of unmelted snow or slush on the roadway in the area of the event, enough to affect the driving task (no ice on the road in the area of interest)
d. Icy - There is some amount of ice on the roadway in the area of the event, enough to affect the driving task
e. Muddy - There is some amount of mud on the roadway in the area of the event, enough to affect the driving task
f. Oily - There is some amount of oil, grease, or other slippery fluid on the roadway in the area of the event, enough to affect the driving task
g. Other - There is some type of foreign substance on the road, not listed in previous categories, enough to affect the driving task
h. Unable to determine

9. StartStopped: **Does the event START while the vehicle is stopped?**
a. No
b. Yes, at intersection (either at signal or at stop sign, may be first in queue, or behind line of other queued vehicles)
c. Yes, in traffic (does not include intersections. This is to be used for traffic jam situations.)
d. Yes, parked (prior to driving, after parking, or waiting for passenger to get in)
e. Yes, other (in line at drive-thru, etc.)
f. Unable to determine

10. AllStopped: **Does the event occur ENTIRELY while the vehicle is stopped?**
a. No (Continue)
b. Yes, at intersection (Continue)
c. Yes, in traffic (Continue)
d. Yes, parked (Stop and Save)
e. Yes other (Continue)
f. Unable to determine (Continue)

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11. TrafficFlow: **Traffic Flow at the START of the event:** Roadway design (including the presence or lack of a median) at the start of the event. If the event starts while the driver is at an intersection, the traffic flow conditions just prior to the intersection should be recorded.
a. Not divided, standard 2-way traffic way - with or without center line, but without center 2-way turn lane
b. Not divided, with center 2-way turn lane
c. Divided - median strip or barrier separates opposite direction
d. One-way traffic
e. No lanes – such as a Parking lot, Driveway, etc.
f. Other
g. Unable to determine

12. ContigTravelLanes: **TOTAL number of CONTIGUOUS travel lanes present at START of the event, including turn, exit-entrance, and oncoming:** includes the total number of all: lanes in the direction the driver is driving, oncoming lanes, turn lanes, entrance/exit ramps, and lanes with parked vehicles. If the event starts while the driver is at an intersection, the number of lanes just prior to the intersection should be recorded

a. 0 (No Lanes) - vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. 8+
j. Unable to determine

13. NumDirectLanes: **Number of travel through lanes in the DIRECTION OF TRAVEL ONLY at the START of the event:** includes only the total number of lanes in the direction the driver is driving. Do **NOT** include: oncoming lanes, turn lanes, entrance/exit ramps, or lanes with parked vehicles. If the event starts while the driver is at an intersection, the number of lanes just prior to the intersection should be recorded

a. 0 (No Lanes) – vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. 8+
j. Unable to determine

14. StartingLane: **In which of the lanes counted in the question Above is the driver traveling at the START of the event? - Note:** Lanes should be counted from **left to right**

a. Not in through lane
b. 0 (No Lanes) - vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
c. 1 (Left-most lane or only lane)
d. 2
e. 3
f. 4
g. 5
h. 6

i. 7
j. 8+
k. Unable to determine

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15. RoadAlignment: **Roadway alignment at the START of the event:**

a. Straight – Road alignment is straight
b. Curve Left – Road alignment is curved to the left
c. Curve Right – Road alignment is curved to the right
d. Unable to determine

16. RoadGrade: **Roadway grade at START of the event:**

a. Level
b. Grade Up – profile of road is graded, and vehicle is going up a hill
c. Hillcrest – vehicle is at a hillcrest (area of transition between an upgrade and a downgrade)
d. Grade Down – profile of road is graded, and vehicle is going down a hill
e. Dip – vehicle is in a dip
f. Unable to determine

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17. Locality: **Locality at the START of the event:**

a. Interstate/bypass/divided highway with no traffic signals
b. Bypass/divided highway with traffic signals
c. Business/industrial - Vehicle passes any type of business or industrial structure
d. Open country - Other than the roadway, there is nothing visible that is described in any of the other categories
e. Residential - Vehicle passes at least one house or evidence of a residential neighborhood but does not drive through a business or industrial area.
f. Construction zone - Vehicle is in a construction zone (construction equipment, barrel, etc. are visible) *(This category takes precedence over others)*
g. School - Vehicle passes any type of school building, including adult learning institutions *(This category takes precedence over others)*
h. Church *(This category takes precedence over others)*
i. Playground - Vehicle passes any type of playground or children's playing field *(This category takes precedence over others)*
j. Other - Locality is one not described in other categories
k. Unable to determine

18. TrafficDensity: **Traffic density at the START of the event:**

a. N/A – Stopped at Intersection
b. LOS A1: Free flow – No leading traffic in any lane – Subject driver is unaffected in the traffic stream because there are no leading vehicles in any lane. Freedom to select desired speeds and to maneuver within the traffic stream is at the highest level possible.

c. LOS A2: Free flow – Leading traffic present in at least one lane - Individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.
d. LOS B: Flow with some restrictions - In the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.
e. LOS C: Stable flow, maneuverability and speed are more restricted - In the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.
f. LOS D: Unstable flow - temporary restrictions substantially slow driver - High-density, but stable flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.
g. LOS E: Flow is unstable, vehicles are unable to pass, temporary stoppages, etc. - Operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.
h. LOS F: Forced traffic flow, low speeds, traffic volumes below capacity - Forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. LOS F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow, which causes the queue to form, and LOS F is an appropriate designation for such points.
i. Unable to determine

19. LVPresent: **Is there a lead vehicle traveling in the same lane at the START of the event?**

a. Yes
b. No (Skip to Page 6)
c. Unable to determine

20. LVObjectID (text): **What is the object ID of the lead vehicle reported by the radar at the START of the event?**

- If there is a lead vehicle reported by the radar, enter the Object ID
- If radar data is not available, enter "N/A"
- If unsure, enter "Unable to determine"

21. LVActualRange (text): **What is the X-Range to the lead vehicle reported by the radar at the START of the event?**

- If there is a lead vehicle reported by the radar, enter the X_Range
- If radar data is not available, enter "N/A"
- If unsure, enter "Unable to determine"

22. LVEstRange: **Estimate the range to the lead vehicle at the START of the event:**

a. Far (Greater than 40 m or 3 standard lane markings away)
b. Medium (Between 12 and 40 m or 1-3 standard lane markings away)
c. Close (Less than 12 m or 1 standard lane marking away)
d. Unable to determine
e. N/A (No lead vehicle)

Lead Vehicle Range Estimate Diagrams

***Standard lane markings are 10 ft. (3 m) long, and the distance between each one is 30 ft. (9 m). Thus, from the start of one standard marking to the start of the next is 40 feet or about 12 meters. Non-standard lane markings (such as during a merge or delineating a turn lane) have different measurements and cannot be used in this manner.

Close (Less than 14 m on radar, or just over one standard lane marking)

<u>Medium (14 to 40 m on radar or 1-3 standard lane markings)</u>

<u>Far (Greater than 40 m on radar or more than 3 standard lane markings)</u>

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23. LVActualRate (text): **What is the relative X-velocity of the lead vehicle reported by the radar at the START of the event?**
- If there is a lead vehicle reported by the radar, enter the X-velocity
- If radar data is not available, enter "N/A"
- If unsure, Enter "Unable to determine"

24. LVEstRate: **Estimate the closing rate to the lead vehicle at the START of the event:**
a. <u>Distance Rapidly Increasing</u>
b. <u>Distance Increasing</u>
c. <u>Distance Constant</u>
d. <u>Distance Closing</u>
e. <u>Distance Rapidly Closing</u>
f. <u>Unable to Determine</u>
g. <u>N/A</u> (No lead vehicle)

25. SVLaneChange: **Does the subject driver CHOOSE to change lanes during the 10-second time interval centered on the start of the baseline or subtask?** This 10-second time interval includes 5 seconds before the start of the event to 5 seconds after the start of the event.

a. No - driver does not change lanes, OR any lane change performed is forced by lane closure, merging requirements, or turn lane movements
b. Yes, planned lane change – driver changes lanes based on a choice to travel in a different lane. This does **NOT** include when the driver makes required merges (such as merging onto/off of a highway, moving into a turn lane, or lanes ending/beginning – all of which should be answered “No”).
c. Yes, evasive/unplanned lane change – driver changes lanes in order to avoid an accident, or an animal/object/pedestrian in the forward roadway
d. Unable to determine

26. SVTurnSignal: **If driver changes lanes as above, does he/she use the turn signal?**
a. Driver does not change lanes
b. Yes
c. No
d. Unable to determine

27. RVPresent: **Is there a trailing rear vehicle traveling in the same lane as the driver at the START of the event?**
a. Yes
b. No (Skip to Page (7)
c. Unable to determine

28. RVEstRange: **Estimate the range to the rear vehicle at the START of the event:**
a. Far (Greater than 40 m or 3 standard lane markings away)
b. Medium (Between 12 m and 40 m or 1 to 3 standard lane markings away)
c. Close (Less than 12 m or 1 standard lane marking away)
d. Unable to determine
e. N/A (No rear vehicle)

Rear Vehicle Range Estimate Diagrams

***Standard lane markings are 10 ft. long, and the distance between each one is 30 ft. Thus, from the start of one standard marking to the start of the next is 40 feet or about 12 meters. Non-standard lane markings (such as during a merge or delineating a turn lane) have different measurements and cannot be used in this manner.

Close (Less than14 m or just over one standard lane marking)

Medium (14 to 40 m or 1-3 standard lane markings)

Far (Greater than 40 m away or more than 3 standard lane markings)

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29. RVEstRate: **Estimate the closing rate of the rear trailing vehicle at the START of the event:**

a. Distance Rapidly Increasing
b. Distance Increasing
c. Distance Constant
d. Distance Closing
e. Distance Rapidly Closing

f. Unable to Determine
g. N/A (No rear vehicle)

30. RVLaneChange: **Does the rear trailing vehicle change lanes to pass the subject vehicle within 10 seconds of the START of the event?** This 10-second time interval includes the start of the subtask to 10 seconds after the start of the subtask.

a. Yes, Rear Vehicle Moves to Pass (PLANNED) – Rear vehicle changes lanes based on a choice to travel in a different lane or in order to drive at a faster speed than the subject. This does **NOT** include when the rear vehicle makes required merges (such as merging onto/off of a highway, moving into a turn lane, or lanes ending/beginning – all of which should be answered "No").
b. Yes, Rear Vehicle Moves to Pass (EVASIVE) - rear vehicle changes lanes in order to avoid an accident, or an animal/object/pedestrian
c. No – rear vehicle does not change lanes, OR any lane change performed is forced by lane closure, merging requirements, or turn lane movements
d. Unable to determine
e. N/A (No rear vehicle)

31. RelationToJunction**: Relation to junction at START of event:**

a. Non-junction – Subject vehicle is not close to a junction (the area formed by the connection of two roadways)
b. Intersection – Subject vehicle is at or within 1 car length (~20 feet) of an intersection (roads cross at the same grade)
c. Intersection-related – Subject vehicle is within 3 car lengths (~60 feet) of an intersection (where roads cross at the same grade), either approaching or exiting the intersection
d. Interchange area – Subject vehicle is within the boundaries of an interchange with exit and/or entrance ramps present (a road junction that typically utilizes grade separation and one or more ramps to permit traffic on at least one road to pass through the junction without crossing any other traffic stream)
e. Entrance ramp – Subject vehicle is on or entering/exiting an entrance ramp (a transition roadway connecting two roadways or used for entering through-traffic lanes)
f. Exit ramp – Subject vehicle is on or entering/exiting an exit ramp (a transition roadway connecting two roadways or used for exiting through-traffic lanes)
g. Driveway, alley access, etc. – Subject vehicle is on or entering/exiting a driveway, alley, or some other roadway providing access to property adjacent to the traffic way
h. Rail grade crossing – Subject vehicle is close to the at-grade connection of a railroad bed and roadway
i. Parking lot – subject vehicle is within the boundaries of a parking lot
j. Other – subject vehicle is related to a junction in a manner not described in other categories. This includes tunnels, toll booths, and bridges
k. Unable to determine

32. TrafficControlDevice: **Traffic control device (if any) in effect at the START of the event:**

a. No traffic control - There is no traffic control applicable to the subject vehicle at the time of the event
b. Traffic signal - A traffic signal (by colors or flashing) is controlling some aspect of the traffic flow applicable to the subject vehicle
c. Stop sign
d. Yield sign
e. Construction signs/warnings
f. Slow or warning sign, other
g. School-zone related sign
h. Officer or watchman/traffic guard
i. Traffic lanes marked - There are markings on the road that contain information or warnings applicable to the driving task for the subject vehicle (use if NO other types of devices/signs are used to convey the same information). Does not include Railroad crossings (see below).
j. No passing signs
k. One-way road or street
l. Railroad crossing with markings or signs - A railroad crossing with associated signage (including markings on the road, signs, cross bucks) is controlling some aspect of traffic flow applicable to the subject vehicle
m. Railroad crossing with signals - A railroad crossing with associated signals (including flashing lights, traffic lights) is controlling some aspect of traffic flow applicable to the subject vehicle
n. Railroad crossing with gate and signals - A railroad crossing with associated gate(s) with or without signals (including flashing lights, traffic lights). Is controlling some aspect of traffic flow applicable to the subject vehicle
o. Other - There is some type of traffic control device, not described in previous categories, controlling some aspect of traffic flow applicable to the subject vehicle
p. Unable to determine

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33. IntersectionPresent: **What is the first type of intersection entered within 10 seconds from START of the event?** This 10-second time interval includes the start of the subtask to 10 seconds after the start of the subtask.

a. No Intersection Entered – Skip to Page 9 – if this option is selected, SKIP to question 36 on page 9 of the question annotation
b. Signalized – subject's path through intersection is controlled by a stoplight only
c. Stop sign – subject's path through intersection is controlled by a stop sign only
d. Yield sign – subject's path through intersection is controlled by a yield sign only
e. Uncontrolled – subject's path through intersection is not controlled by any means (no signs nor stoplights)
f. Unable to determine

34. IntersectionScan1: **For the intersection coded above, does the driver appropriately scan for traffic PRIOR to entering the intersection?** Proper scanning consists of gazing to roadway junctions and NOT driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right is required; for a right 3-way intersection, a glance to the right is required; for a left 3-way intersection, a glance to the left is required, etc. These glances are required regardless of traffic control status (traffic light color, etc.).

a. Yes, driver scans appropriately
b. No, driver does not scan
c. Unable to determine
d. N/A - No intersection entered

35. IntersectionViolate: **What stopping behavior is exhibited at the intersection coded above?** (use the unit converter to convert to miles per hour)

a. Stop not required
b. Proper stop performed
c. Rolling stop (minimum speed <15 mph, but greater than 0)
d. Complete stop, but past the stop bar/sign AND in path of cross traffic
e. No stop when stop required (minimum speed is >=15mph)
f. Unable to determine
g. N/A - No intersection entered

36. IntersectionScan2: **If the driver stops as first in queue at a light at the intersection coded above, does he/she scan within 6 seconds before the vehicle starts moving?** Proper scanning consists of gazing to roadway junctions and NOT driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right is required; for a right 3-way intersection, a glance to the right is required; for a left 3-way intersection, a glance to the left is required, etc. These glances are required regardless of traffic control status (traffic light color, etc.).

a. N/A, driver does not stop
b. N/A, driver stops, but not first in queue at light
c. Yes, driver scans before moving
d. No, driver does not scan before moving
e. Unable to determine
f. N/A - No intersection entered

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37. NumLaneBust (text): **Number of unintentional lane busts occurring during this event** – enter the total number of unintentional lane busts that occur during the entire event. Do NOT count intentional lane busts (such as when the driver must swerve to avoid an accident or an animal/object/pedestrian in the road, etc.). If there are no unintentional lane busts, enter “0” and skip to Page 10.

38. BeginLaneBust1 (text): **Begin timestamp of FIRST lane bust** – enter the timestamp of the beginning of the first lane that occurs during this event.

39. BeginLaneBust2 (text): **Begin timestamp of SECOND lane bust** – enter the timestamp of the beginning of the second lane that occurs during this event.

40. BeginLaneBust3 (text): **Begin timestamp of THIRD lane bust** – enter the timestamp of the beginning of the first third bust that occurs during this event.

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41. SecondaryTask1: **Secondary Task 1** – Indicate any secondary tasks (up to (3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

42. SecondaryTask2: **Secondary Task 2** – Indicate any secondary tasks (up to (3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

43. SecondaryTask3: **Secondary Task 3** – Indicate any secondary tasks (up to (3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

44. SecondaryTaskDesc (textbox): **Define/Describe OTHER tasks above** – For any secondary tasks listed as "other," "unknown," "other device," "reaching for object: other," or "holding object: other" above, provide a description. Also use this space to further explain anything unusual about the list distractions.

Secondary Task	Description
No Secondary Task	There are no observable signs of driver distraction
Cell Phone: Holding/Wearing ONLY (Does not Apply to Subtask Events)	Driver is holding a hand-held phone without interacting with it in ANY way (including not talking on speaker phone) and/or Driver is wearing or holding an earpiece/headset without interacting with it in ANY way (including talking on it). Do NOT use this option if Driver is interacting with any phone, headset, or integrated device. See Cell Phone: Complex Task.
Cell Phone: Complex Task (Does not Apply to Subtask Events)	Driver is interacting with a hand-held phone, earpiece/headset, or integrated hands-free device in some way OTHER than simply holding/wearing it. This category includes reaching/locating, dialing (buttons or voice), talking, text messaging, browsing, viewing, or any other task beyond holding/wearing.
Lost in thought	Driver performs multiple non-specific eye glances within 6-second period of time (not focusing on objects of glances), or appears to be in a daze resulting in potential conflict.
Looked but did not see	Driver is looking right at (or looks at) where incident occurs, but shows no reaction. Often seen when blind spot is checked, but vehicles present are not seen.

Secondary Task	Description
Talking/singing/dancing (w/o passenger or cell)	Driver is moving lips as if in conversation or singing a song. Also use if driver is moving his/her arms, head, or other body part in time with the beat of music Mark this if driver is talking or singing or dancing and there is no obvious passenger component (either passenger is clearly not present or the driver is not looking in the direction of a passenger seat and does not turn head as if communicating with someone).
Reading/Writing	Driver is reading or writing on material that is in the vehicle, but not a part of the vehicle (i.e., not reading external signs, or radio display). This could be reading or writing on directions, paper material, packaging. If reading a phone number, record as dialing cell phone.
Cognitive, other	Driver is emotionally upset or angry, or engaged in another activity not included in other categories, that requires the driver to obviously be thinking about something other than driving. Details about condition or emotional state should be specified in the appropriate questions.
Interacting with passenger	A passenger is visible or not visible, but the driver is clearly interacting with a passenger in either the adjacent or rear seat. This could be talking, listening, reacting to (i.e., laughing), moving toward or away from the passenger (i.e., reaching for the passenger, or avoiding a pat from the person).
Moving object in vehicle	An object inside the vehicle is in motion and causes the driver to look away from the driving task, either due to the motion of the vehicle or due to another passenger throwing the object. (Ex. object fell off seat when driver stopped hard at a traffic light.)
Insect in vehicle	Interaction with any insect in the vehicle (e.g., swatting at insect, moving body to avoid insect, looking around trying to locate insect).
Pet in vehicle	Any interaction with pet, including petting, talking to, or moving pet or interacting with pet carrier. Only code if animal/pet is visible at some point in the trip file or if there is history/context with the driver and the driver is exhibiting behaviors that are appropriate to having a pet in the vehicle.
Object dropped by driver	Driver is holding something and it drops and the driver then picks it back up. This category supersedes other "reaching" categories in the situation of an object being dropped and immediately retrieved.
Reaching for object, other	Driver reaches for an object not described in any other category. Once the driver has finished reaching for the object and has it in hand (if not being moved for intended usage), then it becomes "object in vehicle, other," as long as it doesn't fit into any of the other categories (e.g., eating, drinking, etc.).

Secondary Task	Description
Holding object, other	Driver is holding an object not described in other categories. Could be food, drink, pen, paper, etc. Must continue for at least 5 seconds without other manipulations. If less than 5 seconds, code as previous task (e.g., reaching for object, personal hygiene).
Object in vehicle, other	Driver clearly is looking at, handling, or manipulating an object (visible or not) or thing located in the vehicle, other than those listed in other categories.
Operating other electronic device	Driver is manipulating some non-manufacturer-installed electronic device (PDA, laptop, mp3 player, etc.) either by pressing buttons, viewing, opening/closing, plugging in, etc. Reaching for this object should be coded as "Reaching for object, other."
Adjusting radio or HVAC	Driver interacts with climate control or radio either by touching the buttons on the center stack, dashboard, or steering wheel, or glancing at the controls. Includes inserting/retrieving CDs and adjusting vents.
Adjusting/monitoring other devices integral to vehicle	Driver interacts with a manufacturer-installed device other than those listed in other categories, either by touching or glancing at the device. Includes interaction with seat belt, door locks, sun visor, etc. Does NOT include interacting with driving-critical tasks such as turn signal, headlights, gear shift, and windshield wipers.
Looking at non-driving related external object/event	Driver is looking outside of the vehicle in the direction of what is obviously an object or incident that is not related to the driving task. May include looking at an accident, aspects of construction sites/zones, animals/pedestrians that are not in or entering the path of travel. Only mark if it is clear that the driver is tracking a specific external distraction as they drive by. Other non-specific or driving-related glances should be coded as "Driving related inattention to forward roadway"
Eating/drinking	Driver has food or drink that will be put in his/her mouth with or without the use of a utensil. If driver is chewing (except gum) also code as Eating/drinking. If driver is simply holding food or drink for 5 or more seconds, code as Holding Object: Other
Smoking/tobacco	Lighting, smoking, or extinguishing cigar or cigarette. Also includes use of chewing tobacco or holding a lit cigarette. Reaching for tobacco products should be coded "Reaching for object: other"
Personal hygiene	Includes applying make-up (including lotion/chapstick), checking self in mirror, purposefully fixing/brushing hair, shaving, tweezing, brushing/flossing teeth, putting on/removing/adjusting jewelry (including watches), putting on/removing/adjusting contacts or glasses. Reaching for hygiene-related items should be coded as "Reaching for object: other." Does not include swiping hair from eyes or quick/thoughtless rubbing/scratching, twirling hair.

Secondary Task	Description
Driving-related inattention to forward roadway	Driver glances away from the direction of travel out a window or at a side or center mirror for a driving-related issue (i.e., changing lanes, crossing through an intersection). ***Exception:*** if the vehicle is backing and the driver is looking out of the left window to see the road in the direction of travel, this is not coded as a distraction.
Other Secondary Task (define in Text box)	Driver is looking in a location other than the direction of travel, in a manner not listed in other categories.
Unknown	Can't tell or make a judgment whether there is a distraction Ex. Part of the video is missing or there is insufficient information in the video to make a determination.

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45. DriverExpectation: **If an external incident occurs within 6 seconds after the START of the event, describe the driver's reaction to it:** An external incident is anything unexpected or out of the ordinary that presents a safety hazard.

a. No external event occurs – if this option is selected, SKIP to question 44 at the bottom of this page on the question annotation
b. Fully expects, drives appropriately/reacts in a timely manner
c. Somewhat caught off guard, but quickly reacts in appropriate manner
d. Very much caught off guard, has a delayed reaction (~ > 0.75 s)
e. Extremely caught off guard, does not react at all
f. Unable to determine

46. Emotion: **Prior to any external incident noted above, rate the driver's emotional state during the first 6 seconds from the START of the event:**

a. Neutral/No Emotion Shown
b. Happy
c. Angry/Frustrated/Impatient
d. Sad
e. Surprised
f. Other (Could be Concerned/Opinionated/Apologetic/Guilt/Contempt)
g. Unable to determine

Driver Emotional State Definitions

Emotion	Operational Definition
Unable to Determine	• Cannot tell what emotion the driver is showing
Neutral/No Emotion Shown	• The driver has a straight face, does not smile or laugh, does not gesture
Happy	• The driver smiles or laughs • The driver gestures in excitement
Angry/Frustrated	• The driver lowers/squeezes eyebrows, wrinkling forehead • The driver clenches his/her teeth

Emotion	Operational Definition
	• The driver yells (opens mouth wide with eyebrows lowered) • The driver gestures in anger/frustration • The driver raises his/her upper lip or tightens lips
Sad	• The driver has droopy eyebrows (raises inner eyebrows, lowers outer eyebrows) • The driver frowns by lowering the outer corners of his/her lips
Surprised	• The driver's eyebrows raise • The driver's mouth opens • The driver gestures
Other	• Emotional reaction that does not fit into any other category

47. EmotionIntensity: **Prior to any external incident noted above, rate the intensity of the driver's emotional state during the first 6 seconds of the event:**

a. Neutral/No Emotion Shown
b. Slight (Emotion Somewhat Shown)
c. Marked or Pronounced (Emotion Very Much Shown)
d. Severe (Emotion Extremely Shown)
e. Unable to determine

Driver Emotional Intensity Reduction Definitions

Intensity of Emotion	Operational Definition
Unable to Determine	• Cannot tell the intensity of the emotion
Neutral/No Emotion Shown	• The driver has a straight face, does not smile or laugh, does not gesture • Note, will always be selected if Neutral/No Emotion is selected above
Slight (Emotion Somewhat Shown)	• The driver no longer has a straight face • However, no gesturing or head movement is observed
Marked or Pronounced (Emotion Very Much Shown)	• The driver no longer has a straight face • The driver gestures one time in a reserved manner • The driver moves his head one time
Severe (Emotion Extremely Shown)	• The driver has wide eyes and a wide open mouth • The driver is screaming • The driver gestures wildly, or the driver moves his head frequently

48. RaterSurprise **As the analyst, how surprised/shocked/interested were you by the video captured during this event?**

a. No heightened level of surprise/shock/interest
b. Somewhat surprised/shocked/interested
c. Very much surprised/shocked/interested
d. Extremely surprised/shocked/interested
e. Unable to determine

49. NoteComments (text): **General Notes/Comments** – include descriptions of any instances where you coded “Unable to determine” or “Other” in the questions above. As well as notes about any other circumstances that help to explain your responses and/or better define the conditions and occurrences of this event. Other notes you should type in include (but are not limited to) when the driver gets out of the vehicle during an event and particularly extreme weather conditions.

A.5 Definition of Eyeglance Locations

Reductionists recorded the drivers' eye glance locations over the duration of each sampled subtask. Eye glance locations were recorded at 10 Hz. The eyeglance locations, with definitions, are listed in Table 37.

Table 37. Definitions of Eyeglance Locations From Reduction Protocol

Keyboard Shortcut	Glance Location	Operational Definition
F	Forward (Center)	Any glance out the forward windshield directed towards the direction of the vehicle's travel. Note that when the vehicle is turning, these glances may not be directed directly forward but towards the vehicle's heading. Count these as forward glances.
D	Left Forward	Any glance out the forward windshield where the driver appears to be looking specifically out the left margin of the windshield (e.g., as if scanning for traffic before turning or glancing at oncoming traffic). This glance location includes anytime the driver is looking out the windshield, but clearly not in the direction of travel (e.g., at road signs or buildings).
G	Right Forward	Any glance out the forward windshield where the driver appears to be looking specifically out the right side of the windshield (e.g., as if scanning for traffic before turning, at a vehicle ahead in an adjacent lane, or reading a road sign). This is often preceded or followed by Left Forward. This glance location includes anytime the driver is looking out the windshield, but clearly not in the direction of travel (e.g., at road signs or buildings).
M	Rearview Mirror	Any glance to the rearview mirror or equipment located around it. This glance generally involves movement of the eyes to the right and up to the mirror. This includes glances that may be made to the rearview mirror in order to look at or interact with back seat passengers.
L	Left Window/Mirror	Any glance to the left side mirror or window.
R	Right Window/Mirror	Any glance to the right side mirror or window
S	Over-The-Shoulder (left or right)	Any glance over either of the participant's shoulders. In general, this will require the eyes to pass the B-pillar. If over the left shoulder, the eyes may not be visible, but this glance location can be inferred from context. NOTE: If it is clear from context that an over-the-shoulder glance is being made NOT to check a blind spot but instead to interact with a rear seat passenger (e.g., food/toy is being handed back), then code the glance as Passenger. If context cannot be known with a high level of certainty, then code as Over-the-Shoulder.
I	Instrument Cluster	Any glance to the instrument cluster underneath the dashboard. This includes glances to the speedometer, control stalks, and steering wheel.
C	Center Stack	Any glance to the vehicle's center stack (vertical).

Keyboard Shortcut	Glance Location	Operational Definition
		Not to be confused with center console (cup holder area between driver and passenger), which is discussed under "Interior Object."
P	Cell Phone (electronic communications device)	Any glance at a cell phone or other electronic communications device (e.g., BlackBerry), no matter where it is located. This includes glances to cell-phone-related equipment (e.g., battery chargers).
H	iPod (or similar)	Any glance at an iPod or other personal digital music device, no matter where it is located
W	Interior Object	Any glance to an identifiable object in the vehicle other than a cell phone. These objects include personal items brought in by the participant (e.g., purse, food, papers), any part of their body that may look at (e.g., hand, ends of hair), electronic devices other than cell phones (e.g., laptop, PDA), and also OEM-installed devices that don't fall into other categories (e.g., door lock, window and seat controls). Glances to the center console (cupholder area between passenger seat and driver seat) will also be included in this category. The object does not need to be in the camera view for a specific frame to be coded with this category. If it is clear from surrounding video that the participant is looking at the object, this category may be used. This category can be used regardless of whether the participant's hands are/aren't visible. NOTE: If the driver is looking at something that the passenger is handing to the driver, code the eyeglance as Passenger, until the object is fully in the driver's hand, then code as Interior Object (unless it's a cell phone, code as Cell Phone). Also, if the driver is looking at something that the passenger is holding (but never hands to the driver), code as passenger glance (not interior object).
A	Passenger	Any glance to a passenger, whether in front seat or rear seat of vehicle. You will need to use context (e.g., they're talking, or handing something) in order to determine this in some situations. NOTE: This does NOT include glances made to rear seat passenger via the rearview mirror. Such glances should be coded as Rearview Mirror. NOTE: If the driver is looking at something that the passenger is handing to the driver, code the eyeglance as Passenger, until the object is fully in the driver's hand, then code as Interior Object (unless it's a cell phone, code as Cell Phone). Also, if the driver is looking at something that the passenger is holding (but never hands to the driver), code as passenger glance (not interior object).
V	No Video	Unable to complete glance analysis because the face video view is temporarily unavailable. NOTE: this sometimes occurs for 1-2 timestamps at a time, and a "video not available" message may appear. If the glance location is the same before and after this occurs and the period is only 1-2

Keyboard Shortcut	Glance Location	Operational Definition
		timestamps long, then code through this period as the glance location present before and after. If the “video not available” period is longer than 2 timestamps OR it occurs during a transition between glance locations, use the “No Video” option.
E	No Eyes Visible-Glance Location Unknown	Unable to complete glance analysis due to an inability to see the driver’s eyes/face. Video data is present, but the driver’s eyes and face are not visible due to an obstruction (e.g., visor, hand), or due to glare. Use this category when there is no way to tell whether the participant’s eyes are on or off the road. This is the default and most often used “unknown” option, but there may be times when the “off road” option listed below may be appropriate.
T	No Eyes Visible. Eyes Are Off-Road	Unable to enter in specific glance location due to an inability to see the driver’s eyes/face. However, it is clear that the participant is not looking at the roadway. Video is present, but the driver’s eyes and face are not visible due to an obstruction (e.g. visor, hand), head position, or due to glare. Use this category when the eyes are not visible, you are not sure what the participant is looking at, but it is obvious that the eyes are not on the roadway.
Z	Eyes Closed	Any time that BOTH the participant’s eyes are closed outside of normal blinking (e.g., the subject is falling asleep or rubbing eyes). As a rule of thumb, if the eyes are closed for five or more syncs (1/2 a second) during a slow blink, code it as Eyes Closed. Otherwise, code it as the glance location present before the eyes closed. If one eye remains open, code the location according to the open eye. If only one eye is visible, code according to the visible eye.
O	Other	Any glance that cannot be categorized using the above codes. Some pre-approved uses of the “other” option are listed below: • When the driver is looking forward, and then looks straight up at the sky as if watching a plane fly by. • When the driver is tilting head back to drink and the eyes leave the forward glance but do not really focus on anything at all.

A.6 Subtask-level Kinematic Data

Kinematic measures were collected at different points along each subtask of interest. The following tables summarize when each variable was collected, expressed as a function of the general use for that variable.

Table 38. Descriptive Kinematic Measures

Variable	SCE Interval	SCE-Baseline Interval	Subtask Interval	Subtask-Baseline Interval
Average Speed	Entire sample	Entire sample	Entire subtask	Entire subtask
Minimum Speed	Entire sample	Entire sample	Entire subtask	Entire subtask
Maximum Speed	Entire sample	Entire sample	Entire subtask	Entire subtask

Table 39. Driving Performance Degradation Measures

Variable	SCE Interval	SCE-Baseline Interval	Subtask Interval	Subtask-Baseline Interval
Average Speed	20 s (-15s to +5s, centered on start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)
Average Speed	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)
Minimum Speed	20 s (-15s to +5s, centered on start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)
Minimum Speed	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)
Maximum Speed	20 s (-15s to +5s, centered on start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)
Maximum Speed	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)
Speed Variance	20 s (-15s to +5s, centered on start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)
Speed Variance	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)
Headway Variance	20 s (-15s to +5s, centered on start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)	20 s (20 s beginning from start of sample)
Headway Variance	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)
Peak Deceleration	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)	10 s (10 s beginning from start of sample)
If the SV changes lanes, does the driver use the turn signal?	10 s (± 5s centered on start of sample)	10 s (± 5s centered on start of sample)	10 s (± 5s centered on start of sample)	10 s (± 5s centered on start of sample)

Table 40. Driver Adaptation Measures

Variable	SCE Interval	SCE-Baseline Interval	Subtask Interval	Subtask-Baseline Interval
Speed	Start of sample 6 s prior to the start of the sample	Start of sample 6 s prior to the start of the sample	Start of subtask 6 s prior to the start of the subtask	Start of subtask 6 s prior to the start of the subtask
Range to LV	Start of sample	Start of sample	Start of subtask	Start of subtask
Range Rate to LV	Start of sample	Start of sample	Start of subtask	Start of subtask
Following Headway	Start of sample	Start of sample	Start of subtask	Start of subtask
TTC	Start of sample	Start of sample	Start of subtask	Start of subtask

A.7 Driver, Vehicle, and Environmental Questions for Safety-Critical Events

Safety-critical events (SCEs) were identified by first identifying through an automated script possible hard braking, hard steering, and close time-to-collision events using the kinematic data that exists in the Cell Phone Pilot database. Then, reductionists reviewed the video for these potential events and validated the events that were true safety-critical events. Some additional events were identified by analysts as video was reviewed during other reduction tasks. All valid events were then confirmed by an expert, and the first phase of reduction (conflict description) was completed at that point. The start and end timestamps for each event were updated based on the conflict information so that each event is now 6 seconds long, with the precipitating (or causative) event occurring after 5 seconds. This protocol provides instructions on how to complete the reduction for environmental and driver-related factors surrounding these events.

Note that the window for analysis (6 seconds) includes 5 seconds of driving before the event begins, and continues for 1 second after the event begins. For this reason, the safety-critical situation is not always completely resolved at the end of the 6 seconds, but the time period of interest for the analysis is limited to the 6 seconds.

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4. Seatbelt: **Driver seatbelt use at Precipitating Event:**
    a. <u>Yes, belt worn</u>
    b. <u>No, belt NOT worn</u>
    c. <u>Unable to determine</u>

5. HHPhoneType: **Type of hand-held phone the driver uses for the majority of the event:**
    a. <u>No hand-held phone used (Skip to Page 2)</u>
    b. <u>Standard keys on front of phone</u>
    c. <u>Vertical flip-phone</u>
    d. <u>Horizontal flip-phone/slide keyboard</u>
    e. <u>Touch screen</u>
    f. <u>BlackBerry/QWERTY on front</u>
    g. <u>Unable to determine</u>

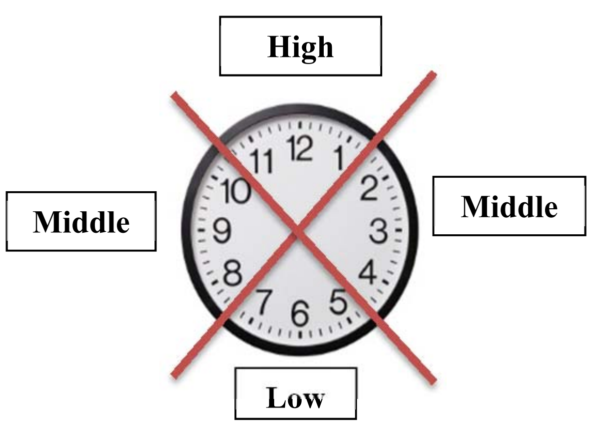
6. PhonePriorLocation: **Location of hand-held phone prior to being reached for (Reaching subtasks only)**: applies only to “HH: Locate/Reach/Answer” subtasks
    o. <u>No hand-held phone used</u>
    p. <u>Reaching for phone does not occur</u> – choose this option if the subtask being coded is an HH task other than “HH: Locate/Reach/Answer” (such as, “HH: Talk/Listen,” “HH: Text,” etc.)
    q. <u>Shirt/Jacket Pocket</u>
    r. <u>Pants Pocket</u>
    s. <u>Cup Holder</u>
    t. <u>on Dash (not in cradle)</u>
    u. <u>Purse (if seen)</u>

v. Passenger Seat
w. In Cradle – usually found attached to dash or windshield
x. Glove Box
y. Center Console Storage
z. Other
aa. Unable to Determine

7. PhoneUseLocation: **Location of hand-held phone during majority of event (not for reaching or ending subtasks):** applies only to "HH: Dial," "HH: View/Browse," "HH: Talk/Listen," "HH: Text," and "HH: Hold" subtasks. See clock diagram of the steering wheel.

a. No hand-held phone used
b. N/A, Reaching or ending HH call – choose this option if the subtask being coded is "HH: Locate/Reach/Answer" or "HH: End Task."
c. In right hand against right ear
d. In left hand against left ear
e. In one hand on steering wheel (low) – 5:00-7:00 on a clock. In both hands resting on steering wheel (low)
f. In one hand resting on steering wheel (middle) – 2:00-4:00 or 8:00-10:00 on a clock. In both hands resting on steering wheel (middle)
g. In one hand resting on steering wheel (high) – 11:00-1:00 on a clock.
h. In both hands resting on steering wheel (high)
i. In one hand raised out in front of forward view
j. In both hands raised out in front of forward window
k. In one hand to side of/in front of steering wheel
l. In both hands to side of/in front of steering wheel
m. In one hand below steering wheel
n. In both hands below steering wheel
o. In one hand placed in front of mouth
p. In both hands placed in front of mouth
q. In right hand against left ear (cross body)
r. In left hand against right ear (cross body)
s. Not in hand – Other

Hand placement on steering wheel diagram



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8. AmbientLighting: **Ambient Lighting at the Precipitating Event:**
   a. Daylight
   b. Dusk – use if the ambient lighting is mostly dark and continues to darken throughout the file. Do not use if it the ambient lighting is daylight, but it is cloudy.
   c. Darkness, lighted – It is nighttime during the subtask, but the roadway is lighted
   d. Darkness, not lighted – It is nighttime during the subtask, and the roadway is NOT lighted
   e. Dawn – use if the ambient lighting is mostly dark and lightens throughout the file. Do not use if it the ambient lighting is daylight, but it is cloudy.
   f. Vehicle is Not Outside
   g. Unable to determine

9. Weather: **Weather conditions at the Precipitating Event:**
   a. No Adverse Conditions – includes cloudy/overcast skies with no visible falling precipitation
   b. Light Rain/Mist
   c. Heavy Rain
   d. Snowing/Sleeting
   e. Fog
   f. Rain + Fog
   g. Snow + Fog
   h. Smoke, Dust - There is smoke and/or dust, either stagnant or blowing, in the air
   i. Other - There is some type of adverse atmospheric condition present, not described in other categories
   j. Unable to Determine

10. RoadSurface: **Road surface condition at the Precipitating Event:**
   a. Dry - There is no foreign material (rain, snow, oil, etc.) on the roadway in the area of the event (nothing on the road to affect the driving task)
   b. Wet - Roadway is completely or partially wet in the area of the event (not snowy, icy, muddy, or oily)
   c. Snowy - There is some amount of unmelted snow or slush on the roadway in the area of the event, enough to affect the driving task (no ice on the road in the area of interest)
   d. Icy - There is some amount of ice on the roadway in the area of the event, enough to affect the driving task
   e. Muddy - There is some amount of mud on the roadway in the area of the event, enough to affect the driving task
   f. Oily - There is some amount of oil, grease, or other slippery fluid on the roadway in the area of the event, enough to affect the driving task
   g. Other - There is some type of foreign substance on the road, not listed in previous categories, enough to affect the driving task
   h. Unable to Determine

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11. TrafficFlow: **Traffic Flow at the Precipitating Event:** Roadway design (including the presence or lack of a median) at the start of the event. If the event starts while the driver is at an intersection, the traffic flow conditions just prior to the intersection should be recorded.
    a. Not divided, standard 2-way traffic way - with or without center line, but without center 2-way turn lane
    b. Not divided, with center 2-way turn lane
    c. Divided - median strip or barrier separates opposite direction
    d. One-way traffic
    e. No lanes – such as a Parking lot, Driveway, etc.
    f. Other
    g. Unable to determine

12. ContigTravelLanes: **TOTAL number of CONTIGUOUS travel lanes present at Precipitating Event, including turn, exit-entrance, and oncoming:** includes the total number of all: lanes in the direction the driver is driving, oncoming lanes, turn lanes, entrance/exit ramps, and lanes with parked vehicles. If the event starts while the driver is at an intersection, the number of lanes just prior to the intersection should be recorded
    a. 0 (No Lanes) - vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7
    i. 8+
    j. Unable to determine

13. NumDirectLanes: **Number of travel through lanes in the DIRECTION OF TRAVEL ONLY at the Precipitating Event:** includes only the total number of lanes in the direction the driver is driving. Do **NOT** include: oncoming lanes, turn lanes, entrance/exit ramps, or lanes with parked vehicles. If the event starts while the driver is at an intersection, the number of lanes just prior to the intersection should be recorded
    a. 0 (No Lanes) – vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7

   i. 8+
   j. Unable to determine

14. StartingLane: **In which of the lanes counted in the question above is the driver traveling at the Precipitating Event? - Note:** Lanes should be counted from **left to right**
    a. Not in through lane
    b. 0 (No Lanes) - vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
    c. 1 (Left-most lane or only lane)
    d. 2
    e. 3
    f. 4
    g. 5
    h. 6
    i. 7
    j. 8+
    k. Unable to determine

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15. RoadAlignment: **Roadway alignment at the Precipitating Event:**
    a. Straight – Road alignment is straight
    b. Curve Left – Road alignment is curved to the left
    c. Curve Right – Road alignment is curved to the right
    d. Unable to determine

16. RoadGrade: **Roadway grade at the Precipitating Event:**
    a. Level
    b. Grade Up – profile of road is graded, and vehicle is going up a hill
    c. Hillcrest – vehicle is at a hillcrest (area of transition between an upgrade and a downgrade)
    d. Grade Down – profile of road is graded, and vehicle is going down a hill
    e. Dip – vehicle is in a dip
    f. Unable to determine

17. Locality: **Locality at the Precipitating Event:**
    a. Interstate/bypass/divided highway with no traffic signals
    b. Bypass/divided highway with traffic signals
    c. Business/industrial - Vehicle passes any type of business or industrial structure
    d. Open country - Other than the roadway, there is nothing visible that is described in any of the other categories
    e. Residential - Vehicle passes at least one house or evidence of a residential neighborhood but does not drive through a business or industrial area.
    f. Construction zone - Vehicle is in a construction zone (construction equipment, barrels, etc. are visible) *(This category takes precedence over others)*

g. School - Vehicle passes any type of school building, including adult learning institutions *(This category takes precedence over others)*
h. Church *(This category takes precedence over others)*
i. Playground - Vehicle passes any type of playground or children's playing field *(This category takes precedence over others)*
j. Other - Locality is one not described in other categories
k. Unable to determine

18. TrafficDensity: **Traffic density at the Precipitating Event:**

a. N/A – Stopped at Intersection
b. LOS A1: Free flow – No leading traffic in any lane – Subject driver is unaffected in the traffic stream because there are no leading vehicles in any lane. Freedom to select desired speeds and to maneuver within the traffic stream is at the highest level possible.
c. LOS A2: Free flow – Leading traffic present in at least one lane - Individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.
d. LOS B: Flow with some restrictions - In the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.
e. LOS C: Stable flow, maneuverability and speed are more restricted - In the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.
f. LOS D: Unstable flow - temporary restrictions substantially slow driver - High-density, but stable flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.
g. LOS E: Flow is unstable, vehicles are unable to pass, temporary stoppages, etc. - Operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

h. LOS F: Forced traffic flow, low speeds, traffic volumes below capacity - Forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more then be required to stop in a cyclic fashion. LOS F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow, which causes the queue to form, and LOS F is an appropriate designation for such points.
i. Unable to determine

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19. LVPresent: **Is there a lead vehicle traveling in the same lane at the Precipitating Event?**
   a. Yes
   b. No (Skip to Page 6)
   c. Unable to determine

20. LVObjectID (text): **What is the object ID of the lead vehicle reported by the radar at the Precipitating Event?**
   - If there is a lead vehicle reported by the radar, enter the Object ID
   - If radar data is not available, enter "N/A"
   - If unsure, enter "Unable to determine"

21. LVActualRange (text): **What is the X-Range to the lead vehicle reported by the radar at the Precipitating Event?**
   - If there is a lead vehicle reported by the radar, enter the X_Range
   - If radar data is not available, enter "N/A"
   - If unsure, enter "Unable to determine"

22. LVEstRange: **Estimate the range to the lead vehicle at the Precipitating Event:**
   a. Far (Greater than 40 m or 3 standard lane markings away)
   b. Medium (Between 12 and 40 m or 1-3 standard lane markings away)
   c. Close (Less than 12 m or 1 standard lane marking away)
   d. Unable to determine
   e. N/A (No lead vehicle)

Lead Vehicle Range Estimate Diagrams

***Standard lane markings are 10 ft. long, and the distance between each one is 30 ft. Thus, from the start of one standard marking to the start of the next is 40 feet or about 12 meters. Non-standard lane markings (such as during a merge or delineating a turn lane) have different measurements and cannot be used in this manner.

Close (Less than 14 m on radar, or just over one standard lane marking)

Medium (14 to 40 m on radar or 1-3 standard lane markings)

Far (Greater than 40 m on radar or more than 3 standard lane markings)

23. LVActualRate (text): **What is the relative X-velocity of the lead vehicle reported by the radar at the Precipitating Event?**
- If there is a lead vehicle reported by the radar, enter the X_Velocity
- If radar data is not available, enter "N/A"
- If unsure, Enter "Unable to determine"

24. LVEstRate: **Estimate the closing rate to the lead vehicle at the Precipitating Event:**

a. Distance Rapidly Increasing
b. Distance Increasing
c. Distance Constant
d. Distance Closing
e. Distance Rapidly Closing
f. Unable to determine
g. N/A (No lead vehicle)

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25. SVLaneChange: **Does the subject driver CHOOSE to change lanes during the 10-second time interval before the Precipitating Event?** This 10-second time interval includes 5 seconds before the start of the event to 5 seconds after the start of the event.

a. No - driver does not change lanes, OR any lane change performed is forced by lane closure, merging requirements, or turn lane movements
b. Yes, planned lane change – driver changes lanes based on a choice to travel in a different lane. This does **NOT** include when the driver makes required merges (such as merging onto/off of a highway, moving into a turn lane, or lanes ending/beginning – all of which should be answered "No".)
c. Yes, evasive/unplanned lane change – driver changes lanes in order to avoid an accident, or an animal/object/pedestrian in the forward roadway
d. Unable to determine

26. SVTurnSignal: **If driver changes lanes as above, does he/she use the turn signal?**

a. Driver does not change lanes
b. Yes
c. No
d. Unable to determine

27. RVPresent: **Is there a trailing rear vehicle traveling in the same lane as the driver at the Precipitating Event?**

a. Yes
b. No (Skip to Page 7)
c. Unable to determine

28. RVEstRange: **Estimate the range to the rear vehicle at the Precipitating Event:**

a. Far (Greater than 40 m or 3 standard lane markings away)
b. Medium (Between 12 m and 40 m or 1 to 3 standard lane markings away)
c. Close (Less than 12 m or 1 standard lane marking away)
d. Unable to determine
e. N/A (No rear vehicle)

Rear Vehicle Range Estimate Diagrams

***Standard lane markings are 10 ft. long, and the distance between each one is 30 ft. Thus from the start of one standard marking to the start of the next is 40 feet or about 12 meters. Non-standard lane markings (such as during a merge or delineating a turn lane) have different measurements and cannot be used in this manner.

Close (Less than14 m or just over one standard lane marking)

Medium (14 to 40 m or 1-3 standard lane markings)

Far (Greater than 40 m away or more than 3 standard lane markings)

29. RVEstRate: **Estimate the closing rate of the rear trailing vehicle at the Precipitating Event:**

a. Distance Rapidly Increasing
b. Distance Increasing
c. Distance Constant

d. Distance Closing
e. Distance Rapidly Closing
f. Unable to determine
g. N/A (No rear vehicle)

30. RVLaneChange: **Does the rear trailing vehicle change lanes to pass the subject vehicle within 10 seconds before the Precipitating Event?** This 10-second time interval includes 5 seconds before the start of the event to 5 seconds after the start of the event.

a. Yes, Rear Vehicle Moves to Pass (PLANNED) – Rear vehicle changes lanes based on a choice to travel in a different lane or in order to drive at a faster speed than the subject. This does **NOT** include when the rear vehicle makes required merges (such as merging onto/off of a highway, moving into a turn lane, or lanes ending/beginning – all of which should be answered “No”).
b. Yes, Rear Vehicle Moves to Pass (EVASIVE) - rear vehicle changes lanes in order to avoid an accident, or an animal/object/pedestrian
c. No – rear vehicle does not change lanes, OR any lane change performed is forced by lane closure, merging requirements, or turn lane movements
d. Unable to determine
e. N/A (No rear vehicle)

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31. RelationToJunction**: Relation to junction at the Precipitating Event:**

l. Non-junction – Subject vehicle is not close to a junction (the area formed by the connection of two roadways)
m. Intersection – Subject vehicle is at or within 1 car length (~20 feet) of an intersection (roads cross at the same grade)
n. Intersection-related – Subject vehicle is within 3 car lengths (~60 feet) of an intersection (where roads cross at the same grade), either approaching or exiting the intersection
o. Interchange area – Subject vehicle is within the boundaries of an interchange with exit and/or entrance ramps present (a road junction that typically utilizes grade separation and one or more ramps to permit traffic on at least one road to pass through the junction without crossing any other traffic stream)
p. Entrance ramp – Subject vehicle is on or entering/exiting an entrance ramp (a transition roadway connecting two roadways or used for entering through-traffic lanes)
q. Exit ramp – Subject vehicle is on or entering/exiting an exit ramp (a transition roadway connecting two roadways or used for exiting through-traffic lanes)
r. Driveway, alley access, etc. – Subject vehicle is on or entering/exiting a driveway, alley, or some other roadway providing access to property adjacent to the traffic way
s. Rail grade crossing – Subject vehicle is close to the at-grade connection of a railroad bed and roadway
t. Parking lot – subject vehicle is within the boundaries of a parking lot

u. Other – subject vehicle is related to a junction in a manner not described in other categories. This includes tunnels, toll booths, and bridges
v. Unable to determine

32. TrafficControlDevice: **Traffic control device (if any) in effect at the Precipitating Event:**

q. No traffic control - There is no traffic control applicable to the subject vehicle at the time of the event
r. Traffic signal - A traffic signal (by colors or flashing) is controlling some aspect of the traffic flow applicable to the subject vehicle
s. Stop sign
t. Yield sign
u. Construction signs/warnings
v. Slow or warning sign, other
w. School-zone related sign
x. Officer or watchman/traffic guard
y. Traffic lanes marked - There are markings on the road that contain information or warnings applicable to the driving task for the subject vehicle (use if NO other types of devices/signs are used to convey the same information). Does not include Railroad crossings (see below).
z. No passing signs
aa. One-way road or street
bb. Railroad crossing with markings or signs - A railroad crossing with associated signage (including markings on the road, signs, cross bucks) is controlling some aspect of traffic flow applicable to the subject vehicle
cc. Railroad crossing with signals - A railroad crossing with associated signals (including flashing lights, traffic lights) is controlling some aspect of traffic flow applicable to the subject vehicle
dd. Railroad crossing with gate and signals - A railroad crossing with associated gate(s) with or without signals (including flashing lights, traffic lights) Is controlling some aspect of traffic flow applicable to the subject vehicle
ee. Other - There is some type of traffic control device, not described in previous categories, controlling some aspect of traffic flow applicable to the subject vehicle
ff. Unable to determine

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33. IntersectionPresent: **What is the first type of intersection entered within 10 seconds centered on the Precipitating Event?** This 10-second time interval includes the start of the event to 10 seconds after the start of the subtask (5 seconds after the precipitating event).

g. No Intersection Entered – Skip to Page 9 – if this option is selected, SKIP to question 36 on page 9 of the question annotation
h. Signalized – subject's path through intersection is controlled by a stoplight only
i. Stop sign – subject's path through intersection is controlled by a stop sign only
j. Yield sign – subject's path through intersection is controlled by a yield sign only

k. Uncontrolled – subject's path through intersection is not controlled by any means (no signs nor stoplights)
l. Unable to determine

34. IntersectionScan1: **For the intersection coded above, does the driver appropriately scan for traffic PRIOR to entering the intersection?** Proper scanning consists of gazing to roadway junctions and NOT driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right is required; for a right 3-way intersection, a glance to the right is required; for a left 3-way intersection, a glance to the left is required, etc. These glances are required regardless of traffic control status (traffic light color, etc.).

e. Yes, driver scans appropriately
f. No, driver does not scan
g. Unable to determine
h. N/A - No intersection entered

35. IntersectionViolate: **What stopping behavior is exhibited at the intersection coded above?** (use the unit converter to convert to miles per hour)

h. Stop not required
i. Proper stop performed
j. Rolling stop (minimum speed <15 mph, but greater than 0)
k. Complete stop, but past the stop bar/sign AND in path of cross traffic
l. No stop when stop required (minimum speed is >=15mph)
m. Unable to determine
n. N/A - No intersection entered

36. IntersectionScan2: **If the driver stops as first in queue at a light at the intersection coded above BEFORE the Precipitating Event, does he/she scan within 6 seconds of when the vehicle starts moving?** Proper scanning consists of gazing to roadway junctions and NOT driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right is required; for a right 3-way intersection, a glance to the right is required; for a left 3-way intersection, a glance to the left is required, etc. These glances are required regardless of traffic control status (traffic light color, etc.).

g. N/A, Driver stops after precipitating event (skip to Page 9)
h. N/A, driver does not stop (skip to Page 9)
i. N/A, driver stops, but not first in queue at light (skip to Page 9)
j. Yes, driver scans before moving
k. No, driver does not scan before moving
l. Unable to determine
m. N/A - No intersection entered (skip to Page 9)

34. IntersectionPhone: **If SV was stopped at intersection as in above question, did subject complete all complex cell phone subtasks before the vehicle started moving.**

a. N/A, Cell phone use does not occur while vehicle is stopped.
b. N/A, Cell phone use while stopped is limited to Holding/wearing or Talking only

c. No, Complex cell phone subtasks (other than holding/wearing/talking) continue after vehicle starts moving
d. Yes, all complex cell phone subtask(s) completed before vehicle starts moving.
e. Unsure

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35. NumLaneBust (text): **Number of unintentional lane busts occurring during this event** – enter the total number of unintentional lane busts that occur during the entire event. Do NOT count intentional lane busts (such as when the driver must swerve to avoid an accident or an animal/object/pedestrian in the road, etc.). If there are no unintentional lane busts, enter "0" and skip to Page 10.

36. BeginLaneBust1 (text): **Begin timestamp of FIRST lane bust** – enter the timestamp of the beginning of the first lane that occurs during this event. The timestamp can be found in the Collection Navigator at the lower, right-hand side of Hawkeye.

37. BeginLaneBust2 (text): **Begin timestamp of SECOND lane bust** – enter the timestamp of the beginning of the second lane that occurs during this event.

38. BeginLaneBust3 (text): **Begin timestamp of THIRD lane bust** – enter the timestamp of the beginning of the first third bust that occurs during this event.

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39. SecondaryTask1: **Secondary Task 1** – Indicate any secondary tasks (up to 3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

40. SecondaryTask2: **Secondary Task 2** – Indicate any secondary tasks (up to 3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

41. SecondaryTask3: **Secondary Task 3** – Indicate any secondary tasks (up to 3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

42. SecondaryTaskDesc (textbox): **Define/Describe OTHER tasks above** – For any secondary tasks listed as "other," "unknown," "other device," "reaching for object: other," or "holding object: other" above, provide a description. Also use this space to further explain anything unusual about the list distractions.

43. BothHandsOff: **If cell phone use is listed above, does the driver take both hands off the steering wheel during the cell phone task(s) that occur within the 6-second window?**

a. N/A - No cell use listed above
b. No, at least one hand is on the wheel for all cell use
c. Yes, both hands off wheel at least once during cell use

Secondary Task	Description
No Secondary Task	There are no observable signs of driver distraction
Lost in thought	Driver performs multiple non-specific eye glances within 6-second period of time (not focusing on objects of glances), or appears to be in a daze resulting in potential conflict.
Looked but did not see	Driver is looking right at (or looks at) where incident occurs, but shows no reaction. Often seen when blind spot is checked, but vehicles present are not seen.
Cell Hand-Held: Locate/Reach/Answer	When the driver looks for or reaches towards his/her hand-held cell phone or manipulates it to answer a call.
Cell Hand-Held: Talk/Listen/Voice Commands	When a driver is talking on a hand-held phone or has the phone up to his/her ear as if listening to a phone conversation or waiting for a person they are calling to pick up the phone. **NOTE:** If the driver uses the speaker phone function on a hand-held cell phone: Code as "HH: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function. Code as "PHF: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.
Cell Hand-Held: Dialing	When the driver is pressing buttons or interacting with a touch screen on a hand-held cell phone in order to dial a phone number to make a call. This can include dialing, searching for a contact's number, entering a voice mail password, etc. **NOTE**: This does NOT include pressing a button to answer a call (coded as "HH: Locating/Reaching/Answering") or pressing a button to end a call (coded as "HH: End Task"). **NOTE**: Additionally, "HH: Dialing" does NOT include pressing buttons or interacting with a touch screen in order to type/read a text message (which should be coded as "HH: Text messaging" if driver types or "HH: Viewing/Browsing/Reading" if driver reads) or browse the Internet/use phone applications (which should be coded as "HH: Viewing/Browsing/Reading").
Cell Hand-Held: Text messaging	When a driver is pushing buttons or interacting with a touch screen on a hand-held cell phone in order to type a text message. **NOTE:** This does not include reading a text message, which should be coded as "HH: Viewing/Browsing/Reading."

Secondary Task	Description
Cell Hand-Held: Viewing/Browsing/Reading	When the driver views the hand-held cell phone display with or without pressing buttons or manipulating the touch screen for a purpose other than making/receiving a call or sending a text message. Examples include: when the driver uses the cell phone to check time, read a received text message, browse the Internet or email, or use the phone's other applications. **NOTE:** If any viewing and/or button manipulation is seen and there is NO record of a call being made/received/ended or a text being sent, then use this category. Reading a received text message would be coded using this category. **NOTE**: Exceptions to this rule: #1 - When a call is ending, code as "HH: End Task" if the driver looks at the phone and/or presses a button to end a call. #2 - When a call is being answered, any glances or associated button presses should be coded as "HH: Locate/Reach/Answer."
Cell Hand-Held: Holding	When the driver holds a hand-held cell phone in his/her hand but does not interact with it. It does NOT count as holding if the phone is resting on the driver's seat (next to or between legs), or on the driver's lap (both of which would end the cell phone interaction and be coded as no cell phone task). **NOTE (The 5-Second Rule):** If the subject is viewing, dialing, or performing another task with a hand-held phone, then holds the phone without visually or manually interacting with it for at least 5,000 consecutive timestamps (or 5 consecutive seconds), this "break" period should be coded as "HH: Holding." If the driver resumes another (or the same) subtask before the 5-consecutive-second period ends, do NOT code "HH: Holding." Rather, continue to code as the initial task until a new task begins. NOTE: Holding is assumed in all other hand-held subtasks ("HH:…") and does not need to be coded simultaneously with any other hand-held task. <u>However, if the phone is being held during any Portable Hands Free (PHF) or Integrated Hands Free (IHF) tasks, then "HH: Holding" would need to be simultaneously coded.</u>
Cell Hand-Held: End Task	When the driver completes a specific cell phone objective by either pressing a button to end the call, putting the phone down after ending a call or text, or flipping/sliding the phone closed after ending a call or text.
Cell Integrated Hands-Free: Press Button to Begin/Answer	When the driver presses a button on the steering wheel or center stack in order to begin a cell phone interaction. This can include pushing to answer a call, pushing to voice dial, or pushing to enter a voice command.
Cell Integrated Hands-Free: Talk/Listen/Voice Commands	When a driver talks, listens, or gives voice commands on an integrated device. Driver must be observed talking repeatedly with no obvious passenger interaction. Additionally, this option should only be used when the cell records indicate that the driver has made or received a call

Secondary Task	Description
	on an integrated hands-free device.
Cell Integrated Hands-Free: Press button to end	When the driver presses the button on the steering wheel or center stack in order to end the cell phone interaction.
Cell Portable Hands-Free: Locate/Put-on Headset/Earpiece	When the driver looks for or reaches towards a headset or earpiece. If more than one task occurs (i.e., driver looks for earpiece, reaches for it and then puts it in his ear), the first frame number would be the start of the first task (reaching for earpiece) and the last frame number coded would be the end of the last task (i.e., placing earpiece in ear).
Cell Portable Hands-Free: Holding/Wearing Headset/Earpiece	When a driver is holding a headset/earpiece in his/her hand or wearing it on his/her head but not interacting with it (and not involved in a phone conversation). Also code as "PHF: Hold/Wearing" if the driver has been holding the earpiece/headset in his/her hand(s) for some time and finally moves to put it on. It does NOT count as holding if the headset/earpiece is resting on the driver's seat (next to or between legs), or on the driver's lap. **NOTE**: If the subject is talking/listening on a portable hands-free device or performing another task with a hand-held phone or portable hands-free device, then holds the headset/earpiece in hand or on his/her head without interacting for at least 5 consecutive seconds, this "break" period should be coded as "PHF: Hold/Wear Headset/Earpiece." If the driver resumes another task before the 5-consecutive-second period ends, do NOT code "PHF: Hold/Wear Headset/Earpiece." **NOTE**: While coding PHF: Talk/Listen, do NOT intersperse PHF: Hold/Wear unless is it clear that a phone call has ended. The driver may stop talking for periods of time (including breaks longer than 5 seconds) to listen to the conversation. This should be coded straight through as PHF: Talk/Listen. **NOTE:** Holding/wearing headset or earpiece is assumed in all other Portable Hands Free ("PHF:…") subtasks and does not need to be coded simultaneously with any other PHF task. <u>However, if a headset/earpiece is being held or worn during any Hand-Held (HH) or Integrated Hands Free (IHF) tasks, then "PHF: Holding/Wearing" would need to be simultaneously coded.</u>
Cell Portable Hands-Free: Push Button to Begin/Answer	When the driver presses a button on the headset/earpiece in order to begin a cell phone interaction. This can include pushing to answer a call or pushing to give a voice command to make a call. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone. **NOTE:** If instead of pushing a button on the headset/earpiece to answer or make a call, the driver pushes a button or dials on a hand-held phone, this would be coded as "HH: Dialing" or "HH: Locate/Reach/Answer,"

Secondary Task	Description
	even if the subsequent conversation takes place via a portable hands-free device.
Cell Portable Hands-Free: Talk/Listen/Voice Commands	When a driver is talking on a headset, earpiece, or other aftermarket device, OR listening to a phone conversation, OR waiting for a person they are calling to pick up the phone. Driver must be observed talking repeatedly with no obvious passenger interaction to conclude that the headset/earpiece is in use. **NOTE:** This subtask should be coded if the talking subtask is performed on a portable hands-free device, even if the dialing, answering, or call-ending subtasks are performed using a hand-held phone. **NOTE:** If the driver uses the speaker phone function on a hand-held cell phone: Code as "Hand-Held: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function. Code as "Portable Hands-free: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.
Cell Portable Hands-Free: Push Button to End	When the driver presses the button on the headset/ear piece in order to end the cell phone interaction. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone. **NOTE:** If instead of pushing a button on the headset/earpiece to end a call, the driver pushes a button on a hand-held phone, this would be coded as "HH: End Task," even if the conversation took place via a Portable Hands-free device.
Cell Phone Navigation	When the driver is using the navigation feature of a hand-held cell phone. Is is not entirely clear what this will look like, but it may occur when the phone is in a cradle on the dash, or when the driver is clearly using the phone for turn-by-turn navigation purposes.
Cell Other Cell Phone Task	When a driver is interacting with a hand-held cell phone, portable hands-free device, or integrated hands-free device in some manner not described in previous categories. This includes, but is not limited to, the following: • When the driver plugs a hand-held phone into a power charger. • When the subject is playing with a hand-held phone or portable hands-free device, or fiddling with them without any purposeful manipulation. • When the subject puts a hand-held cell phone into a case after holding it in his/her hand for 5 or more consecutive seconds after other HH tasks have ended. Includes reaching for the separate case, maneuvering phone into the case, and then putting it down or holding it (coded as holding if longer than 5 seconds).

Secondary Task	Description
	NOTE: If subject must remove a hand-held cell phone from the case before using it, code as “HH: Locating/Reaching/Answering.” If the subject is putting the phone back INTO case immediately following a call or text, code it as “HH: End Task.” If the subject is putting the phone back INTO a case after “HH: Holding,” code as “Other Cell Phone Task.”
Talking/singing/dancing (w/o passenger or cell)	Driver is moving lips as if in conversation or singing a song. Also use if driver is moving his/her arms, head, or other body part in time with the beat of music Mark this if driver is talking or singing or dancing and there is no obvious passenger component (either passenger is clearly not present or the driver is not looking in the direction of a passenger seat and does not turn head as if communicating with someone).
Reading/Writing	Driver is reading or writing on material that is in the vehicle, but not a part of the vehicle (i.e., not reading external signs, or radio display). This could be reading or writing on directions, paper material, packaging. If reading a phone number, record as dialing cell phone.
Cognitive, other	Driver is emotionally upset or angry, or engaged in another activity not included in other categories, that requires the driver to obviously be thinking about something other than driving Details about condition or emotional state should be specified in the appropriate questions.
Interacting with passenger	A passenger is visible or not visible, but the driver is clearly interacting with a passenger in either the adjacent or rear seat. This could be talking, listening, reacting to (e.g., laughing), moving toward or away from the passenger (i.e., reaching for the passenger, or avoiding a pat from the person).
Moving object in vehicle	An object inside the vehicle is in motion and causes the driver to look away from the driving task, either due to the motion of the vehicle or due to another passenger throwing the object. (Ex. object fell off seat when driver stopped hard at a traffic light)
Insect in vehicle	Interaction with any insect in the vehicle (e.g., swatting at insect, moving body to avoid insect, looking around trying to locate insect)
Pet in vehicle	Any interaction with pet, including petting, talking to, or moving pet or interacting with pet carrier. Only code if animal/pet is visible at some point in the trip file or if there is history/context with the driver and the driver is exhibiting behaviors that are appropriate to having a pet in the vehicle
Object dropped by driver	Driver is holding something and it drops and the driver then picks it back up This category supersedes other "reaching" categories in the situation of an object being dropped and immediately retrieved

Secondary Task	Description
Reaching for object, other	Driver reaches for an object not described in any other category. Once the driver has finished reaching for the object and has it in hand (if not being moved for intended usage), then it becomes "object in vehicle, other," as long as it doesn't fit into any of the other categories (e.g., eating, drinking, etc.)
Holding object, other	Driver is holding an object not described in other categories. Could be food, drink, pen, paper, etc. Must continue for at least 5 seconds without other manipulations. If less than 5 seconds, code as previous task (e.g., reaching for object, personal hygiene).
Object in vehicle, other	Driver clearly is looking at, handling, or manipulating an object (visible or not) or thing located in the vehicle, other than those listed in other categories
Operating other electronic device	Driver is manipulating some non-manufacturer-installed electronic device (PDA, laptop, mp3 player, etc.) either by pressing buttons, viewing, opening/closing, plugging in, etc. Reaching for this object should be coded as "Reaching for object, other"
Adjusting radio or HVAC	Driver interacts with climate control or radio either by touching the buttons on the center stack, dashboard, or steering wheel, or glancing at the controls. Includes inserting/retrieving CDs and adjusting vents.
Adjusting/monitoring other devices integral to vehicle	Driver interacts with a manufacturer-installed device other than those listed in other categories, either by touching or glancing at the device. Includes interaction with seat belt, door locks, sun visor, etc. Does NOT include interacting with driving-critical tasks such as turn signal, headlights, gear shift, and windshield wipers.
Looking at non-driving related external object/event	Driver is looking outside of the vehicle in the direction of what is obviously an object or incident that is not related to the driving task. May include looking at an accident, aspects of construction sites/zones, animals/pedestrians that are not in or entering the path of travel. Only mark if it is clear that the driver is tracking a specific external distraction as he/she drives by. Other non-specific or driving-related glances should be coded as "Driving-related inattention to forward roadway"
Eating/drinking	Driver has food or drink that will be put in his/her mouth with or without the use of a utensil. If driver is chewing (except gum) also code as Eating/drinking. If driver is simply holding food or drink for 5 or more seconds, code as Holding Object: Other
Smoking/tobacco	Lighting, smoking, or extinguishing cigar or cigarette. Also includes use of chewing tobacco or holding a lit cigarette. Reaching for tobacco products should be coded "Reaching for object: other"
Personal hygiene	Includes applying make-up (including lotion/chapstick), checking self in mirror, purposefully fixing/brushing hair, shaving, tweezing, brushing/flossing teeth, putting on/removing/adjusting jewelry (including watches), putting on/removing/adjusting contacts or glasses. Reaching for hygiene-related items should be coded as "Reaching for object: other" Does not include swiping hair from eyes or quick/thoughtless rubbing/scratching, twirling hair.

Secondary Task	Description
Driving-related inattention to forward roadway	Driver glances away from the direction of travel out a window or at a side or center mirror for a driving-related issue (i.e., changing lanes, crossing through an intersection). ***Exception:*** if the vehicle is backing and the driver is looking out of the left window to see the road in the direction of travel, this is not coded as a distraction.
Other Secondary Task (define in text box)	Driver is looking in a location other than the direction of travel, in a manner not listed in other categories.
Unknown	Can't tell or make a judgment whether there is a distraction Ex. Part of the video is missing or there is insufficient information in the video to make a determination

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44. DriverExpectation: **If an external incident occurs within the 6-second window, describe the driver's reaction to it:** An external incident is anything unexpected or out of the ordinary that presents a safety hazard.

g. <u>No external event occurs</u>
h. <u>Fully expects, drives appropriately/reacts in a timely manner</u>
i. <u>Somewhat caught off guard, but quickly reacts in appropriate manner</u>
j. <u>Very much caught off guard, has a delayed reaction (~ > 0.75 s or 750 timestamps)</u>
k. <u>Extremely caught off guard, does not react at all</u>
l. <u>Unable to determine</u>

45. Emotion: **Prior to any external incident noted above, rate the driver's emotional state during the 6-second window:**

h. <u>Neutral/No Emotion Shown</u>
i. <u>Happy</u>
j. <u>Angry/Frustrated/Impatient</u>
k. <u>Sad</u>
l. <u>Surprised</u>
m. <u>Other</u> (Could be Concerned/Opinionated/Apologetic/Guilt/Contempt)
n. <u>Unable to determine</u>

Driver Emotion Reaction Definitions

Emotion	Operational Definition
Unable to Determine	• Cannot tell what emotion the driver is showing
Neutral/No Emotion Shown	• The driver has a straight face, does not smile or laugh, does not gesture
Happy	• The driver smiles or laughs • The driver gestures in excitement
Angry/Frustrated	• The driver lowers/squeezes eyebrows, wrinkling forehead • The driver clenches his/her teeth • The driver yells (opens mouth wide with eyebrows lowered)

Emotion	Operational Definition
	• The driver gestures in anger/frustration • The driver raises his/her upper lip or tightens lips
Sad	• The driver has droopy eyebrows (raises inner eyebrows, lowers outer eyebrows) • The driver frowns by lowering the outer corners of his/her lips
Surprised	• The driver's eyebrows raise • The driver's mouth opens • The driver gestures
Other	• Emotional reaction that does not fit into any other category

46. EmotionIntensity: **Prior to any external incident noted above, rate the intensity of the driver's emotional state during the 6-second window:**

f. Neutral/No Emotion Shown
g. Slight (Emotion Somewhat Shown)
h. Marked or Pronounced (Emotion Very Much Shown)
i. Severe (Emotion Extremely Shown)
j. Unable to determine

Driver Emotional Intensity Reduction Definitions

Intensity of Emotion	Operational Definition
Unable to Determine	• Cannot tell the intensity of the emotion
Neutral/No Emotion Shown	• The driver has a straight face, does not smile or laugh, does not gesture • Note: will always be selected if Neutral/No Emotion is selected above
Slight (Emotion Somewhat Shown)	• The driver no longer has a straight face • However, no gesturing or head movement is observed
Marked or Pronounced (Emotion Very Much Shown)	• The driver no longer has a straight face • The driver gestures one time in a reserved manner • The driver moves his head one time
Severe (Emotion Extremely Shown)	• The driver has wide eyes and a wide open mouth • The driver is screaming • The driver gestures wildly, or the driver moves his head frequently

47. RaterSurprise **As the analyst, how surprised/shocked/interested were you by the video captured during this event?**

f. No heightened level of surprise/shock/interest
g. Somewhat surprised/shocked/interested
h. Very much surprised/shocked/interested
i. Extremely surprised/shocked/interested
j. Unable to determine

48. NoteComments (text): **General Notes/Comments** – include descriptions of any instances where you coded "Unable to determine" or "Other" in the questions above. As well as notes about any other circumstances that help to explain your responses and/or better define the conditions and occurrences of this event. Other notes you should type in include (but are not limited to) when the driver gets out of the vehicle during an event and particularly extreme weather conditions.

A.8 Characterization of Safety-Critical Events

Event Nature	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Conflict with a lead vehicle	153 (37%)	3 (75%)	0 (0%)	20 (28%)	130 (49%)	0 (0%)
Conflict with vehicle in adjacent lane	74 (18%)	0 (0%)	0 (0%)	27 (38%)	47 (18%)	0 (0%)
No known conflict (non-conflict incidents)	72 (17%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	71 (100%)
Conflict with animal	20 (5%)	1 (25%)	0 (0%)	1 (1%)	18 (7%)	0 (0%)
Conflict with vehicle turning across another vehicle path (opposite direction)	15 (4%)	0 (0%)	0 (0%)	2 (3%)	13 (5%)	0 (0%)
Conflict with merging vehicle	13 (3%)	0 (0%)	0 (0%)	4 (6%)	9 (3%)	0 (0%)
Conflict with vehicle turning into another vehicle path (same direction)	13 (3%)	0 (0%)	0 (0%)	3 (4%)	10 (4%)	0 (0%)
Conflict with pedestrian	13 (3%)	0 (0%)	0 (0%)	2 (3%)	11 (4%)	0 (0%)
Conflict with vehicle moving across another vehicle path (through intersection)	11 (3%)	0 (0%)	0 (0%)	3 (4%)	8 (3%)	0 (0%)
Conflict with oncoming traffic	8 (2%)	0 (0%)	0 (0%)	4 (6%)	4 (2%)	0 (0%)
Conflict with obstacle/object in roadway	8 (2%)	0 (0%)	2 (100%)	3 (4%)	3 (1%)	0 (0%)
Conflict with a following vehicle	6 (1%)	0 (0%)	0 (0%)	1 (1%)	5 (2%)	0 (0%)
Conflict with pedalcyclist	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)
Single-vehicle conflict	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Conflict with vehicle turning across another vehicle path (same direction)	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Conflict with parked vehicle	1 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Conflict with vehicle turning into another vehicle path (opposite direction)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unknown conflict	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Number of Vehicles/Non-Motorists Involved	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
0	100 (24%)	1 (25%)	2 (100%)	5 (7%)	21 (8%)	71 (100%)
1	300 (73%)	3 (75%)	0 (0%)	64 (89%)	233 (88%)	0 (0%)
2	11 (3%)	0 (0%)	0 (0%)	3 (4%)	8 (3%)	0 (0%)
3	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
5 or more	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Vehicle Type	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Automobile	139 (34%)	3 (75%)	0 (0%)	33 (46%)	103 (39%)	0 (0%)
Not applicable	75 (18%)	0 (0%)	0 (0%)	1 (1%)	3 (1%)	71 (100%)
Sport utility vehicle	75 (18%)	0 (0%)	0 (0%)	18 (25%)	57 (22%)	0 (0%)
Van (minivan or standard van)	27 (7%)	0 (0%)	0 (0%)	5 (7%)	22 (8%)	0 (0%)
Pickup truck	26 (6%)	0 (0%)	0 (0%)	2 (3%)	24 (9%)	0 (0%)
Animal	20 (5%)	1 (25%)	0 (0%)	1 (1%)	18 (7%)	0 (0%)
Pedestrian	13 (3%)	0 (0%)	0 (0%)	2 (3%)	11 (4%)	0 (0%)
Tractor-trailer: Enclosed box	10 (2%)	0 (0%)	0 (0%)	3 (4%)	7 (3%)	0 (0%)
Object	6 (1%)	0 (0%)	2 (100%)	3 (4%)	1 (0%)	0 (0%)
Unknown vehicle type	4 (1%)	0 (0%)	0 (0%)	2 (3%)	2 (1%)	0 (0%)
Single-unit straight truck: Box	3 (1%)	0 (0%)	0 (0%)	2 (3%)	1 (0%)	0 (0%)
Single-unit straight truck: Dump	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)
Pedalcyclist	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)
Tractor-trailer, other	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
Greyhound bus	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Single-unit straight truck: Multistop/step van	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Tractor only	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Tractor-trailer: Flatbed	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Tractor-trailer: Multiple box	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Other large construction equipment	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Other vehicle type	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
School bus	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Transit bus	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Conversion bus	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck: Garbage/recycling	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck: Concrete mixer	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck: Beverage	0(0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck: Flatbed	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck: Tow truck	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck, other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Single-unit straight truck, unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Straight truck + trailer	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Tractor-trailer: Livestock	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Tractor-trailer: Lowboy trailer	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Vehicle Type	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Tractor-trailer: Dump trailer	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Tractor-trailer: Multiple grain	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Motorcycle or moped	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Ambulance	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fire truck/car	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Police	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Precipitating Event	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Other vehicle ahead - decelerating	81 (20%)	0 (0%)	0 (0%)	7 (10%)	74 (28%)	0 (0%)
Other event not attributed to subject vehicle	58 (14%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	57 (80%)
Other vehicle lane change - left in front of subject	39 (9%)	0 (0%)	0 (0%)	7 (10%)	32 (12%)	0 (0%)
Other vehicle ahead - slowed and stopped 2 seconds or less	38 (9%)	3 (75%)	0 (0%)	9 (13%)	26 (10%)	0 (0%)
Other vehicle lane change - right in front of subject	21 (5%)	0 (0%)	0 (0%)	8 (11%)	13 (5%)	0 (0%)
Other vehicle entering intersection - left turn across path	18 (4%)	0 (0%)	0 (0%)	3 (4%)	15 (6%)	0 (0%)
Animal in roadway	16 (4%)	1 (25%)	0 (0%)	1 (1%)	14 (5%)	0 (0%)
Other vehicle encroaching into lane, over left lane line	13 (3%)	0 (0%)	0 (0%)	3 (4%)	10 (4%)	0 (0%)
Other vehicle encroaching into lane, over right lane line	11 (3%)	0 (0%)	0 (0%)	4 (6%)	7 (3%)	0 (0%)
Subject in intersection - turning left	10 (2%)	0 (0%)	0 (0%)	1 (1%)	4 (2%)	5 (7%)
Other vehicle ahead - stopped on roadway more than 2 seconds	10 (2%)	0 (0%)	0 (0%)	4 (6%)	6 (2%)	0 (0%)
Pedestrian in roadway	8 (2%)	0 (0%)	0 (0%)	2 (3%)	6 (2%)	0 (0%)
Other vehicle entering intersection - straight across path	7 (2%)	0 (0%)	0 (0%)	3 (4%)	4 (2%)	0 (0%)
Subject in intersection - passing through	6 (1%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	5 (7%)
Subject vehicle ahead - decelerating	6 (1%)	0 (0%)	0 (0%)	1 (1%)	5 (2%)	0 (0%)
Other vehicle lane change - left, sideswipe threat	6 (1%)	0 (0%)	0 (0%)	4 (6%)	2 (1%)	0 (0%)
Other vehicle lane change - right, sideswipe threat	6 (1%)	0 (0%)	0 (0%)	4 (6%)	2 (1%)	0 (0%)
Subject in intersection - turning right	5 (1%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	4 (6%)
Other vehicle entering intersection - turning same direction	5 (1%)	0 (0%)	0 (0%)	2 (3%)	3 (1%)	0 (0%)
Other vehicle from driveway - turning into same direction	4 (1%)	0 (0%)	0 (0%)	0 (0%)	4 (2%)	0 (0%)
Pedestrian approaching roadway	4 (1%)	0 (0%)	0 (0%)	0 (0%)	4 (2%)	0 (0%)
Animal approaching roadway	4 (1%)	0 (0%)	0 (0%)	0 (0%)	4 (2%)	0 (0%)
Object approaching roadway	4 (1%)	0 (0%)	1 (50%)	2 (3%)	1 (0%)	0 (0%)
Subject over left lane line into oncoming traffic way	3 (1%)	0 (0%)	0 (0%)	2 (3%)	1 (0%)	0 (0%)
Subject over right edge of road	3 (1%)	0 (0%)	1 (50%)	1 (1%)	1 (0%)	0 (0%)
Subject lane change - left behind vehicle	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)

Precipitating Event	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Other vehicle ahead - at a slower constant speed	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)
Subject lane change - right in front of vehicle	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
Subject lane change - left, sideswipe threat	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
Subject lane change - right, sideswipe threat	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Subject lane change - right, other	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
Other vehicle - backing	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Other vehicle entering intersection - intended path unknown	2 (0%)	0 (0%)	0(0%)	0 (0%)	2 (1%)	0 (0%)
Pedalcyclist/other non-motorist in roadway	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
Object in roadway	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
This vehicle lost control - other cause	1 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Subject over left edge of road	1 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Subject lane change - right behind vehicle	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Subject vehicle ahead - at a slower constant speed	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Other vehicle oncoming - over left line	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
This vehicle lost control - blow-out or flat tire	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This vehicle lost control - stalled engine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This vehicle lost control - disabling vehicle failure	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This vehicle lost control - minor vehicle failure	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This vehicle lost control - poor road conditions	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This vehicle lost control - excessive speed	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
This vehicle lost control - unknown cause	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 0%)	0 (0%)
Subject over right lane line into oncoming traffic way	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject vehicle - end departure	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject vehicle ahead - stopped on roadway more than 2 seconds	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject vehicle ahead - slowed and stopped 2 seconds or less	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject lane change - left in front of vehicle	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject lane change - left, other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject vehicle making a U-turn	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Subject vehicle ahead - other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle ahead - accelerating	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Precipitating Event	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Other vehicle - traveling in opposite direction	0 (0%)	0 (0%)	0(0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle - in crossover	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle - making U-turn	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle lane change - left behind subject	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle lane change - right behind subject	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle lane change - left other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle lane change - right other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle oncoming - over right line	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle from parallel/diagonal parking lane	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle entering intersection - turning onto opposite direction	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle from driveway - straight across path	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle from driveway - turning into opposite direction	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle from driveway - intended path unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other vehicle from entrance to limited access highway	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pedestrian in unknown location	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pedalcyclist/other non-motorist approaching roadway	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Pedalcyclist/other non-motorist in unknown location	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Animal in unknown location	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Object in unknown location	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Which Vehicle is Considered to be at Fault?	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Subject driver	254 (62%)	3 (75%)	2 (100%)	38 (53%)	140 (53%)	71 (100%)
Driver 2	124 (30%)	0 (0%)	0 (0%)	30 (42%)	94 (36%)	0 (0%)
Unknown	1 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Not applicable	32 (8%)	1 (25%)	0 (0%)	3 (4%)	28 (11%)	0 (0%)
Driver 3	2 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (1%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Subject Driver Reaction	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Braked (no lockup)	329 (80%)	2 (50%)	1 (50%)	39 (54%)	219 (83%)	68 (96%)
Braked and steered left	39 (9%)	0 (0%)	0 (0%)	18 (25%)	21 (8%)	0 (0%)
Braked and steered right	32 (8%)	1 (25%)	0 (0%)	12 (17%)	19 (7%)	0 (0%)
No reaction	7 (2%)	1 (25%)	0 (0%)	1 (1%)	2 (1%)	3 (4%)
Steered to left	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Steered to right	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Accelerated and steered right	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Other actions	1 (0%)	0 (0%)	1 (50%)	0 (0%)	0 (0%)	0 (0%)
No driver present	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Braked (lockup)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Braked (lockup unknown)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Released brakes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Accelerated	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Accelerated and steered left	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unknown if action was attempted	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Incident Type	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Rear-end, striking	176 (43%)	3 (75%)	0 (0%)	25 (35%)	148 (56%)	0 (0%)
Sideswipe, same direction (left or right)	65 (16%)	0 (0%)	0 (0%)	26 (36%)	39 (15%)	0 (0%)
Other	62 (15%)	0 (0%)	1 (50%)	3 (4%)	4 (2%)	54 (76%)
Turn across path	23 (6%)	0 (0%)	0 (0%)	4 (6%)	19 (7%)	0 (0%)
Violation of stop sign or signal at intersection	20 (5%)	0 (0%)	0 (0%)	2 (3%)	1 (0%)	17 (24%)
Animal-related	20 (5%)	1 (25%)	0 (0%)	1 (1%)	18 (7%)	0 (0%)
Pedestrian-related	13 (3%)	0 (0%)	0 (0%)	2 (3%)	11 (4%)	0 (0%)
Turn into path (same direction)	10 (2%)	0 (0%)	0 (0%)	3 (4%)	7 (3%)	0 (0%)
Straight crossing path, not involving sign/signal violation	7 (2%)	0 (0%)	0 (0%)	1 (1%)	6 (2%)	0 (0%)
Rear-end, struck	6 (1%)	0 (0%)	0 (0%)	1 (1%)	5 (2%)	0 (0%)
Opposite direction (head-on or sideswipe)	4 (1%)	0 (0%)	0 (0%)	2 (3%)	2 (1%)	0 (0%)
Road departure (left or right)	3 (1%)	0 (0%)	1 (50%)	1 (1%)	1 (0%)	0 (0%)
Pedalcyclist-related	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)
Backing into traffic	1 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Road departure (end)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Turn into path (opposite direction)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Backing, fixed object	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Driver Impairments	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
None apparent	298 (72%)	0 (0%)	1 (50%)	41 (57%)	190 (72%)	66 (93%)
Distracted	99 (24%)	2 (50%)	1 (50%)	27 (38%)	65 (25%)	4 (6%)
Drowsy, sleepy, asleep, fatigued	12 (3%)	2 (50%)	0 (0%)	3 (4%)	6 (2%)	1 (1%)
Angry	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Other emotional state	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Other	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Ill, blackout	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Drugs, medication	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Drugs, alcohol	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other illicit drugs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Restricted to wheelchair	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Impaired due to previous injury	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Deaf	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71(100%)**

Driver Seat Belt Use	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Yes, belt worn	403 (98%)	4 (100%)	2 (100%)	72 (100%)	259 (98%)	66 (93%)
No, belt NOT worn	10 (2%)	0 (0%)	0 (0%)	0 (0%)	5 (2%)	5 (7%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Ambient Lighting	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Daylight	348 (84%)	3 (75%)	2 (100%)	61 (85%)	228 (86%)	54 (76%)
Darkness, lighted	28 (7%)	1 (25%)	0 (0%)	6 (8%)	12 (5%)	9 (13%)
Darkness, not lighted	27 (7%)	0 (0%)	0 (0%)	3 (4%)	17 (6%)	7 (10%)
Dusk	10 (2%)	0 (0%)	0 (0%)	2 (3%)	7 (3%)	1 (1%)
Dawn	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Vehicle is Not Outside	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to Determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Weather Conditions	**Total Safety-Critical Events N (%)**	**Crashes N (%)**	**Curb Strikes N (%)**	**Near-Crashes N (%)**	**Crash-Relevant Conflicts N (%)**	**Intersection Violations N (%)**
No Adverse Conditions	385 (93%)	4 (100%)	2 (100%)	64 (89%)	250 (95%)	65 (92%)
Light Rain/Mist	20 (5%)	0 (0%)	0 (0%)	7 (10%)	9 (3%)	4 (6%)
Heavy Rain	8 (2%)	0 (0%)	0 (0%)	1 (1%)	5 (2%)	2 (3%)
Snowing/Sleeting	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fog	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rain + Fog	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Snow + Fog	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Smoke, dust	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Trafficway Flow	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Divided	280 (68%)	1 (25%)	0 (0%)	50 (69%)	177 (67%)	52 (73%)
Not divided, standard 2-way traffic way	104 (25%)	3 (75%)	0 (0%)	16 (22%)	68 (26%)	17 (24%)
One-way traffic	14 (3%)	0 (0%)	1 (50%)	2 (3%)	10 (4%)	1 (1%)
Not divided, with center 2-way turn lane	10 (2%)	0 (0%)	0 (0%)	3 (4%)	6 (2%)	1 (1%)
No lanes	5 (1%)	0 (0%)	1 (50%)	1 (1%)	3 (1%)	0 (0%)
Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Number of Traffic Lanes	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
0 (No Lanes)	5 (1%)	0 (0%)	1 (50%)	1 (1%)	3 (1%)	0 (0%)
1	11 (3%)	0 (0%)	1 (50%)	2 (3%)	7 (3%)	1 (1%)
2	145 (35%)	2 (50%)	0 (0%)	21 (29%)	105 (40%)	17 (24%)
3	110 (27%)	0 (0%)	0 (0%)	20 (28%)	66 (25%)	24 (34%)
4	87 (21%)	1 (25%)	0 (0%)	15 (21%)	54 (20%)	17 (24%)
5	39 (9%)	1 (25%)	0 (0%)	9 (13%)	22 (8%)	7 (10%)
6	16 (4%)	0 (0%)	0 (0%)	4 (6%)	7 (3%)	5 (7%)
7	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8+	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Locality	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Business/industrial	130 (31%)	1 (25%)	2 (100%)	26 (36%)	71 (27%)	30 (42%)
Interstate/bypass/divided highway with no traffic signals	117 (28%)	1 (25%)	0 (0%)	22 (31%)	92 (35%)	2 (3%)
Bypass/divided highway with traffic signals	49 (12%)	0 (0%)	0 (0%)	4 (6%)	19 (7%)	26 (37%)
Open country	37 (9%)	1 (25%)	0 (0%)	4 (6%)	23 (9%)	9 (13%)
Residential	37 (9%)	1 (25%)	0 (0%)	8 (11%)	25 (9%)	3 (4%)
Construction zone	32 (8%)	0 (0%)	0 (0%)	5 (7%)	26 (10%)	1 (1%)
School	9 (2%)	0 (0%)	0 (0%)	2 (3%)	7 (3%)	0 (0%)
Church	2 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (0%)	0 (0%)
Playground	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Traffic Density	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
N/A – Stopped at Intersection	5 (1%)	0 (0%)	1 (50%)	1 (1%)	2 (1%)	1 (1%)
LOS A1: Free flow – No leading traffic in any lane	104 (25%)	0 (0%)	1 (50%)	14 (19%)	45 (17%)	44 (62%)
LOS A2: Free flow – Leading traffic present in at least one lane	122 (30%)	1 (25%)	0 (0%)	21 (29%)	78 (30%)	22 (31%)
LOS B: Flow with some restrictions	125 (30%)	0 (0%)	0 (0%)	25 (35%)	96 (36%)	4 (6%)
LOS C: Stable flow, maneuverability and speed are more restricted	35 (8%)	1 (25%)	0 (0%)	6 (8%)	28 (11%)	0 (0%)
LOS D: Unstable flow - temporary restrictions substantially slow driver	15 (4%)	2 (50%)	0 (0%)	1 (1%)	12 (5%)	0 (0%)
LOS E: Flow is unstable, vehicles are unable to pass, temporary stoppages, etc.	6 (1%)	0 (0%)	0 (0%)	3 (4%)	3 (1%)	0 (0%)
LOS F: Forced traffic flow, low speeds, traffic volumes below capacity	1 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Relation to Junction	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
Non-junction	264 (64%)	2 (50%)	0 (0%)	34 (47%)	186 (70%)	42 (59%)
Intersection	55 (13%)	1 (25%)	1 (50%)	14 (19%)	18 (7%)	21 (30%)
Interchange area	40 (10%)	1 (25%)	0 (0%)	9 (13%)	28 (11%)	2 (3%)
Intersection-related	33 (8%)	0 (0%)	0 (0%)	11 (15%)	18 (7%)	4 (6%)
Entrance ramp	10 (2%)	0 (0%)	0 (0%)	2 (3%)	7 (3%)	1 (1%)
Parking lot	6 (1%)	0 (0%)	1 (50%)	1 (1%)	4 (2%)	0 (0%)
Exit ramp	3 (1%)	0 (0%)	0 (0%)	0 (0%)	3 (1%)	0 (0%)
Other	2 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	1 (1%)
Driveway, alley access, etc.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rail grade crossing	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

Traffic Control Device	Total Safety-Critical Events N (%)	Crashes N (%)	Curb Strikes N (%)	Near-Crashes N (%)	Crash-Relevant Conflicts N (%)	Intersection Violations N (%)
No traffic control	263 (64%)	3 (75%)	2 (100%)	50(69%)	201 (76%)	7 (10%)
Traffic signal	113 (27%)	1 (25%)	0 (0%)	15 (21%)	35 (13%)	62 (87%)
Slow or warning sign, other	14 (3%)	0 (0%)	0 (0%)	3 (4%)	11 (4%)	0 (0%)
Stop sign	8 (2%)	0 (0%)	0 (0%)	3 (4%)	3 (1%)	2 (3%)
Construction signs/warnings	8 (2%)	0 (0%)	0 (0%)	0 (0%)	8 (3%)	0 (0%)
Traffic lanes marked	6 (1%)	0 (0%)	0 (0%)	1 (1%)	5 (2%)	0 (0%)
Yield sign	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)
School-zone related sign	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Officer or watchman/traffic guard	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
No passing signs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
One-way road or street	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Railroad crossing with markings or signs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Railroad crossing with signals	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Railroad crossing with gate and signals	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unable to determine	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	**413 (100%)**	**4 (100%)**	**2 (100%)**	**72 (100%)**	**264 (100%)**	**71 (100%)**

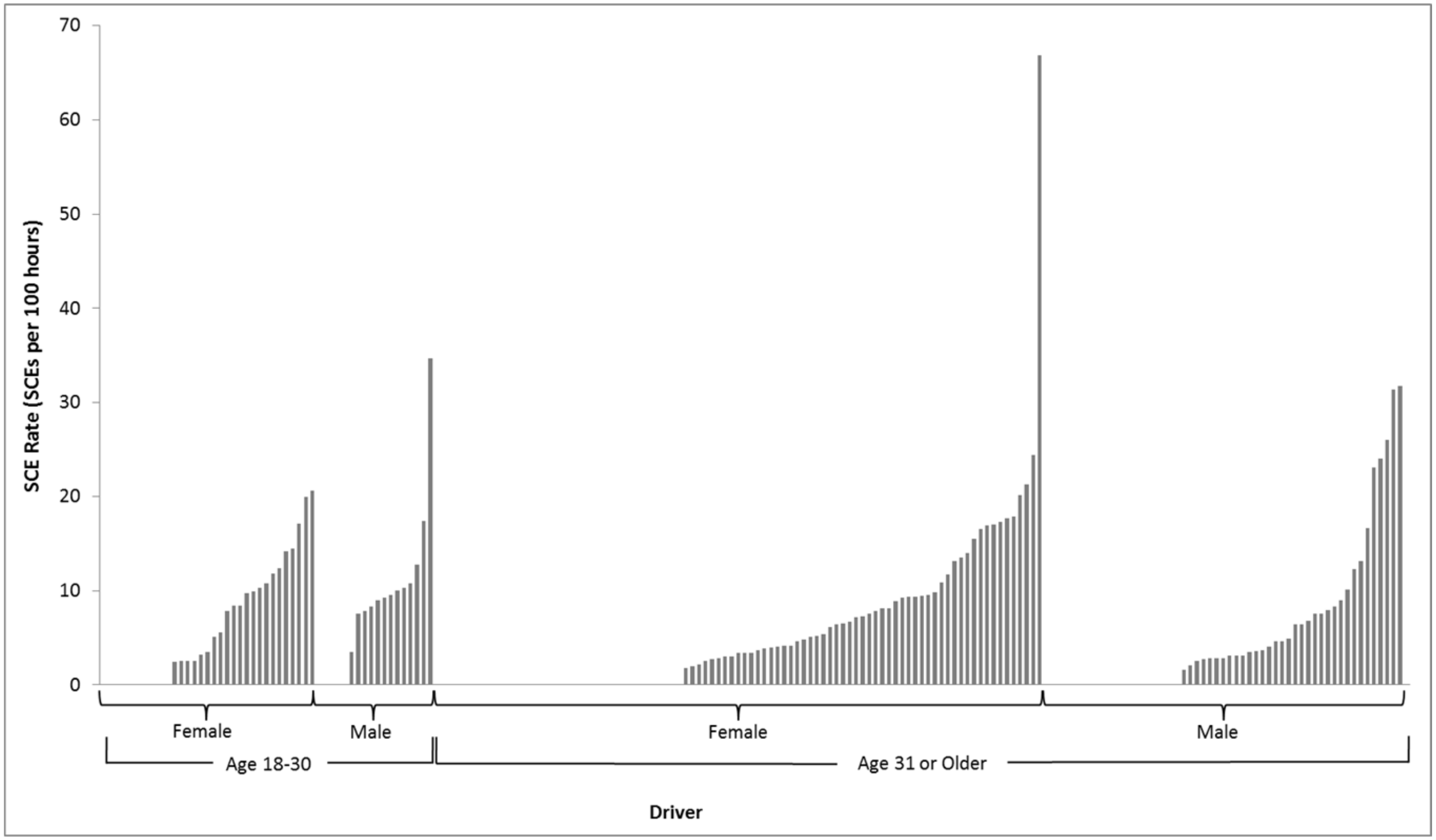

Figure 8. SCE Rate per Driver by Gender and Age Group

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A.9 Driver, Vehicle, and Environmental Questions for Safety-Critical Event Baseline Periods

Baseline periods for safety-critical events were identified by randomly selecting 6-second epochs of driving for each driver in the Cell Phone Pilot database. These baseline periods were selected from all driving events over 5 mph, and are stratified by miles driven. This protocol provides instructions on how to complete the reduction for environmental and driver-related factors during these baseline events.

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37. Seatbelt: **Driver seatbelt use at start of 6-second baseline:**

a. Yes, belt worn
b. No, belt NOT worn
c. Unable to determine

38. HHPhoneType: **Type of hand-held phone the driver uses for the majority of the event:**

a. No hand-held phone used (Skip to Page 2)
b. Standard keys on front of phone
c. Vertical flip-phone
d. Horizontal flip-phone/Slide keyboard
e. Touch screen
f. BlackBerry/QWERTY on Front
g. Unable to determine

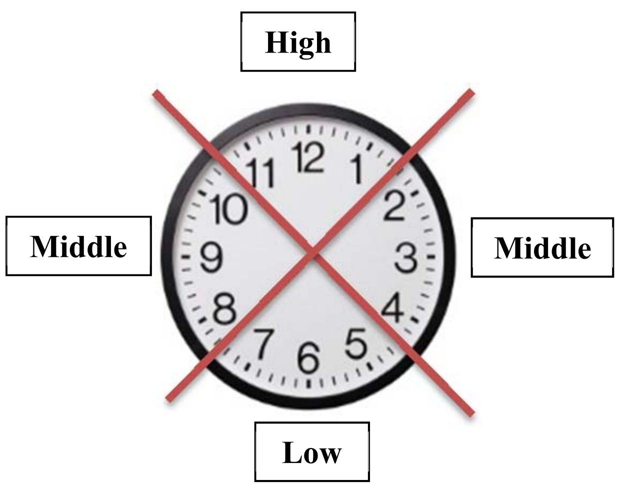
39. PhonePriorLocation: **Location of hand-held phone prior to being reached for (Reaching subtasks only)**: applies only to "HH: Locate/Reach/Answer" subtasks

bb. No hand-held phone used
cc. Reaching for phone does not occur – choose this option if the subtask being coded is an HH task other than "HH: Locate/Reach/Answer" (such as, "HH: Talk/Listen," "HH: Text," etc.)
dd. Shirt/Jacket Pocket
ee. Pants Pocket
ff. Cup Holder
gg. On Dash (not in cradle)
hh. Purse (if seen)
ii. Passenger seat
jj. In cradle – usually found attached to dash or windshield
kk. Glove box
ll. Center Console storage
mm. Other
nn. Unable to determine

40. PhoneUseLocation: **Location of hand-held phone during majority of event (not for reaching or ending subtasks):** applies only to "HH: Dial," "HH: View/Browse," "HH: Talk/Listen," "HH: Text," and "HH: Hold" subtasks. No hand-held phone used

t. N/A, Reaching or ending HH call – choose this option if the subtask being coded is "HH: Locate/Reach/Answer" or "HH: End Task."
u. In right hand against right ear
v. In left hand against left ear
w. In one hand on steering wheel (low) – 5:00-7:00 on a clock.
x. In both hands resting on steering wheel (low)
y. In one hand resting on steering wheel (middle) – 2:00-4:00 or 8:00-10:00 on a clock.
z. In both hands resting on steering wheel (middle)
aa. In one hand resting on steering wheel (high) – 11:00-1:00 on a clock.
bb. In both hands resting on steering wheel (high)
cc. In one hand raised out in front of forward view
dd. In both hands raised out in front of forward window
ee. In one hand to side of/in front of steering wheel
ff. In both hands to side of/in front of steering wheel
gg. In one hand below steering wheel
hh. In both hands below steering wheel
ii. In one hand placed in front of mouth
jj. In both hands placed in front of mouth
kk. In right hand against left ear (cross body)
ll. In left hand against right ear (cross body)
mm. Not in hand – Other

Hand placement on steering wheel diagram



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41. AmbientLighting: **Ambient Lighting at start of 6-second baseline:**

h. Daylight

i. Dusk – use if the ambient lighting is mostly dark and continues to darken throughout the file. Do not use it if the ambient lighting is daylight, but it is cloudy.
j. Darkness, lighted – It is nighttime during the subtask, but the roadway is lighted
k. Darkness, not lighted – It is nighttime during the subtask, and the roadway is NOT lighted
l. Dawn – use if the ambient lighting is mostly dark and lightens throughout the file. Do not use if it the ambient lighting is daylight, but it is cloudy.
m. Vehicle is Not Outside
n. Unable to determine

42. Weather: **Weather conditions at start of 6-second baseline:**

a. No Adverse Conditions – includes cloudy/overcast skies with no visible falling precipitation
b. Light Rain/Mist
c. Heavy Rain
d. Snowing/Sleeting
e. Fog
f. Rain + Fog
g. Snow + Fog
h. Smoke, dust - There is smoke and/or dust, either stagnant or blowing, in the air
i. Other - There is some type of adverse atmospheric condition present, not described in other categories
j. Unable to determine

43. RoadSurface: **Road surface condition at start of 6-second baseline:**

a. Dry - There is no foreign material (rain, snow, oil, etc.) on the roadway in the area of the event (nothing on the road to affect the driving task)
b. Wet - Roadway is completely or partially wet in the area of the event (not snowy, icy, muddy, or oily)
c. Snowy - There is some amount of unmelted snow or slush on the roadway in the area of the event, enough to affect the driving task (no ice on the road in the area of interest)
d. Icy - There is some amount of ice on the roadway in the area of the event, enough to affect the driving task
e. Muddy - There is some amount of mud on the roadway in the area of the event, enough to affect the driving task
f. Oily - There is some amount of oil, grease, or other slippery fluid on the roadway in the area of the event, enough to affect the driving task
g. Other - There is some type of foreign substance on the road, not listed in previous categories, enough to affect the driving task
h. Unable to determine

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44. TrafficFlow: **Traffic Flow at start of 6-second baseline:** Roadway design (including the presence or lack of a median) at the start of the event. If the event starts while the driver is at an intersection, the traffic flow conditions just prior to the intersection should be recorded.

a. Not divided, standard 2-way traffic way - with or without center line, but without center 2-way turn lane
b. Not divided, with center 2-way turn lane
c. Divided - median strip or barrier separates opposite direction
d. One-way traffic
e. No lanes – such as a Parking lot, Driveway, etc.
f. Other
g. Unable to determine

45. ContigTravelLanes: **TOTAL number of CONTIGUOUS travel lanes present at start of 6-second baseline, including turn, exit-entrance, and oncoming:** includes the total number of all: lanes in the direction the driver is driving, oncoming lanes, turn lanes, entrance/exit ramps, and lanes with parked vehicles. If the event starts while the driver is at an intersection, the number of lanes just prior to the intersection should be recorded

a. 0 (No Lanes) - vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. 8+
j. Unable to determine

46. NumDirectLanes: **Number of travel through lanes in the DIRECTION OF TRAVEL ONLY at start of 6 second baseline:** includes only the total number of lanes in the direction the driver is driving. Do **NOT** include: oncoming lanes, turn lanes, entrance/exit ramps, or lanes with parked vehicles. If the event starts while the driver is at an intersection, the number of lanes just prior to the intersection should be recorded

a. 0 (No Lanes) – vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. 8+
j. Unable to determine

47. StartingLane: **In which of the lanes counted in the question above is the driver traveling at start of 6-second baseline?** - **Note:** Lanes should be counted from **left to right**

a. Not in through lane
b. 0 (No Lanes) - vehicle is not in an area intended for traffic. This option should be used if the driver is in a parking lot area or on a roadway with no true lanes.
c. 1 (Left-most lane or only lane)
d. 2
e. 3
f. 4
g. 5
h. 6
i. 7
j. 8+
k. Unable to determine

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48. RoadAlignment: **Roadway alignment at start of 6-second baseline:**

a. Straight – Road alignment is straight
b. Curve Left – Road alignment is curved to the left
c. Curve Right – Road alignment is curved to the right
d. Unable to determine

49. RoadGrade: **Roadway grade at start of 6-second baseline:**

a. Level
b. Grade Up – profile of road is graded, and vehicle is going up a hill
c. Hillcrest – vehicle is at a hillcrest (area of transition between an upgrade and a downgrade)
d. Grade Down – profile of road is graded, and vehicle is going down a hill
e. Dip – vehicle is in a dip
f. Unable to determine

50. Locality: **Locality at start of 6-second baseline:**

a. Interstate/bypass/divided highway with no traffic signals
b. Bypass/divided highway with traffic signals
c. Business/industrial - Vehicle passes any type of business or industrial structure
d. Open country - Other than the roadway, there is nothing visible that is described in any of the other categories
e. Residential - Vehicle passes at least one house or evidence of a residential neighborhood but does not drive through a business or industrial area.
f. Construction zone - Vehicle is in a construction zone (construction equipment, barrel, etc. are visible) *(This category takes precedence over others)*
g. School - Vehicle passes any type of school building, including adult learning institutions *(This category takes precedence over others)*
h. Church *(This category takes precedence over others)*

i. Playground - Vehicle passes any type of playground or children's playing field *(This category takes precedence over others)*
j. Other - Locality is one not described in other categories
k. Unable to determine

51. TrafficDensity: **Traffic density at start of 6-second baseline:**

a. N/A – Stopped at Intersection
b. LOS A1: Free flow – No leading traffic in any lane – Subject driver is unaffected in the traffic stream because there are no leading vehicles in any lane. Freedom to select desired speeds and to maneuver within the traffic stream is at the highest level possible.
c. LOS A2: Free flow – Leading traffic present in at least one lane - Individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.
d. LOS B: Flow with some restrictions - In the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.
e. LOS C: Stable flow, maneuverability and speed are more restricted - In the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.
f. LOS D: Unstable flow - temporary restrictions substantially slow driver - High-density, but stable flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.
g. LOS E: Flow is unstable, vehicles are unable to pass, temporary stoppages, etc. - Operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.
h. LOS F: Forced traffic flow, low speeds, traffic volumes below capacity - Forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues

form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more then be required to stop in a cyclic fashion. LOS F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow, which causes the queue to form, and LOS F is an appropriate designation for such points.

i. Unable to determine

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52. LVPresent: **Is there a lead vehicle traveling in the same lane at start of 6-second baseline?**

a. Yes
b. No (Skip to Page (6)
c. Unable to determine

53. LVObjectID (text): **What is the object ID of the lead vehicle reported by the radar at start of 6-second baseline?**

- If there is a lead vehicle reported by the radar, enter the Object ID
- If radar data is not available, enter "N/A"
- If unsure, enter "Unable to determine"

54. LVActualRange (text): **What is the X-Range to the lead vehicle reported by the radar at start of 6-second baseline?**

- If there is a lead vehicle reported by the radar, enter the X_Range
- If radar data is not available, enter "N/A"
- If unsure, enter "Unable to determine"

55. LVEstRange: **Estimate the range to the lead vehicle at start of 6-second baseline:**

a. Far (Greater than 40 m or 3 standard lane markings away)
b. Medium (Between 12 and 40 m or 1-3 standard lane markings away)
c. Close (Less than 12 m or 1 standard lane marking away)
d. Unable to determine
e. N/A (No lead vehicle)

Lead Vehicle Range Estimate Diagrams

***Standard lane markings are 10 ft. long, and the distance between each one is 30 ft. Thus, from the start of one standard marking to the start of the next is 40 feet or about 12 meters. Non-standard lane markings (such as during a merge or delineating a turn lane) have different measurements and cannot be used in this manner.

<u>**Close (Less than 14 m on radar, or just over one standard lane marking)**</u>

<u>**Medium (14 to 40 m on radar or 1-3 standard lane markings)**</u>

<u>**Far (Greater than 40 m on radar or more than 3 standard lane markings)**</u>

56. LVActualRate (text): **What is the relative X-velocity of the lead vehicle reported by the radar at start of 6-second baseline?**

- If there is a lead vehicle reported by the radar, enter the X_Velocity
- If radar data is not available, enter "N/A"
- If unsure, Enter "Unable to determine"

57. LVEstRate: **Estimate the closing rate to the lead vehicle at start of 6-second baseline:**

a. <u>Distance Rapidly Increasing</u>

b. Distance Increasing
c. Distance Constant
d. Distance Closing
e. Distance Rapidly Closing
f. Unable to determine
g. N/A (No lead vehicle)

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58. SVLaneChange: **Does the subject driver CHOOSE to change lanes during the 10-second time interval (10,000 timestamps) CENTERED on the start of 6-second baseline?** This 10-second time interval includes 4 seconds (4,000 timestamps) after the baseline ends. **The beginning and ending of this time interval are provided for you in Columns J and K (light red) of the Excel log.**

a. No - driver does not change lanes, OR any lane change performed is forced by lane closure, merging requirements, or turn lane movements
b. Yes, planned lane change – driver changes lanes based on a choice to travel in a different lane. This does **NOT** include when the driver makes required merges (such as merging onto/off of a highway, moving into a turn lane, or lanes ending/beginning – all of which should be answered "No").
c. Yes, evasive/unplanned lane change – driver changes lanes in order to avoid an accident, or an animal/object/pedestrian in the forward roadway
d. Unable to determine

59. SVTurnSignal: **If driver changes lanes as above, does he/she use the turn signal?**

a. Driver does not change lanes
b. Yes
c. No
d. Unable to determine

60. RVPresent: **Is there a trailing rear vehicle traveling in the same lane as the driver at start of 6-second baseline?**

a. Yes
b. No (Skip to Page 7)
c. Unable to determine

61. RVEstRange: **Estimate the range to the rear vehicle at start of 6-second baseline:**

a. Far (Greater than 40 m or 3 standard lane markings away)
b. Medium (Between 12 m and 40 m or 1 to 3 standard lane markings away)
c. Close (Less than 12 m or 1 standard lane marking away)
d. Unable to determine
e. N/A (No rear vehicle)

Rear Vehicle Range Estimate Diagrams

***Standard lane markings are 10 ft. long, and the distance between each one is 30 ft. Thus, from the start of one standard marking to the start of the next is 40 feet or about 12 meters. Non-standard lane markings (such as during a merge or delineating a turn lane) have different measurements and cannot be used in this manner.

<u>Close (Less than14 m or just over one standard lane marking)</u>


<u>Medium (14 to 40 m or 1-3 standard lane markings)</u>


<u>Far (Greater than 40 m away or more than 3 standard lane markings)</u>


62. RVEstRate: **Estimate the closing rate of the rear trailing vehicle at start of 6-second baseline:**

a. <u>Distance Rapidly Increasing</u>

b. Distance Increasing
c. Distance Constant
d. Distance Closing
e. Distance Rapidly Closing
f. Unable to determine
g. N/A (No rear vehicle)

63. RVLaneChange: **Does the rear trailing vehicle change lanes to pass the subject vehicle within 10 seconds (or 10,000 timestamps) starting at start of 6-second baseline?** This 10-second time interval includes 4 seconds (4,000 timestamps) after the baseline ends. **The beginning and ending of this time interval are provided for you in Columns H and I (light red) of the Excel log.**

a. Yes, Rear Vehicle Moves to Pass (PLANNED) – Rear vehicle changes lanes based on a choice to travel in a different lane or in order to drive at a faster speed than the subject. This does **NOT** include when the rear vehicle makes required merges (such as merging onto/off of a highway, moving into a turn lane, or lanes ending/beginning – all of which should be answered "No").
b. Yes, Rear Vehicle Moves to Pass (EVASIVE) - rear vehicle changes lanes in order to avoid an accident, or an animal/object/pedestrian
c. No – rear vehicle does not change lanes, OR any lane change performed is forced by lane closure, merging requirements, or turn lane movements
d. Unable to determine
e. N/A (No rear vehicle)

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64. RelationToJunction**: Relation to junction at start of 6-second baseline:**

w. Non-junction – Subject vehicle is not close to a junction (the area formed by the connection of two roadways)
x. Intersection – Subject vehicle is at or within 1 car length (~20 feet) of an intersection (roads cross at the same grade)
y. Intersection-related – Subject vehicle is within 3 car lengths (~60 feet) of an intersection (where roads cross at the same grade), either approaching or exiting the intersection
z. Interchange area – Subject vehicle is within the boundaries of an interchange with exit and/or entrance ramps present (a road junction that typically utilizes grade separation and one or more ramps to permit traffic on at least one road to pass through the junction without crossing any other traffic stream)
aa. Entrance ramp – Subject vehicle is on or entering/exiting an entrance ramp (a transition roadway connecting two roadways or used for entering through-traffic lanes)
bb. Exit ramp – Subject vehicle is on or entering/exiting an exit ramp (a transition roadway connecting two roadways or used for exiting through-traffic lanes)
cc. Driveway, alley access, etc. – Subject vehicle is on or entering/exiting a driveway, alley, or some other roadway providing access to property adjacent to the traffic way

dd. Rail grade crossing – Subject vehicle is close to the at-grade connection of a railroad bed and roadway
ee. Parking lot – subject vehicle is within the boundaries of a parking lot
ff. Other – subject vehicle is related to a junction in a manner not described in other categories. This includes tunnels, toll booths, and bridges
gg. Unable to determine

65. TrafficControlDevice: **Traffic control device (if any) in effect at start of 6-second baseline:**
gg. No traffic control - There is no traffic control applicable to the subject vehicle at the time of the event
hh. Traffic signal - A traffic signal (by colors or flashing) is controlling some aspect of the traffic flow applicable to the subject vehicle
ii. Stop sign
jj. Yield sign
kk. Construction signs/warnings
ll. Slow or warning sign, other
mm. School-zone related sign
nn. Officer or watchman/traffic guard
oo. Traffic lanes marked - There are markings on the road that contain information or warnings applicable to the driving task for the subject vehicle (use if NO other types of devices/signs are used to convey the same information). Does not include Railroad crossings (see below).
pp. No passing signs
qq. One-way road or street
rr. Railroad crossing with markings or signs - A railroad crossing with associated signage (including markings on the road, signs, cross bucks) is controlling some aspect of traffic flow applicable to the subject vehicle
ss. Railroad crossing with signals - A railroad crossing with associated signals (including flashing lights, traffic lights) is controlling some aspect of traffic flow applicable to the subject vehicle
tt. Railroad crossing with gate and signals - A railroad crossing with associated gate(s) with or without signals (including flashing lights, traffic lights) is controlling some aspect of traffic flow applicable to the subject vehicle
uu. Other - There is some type of traffic control device, not described in previous categories, controlling some aspect of traffic flow applicable to the subject vehicle
vv. Unable to determine

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66. IntersectionPresent: **What is the first type of intersection entered within 10 seconds (or 10,000 timestamps) starting at start of 6-second baseline?** This 10-second time interval includes 4 seconds (4,000 timestamps) after the baseline ends. **The beginning and ending of this time interval are provided for you in Columns H and I (light red) of the Excel log.**

m. No Intersection Entered – Skip to Page 9 – if this option is selected, SKIP to question 36 on page 9 of the question annotation
n. Signalized – subject's path through intersection is controlled by a stoplight only
o. Stop sign – subject's path through intersection is controlled by a stop sign only
p. Yield sign – subject's path through intersection is controlled by a yield sign only
q. Uncontrolled – subject's path through intersection is not controlled by any means (no signs nor stoplights)
r. Unable to determine

67. IntersectionScan1: **For the intersection coded above, does the driver appropriately scan for traffic PRIOR to entering the intersection?** Proper scanning consists of gazing to roadway junctions and NOT driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right is required; for a right 3-way intersection, a glance to the right is required; for a left 3-way intersection, a glance to the left is required, etc. These glances are required regardless of traffic control status (traffic light color, etc.).

i. Yes, driver scans appropriately
j. No, driver does not scan
k. Unable to determine
l. N/A - No intersection entered

68. IntersectionViolate: **What stopping behavior is exhibited at the intersection coded above?** (use the unit converter to convert to miles per hour)

o. Stop not required
p. Proper stop performed
q. Rolling stop (minimum speed <15 mph, but greater than 0)
r. Complete stop, but past the stop bar/sign AND in path of cross traffic
s. No stop when stop required (minimum speed is >=15mph)
t. Unable to determine
u. N/A - No intersection entered

69. IntersectionScan2: **If the driver stops as first in queue at a light at the intersection coded above, does he/she scan within 6 seconds (or 6,000 timestamps) before the vehicle starts moving?** Proper scanning consists of gazing to roadway junctions and NOT driveways, alleyways, or parking lot entrances. For a 4-way intersection, a glance to the left and right is required; for a right 3-way intersection, a glance to the right is required; for a left 3-way intersection, a glance to the left is required, etc. These glances are required regardless of traffic control status (traffic light color, etc.).

n. N/A, driver does not stop (skip to Page 9)
o. N/A, driver stops, but not first in queue at light (skip to Page 9)
p. Yes, driver scans before moving
q. No, driver does not scan before moving
r. Unable to determine
s. N/A - No intersection entered (skip to Page 9)

49. IntersectionPhone: **If SV was stopped at intersection as in above question, did subject complete all complex cell phone subtasks before the vehicle started moving.**

f. N/A, Cell phone use does not occur while vehicle is stopped.
g. N/A, Cell phone use while stopped is limited to Holding/wearing or Talking only
h. No, Complex cell phone subtasks (other than holding/wearing/talking) continue after vehicle starts moving
i. Yes, all complex cell phone subtask(s) completed before vehicle starts moving.
j. Unsure

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50. NumLaneBust (text): **Number of unintentional lane busts occurring during this event** – enter the total number of unintentional lane busts that occur during the entire event. Do NOT count intentional lane busts (such as when the driver must swerve to avoid an accident or an animal/object/pedestrian in the road, etc.). If there are no unintentional lane busts, enter "0" and skip to Page 10.

51. BeginLaneBust1 (text): **Begin timestamp of FIRST lane bust** – enter the timestamp of the beginning of the first lane that occurs during this event. The timestamp can be found in the Collection Navigator at the lower, right-hand side of Hawkeye.

52. BeginLaneBust2 (text): **Begin timestamp of SECOND lane bust** – enter the timestamp of the beginning of the second lane that occurs during this event.

53. BeginLaneBust3 (text): **Begin timestamp of THIRD lane bust** – enter the timestamp of the beginning of the first third bust that occurs during this event.

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54. SecondaryTask1: **Secondary Task 1** – Indicate any secondary tasks (up to (3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

55. SecondaryTask2: **Secondary Task 2** – Indicate any secondary tasks (up to (3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

56. SecondaryTask3: **Secondary Task 3** – Indicate any secondary tasks (up to (3) that the driver engages in during the length of the event. If more than 3 secondary tasks are observed, list the 3 most severe/most distracting tasks. Secondary tasks to record are provided in the chart below.

57. SecondaryTaskDesc (textbox): **Define/Describe OTHER tasks above** – For any secondary tasks listed as "other," "unknown," "other device," "reaching for object: other," or "holding object: other" above, provide a description. Also use this space to further explain anything unusual about the list distractions.

58. BothHandsOff: If cell phone use is listed above, does the driver take both hands off the steering wheel during the cell phone task(s) that occur within the 6-second window?

d. N/A - No cell use listed above
e. No, at least one hand is on the wheel for all cell use
f. Yes, both hands off wheel at least once during cell use

Secondary Task	Description
No Secondary Task	There are no observable signs of driver distraction
Lost in thought	Driver performs multiple non-specific eye glances within 6-second period of time (not focusing on objects of glances), or appears to be in a daze resulting in potential conflict.
Looked but did not see	Driver is looking right at (or looks at) where incident occurs, but shows no reaction. Often seen when blind spot is checked, but vehicles present are not seen.
Cell Hand-Held: Locate/Reach/Answer	When the driver looks for or reaches towards his/her hand-held cell phone or manipulates it to answer a call.
Cell Hand-Held: Talk/Listen/Voice Commands	When a driver is talking on a hand-held phone or has the phone up to his/her ear as if listening to a phone conversation or waiting for a person they are calling to pick up the phone. **NOTE:** If the driver uses the speaker phone function on a hand-held cell phone: Code as "HH: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function. Code as "PHF: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.
Cell Hand-Held: Dialing	When the driver is pressing buttons or interacting with a touch screen on a hand-held cell phone in order to dial a phone number to make a call. This can include dialing, searching for a contact's number, entering a voice mail password, etc. **NOTE**: This does NOT include pressing a button to answer a call (coded as "HH: Locating/Reaching/ Answering") or pressing a button to end a call (coded as "HH: End Task"). **NOTE**: Additionally, "HH: Dialing" does NOT include pressing buttons or interacting with a touch screen in order to type/read a text message (which should be coded as "HH: Text messaging" if driver types or "HH: Viewing/Browsing/Reading" if driver reads) or browse the Internet/use phone applications (which should be coded as "HH: Viewing/Browsing/Reading").

Secondary Task	Description
Cell Hand-Held: Text messaging	When a driver is pushing buttons or interacting with a touch screen on a hand-held cell phone in order to type a text message. **NOTE:** This does not include reading a text message, which should be coded as "HH: Viewing/Browsing/Reading."
Cell Hand-Held: Viewing/Browsing/Reading	When the driver views the hand-held cell phone display with or without pressing buttons or manipulating the touch screen for a purpose other than making/receiving a call or sending a text message. Examples include: when the driver uses the cell phone to check time, read a received text message, browse the Internet or email, or use the phone's other applications. **NOTE:** If any viewing and/or button manipulation is seen and there is NO record of a call being made/received/ended or a text being sent, then use this category. Reading a received text message would be coded using this category. **NOTE**: Exceptions to this rule: #1 - When a call is ending, code as "HH: End Task" if the driver looks at the phone and/or presses a button to end a call. #2 - When a call is being answered, any glances or associated button presses should be coded as "HH: Locate/Reach/Answer."
Cell Hand-Held: Holding	When the driver holds a hand-held cell phone in his/her hand but does not interact with it. It does NOT count as holding if the phone is resting on the driver's seat (next to or between legs), or on the driver's lap (both of which would end the cell phone interaction and be coded as no cell phone task). **NOTE (The 5-Second Rule):** If the subject is viewing, dialing, or performing another task with a hand-held phone, then holds the phone without visually or manually interacting with it for at least 5,000 consecutive timestamps (or 5 consecutive seconds), this "break" period should be coded as "HH: Holding." If the driver resumes another (or the same) subtask before the 5-consecutive-second period ends, do NOT code "HH: Holding." Rather, continue to code as the initial task until a new task begins. NOTE: Holding is assumed in all other hand-held subtasks ("HH:…") and does not need to be coded simultaneously with any other hand-held task. <u>However, if the phone is being held during any Portable Hands Free (PHF) or Integrated Hands Free (IHF) tasks, then "HH: Holding" would need to be simultaneously coded.</u>
Cell Hand-Held: End Task	When the driver completes a specific cell phone objective by either pressing a button to end the call, putting the phone down after ending a call or text, or flipping/sliding the phone closed after ending a call or text.
Cell Integrated Hands-Free: Press Button to Begin/Answer	When the driver presses a button on the steering wheel or center stack in order to begin a cell phone interaction. This can include pushing to answer a call, pushing to voice dial, or pushing to enter a voice command.

Secondary Task	Description
	When the driver presses the button on the steering wheel or center stack in order to begin the cell phone interaction.
Cell Integrated Hands-Free: Talk/Listen/Voice Commands	When a driver talks, listens, or gives voice commands on an integrated device. Driver must be observed talking repeatedly with no obvious passenger interaction. Additionally, this option should only be used when the cell records indicate that the driver has made or received a call on an integrated hands-free device.
Cell Integrated Hands-Free: Press button to end	When the driver presses the button on the steering wheel or center stack in order to end the cell phone interaction.
Cell Portable Hands-Free: Locate/Put-on Headset/Earpiece	When the driver looks for or reaches towards a headset or earpiece. If more than one task occurs (e.g., driver looks for earpiece, reaches for it and then puts it in his ear), the first frame number would be the start of the first task (reaching for earpiece) and the last frame number coded would be the end of the last task (i.e., placing earpiece in ear.)
Cell Portable Hands-Free: Holding/Wearing Headset/Earpiece	When a driver is holding a headset/earpiece in his/her hand or wearing it on his/her head but not interacting with it (and not involved in a phone conversation). Also code as "PHF: Hold/Wearing" if the driver has been holding the earpiece/headset in his/her hand(s) for some time and finally moves to put it on. It does NOT count as holding if the headset/earpiece is resting on the driver's seat (next to or between legs), or on the driver's lap. **NOTE**: If the subject is talking/listening on a portable hands-free device or performing another task with a hand-held phone or portable hands-free device, then holds the headset/earpiece in hand or on his/her head without interacting for at least 5,000 timestamps (or 5 consecutive seconds), this "break" period should be coded as "PHF: Hold/Wear Headset/Earpiece." If the driver resumes another task before the 5,000-consecutive-timestamp period ends, do NOT code "PHF: Hold/Wear Headset/Earpiece." **NOTE**: While coding PHF: Talk/Listen, do NOT intersperse PHF: Hold/Wear unless is it clear that a phone call has ended. The driver may stop talking for periods of time (including breaks longer than 5 seconds) to listen to the conversation. This should be coded straight through as PHF: Talk/Listen. **NOTE:** Holding/wearing headset or earpiece is assumed in all other Portable Hands Free ("PHF:…") subtasks and does not need to be coded simultaneously with any other PHF task. <u>However, if a headset/earpiece is being held or worn during any Hand-Held (HH) or Integrated Hands Free (IHF) tasks, then "PHF: Holding/Wearing" would need to be simultaneously coded.</u>

Secondary Task	Description
Cell Portable Hands-Free: Push Button to Begin/Answer	When the driver presses a button on the headset/earpiece in order to begin a cell phone interaction. This can include pushing to answer a call or pushing to give a voice command to make a call. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone. **NOTE:** If instead of pushing a button on the headset/earpiece to answer or make a call, the driver pushes a button or dials on a hand-held phone, this would be coded as "HH: Dialing" or "HH: Locate/Reach/Answer," even if the subsequent conversation takes place via a Portable Hands Free device.
Cell Portable Hands-Free: Talk/Listen/Voice Commands	When a driver is talking on a headset, earpiece, or other aftermarket device, OR listening to a phone conversation, OR waiting for a person they are calling to pick up the phone. Driver must be observed talking repeatedly with no obvious passenger interaction to conclude that the headset/earpiece is in use. **NOTE:** This subtask should be coded if the talking subtask is performed on a portable hands-free device, even if the dialing, answering, or call-ending subtasks are performed using a hand-held phone. **NOTE:** If the driver uses the speaker phone function on a hand-held cell phone: Code as "Hand-held: Talk/Listen/Voice Commands" if the driver keeps the hand-held phone in his/her hand(s) while using the speaker phone function. Code as "Portable Hands-Free: Talk/Listen/Voice Commands" if the driver puts the phone down (thus, does NOT hold it in his/her hand(s)) while using the speaker phone function.
Cell Portable Hands-Free: Push Button to End	When the driver presses the button on the headset/ear piece in order to end the cell phone interaction. This button may be located on the headset/earpiece itself, or occasionally somewhere on the wire connecting the device to the phone. **NOTE:** If instead of pushing a button on the headset/earpiece to end a call, the driver pushes a button on a hand-held phone, this would be coded as "HH: End Task," even if the conversation took place via a Portable Hands Free device.
Cell Phone Navigation	When the driver is using the navigation feature of a hand-held cell phone. It is not entirely clear what this will look like, but it may occur when the phone is in a cradle on the dash, or when the driver is clearly using the phone for turn-by-turn navigation purposes. **NOTE**: Please note this interaction in the Comments section of Excel log so that a closer examination can be performed.

Secondary Task	Description
Cell Other Cell Phone Task	When a driver is interacting with a hand-held cell phone, portable hands-free device, or integrated hands-free device in some manner not described in previous categories. This includes, but is not limited to, the following: • When the driver plugs a hand-held phone into a power charger. • When the subject is playing with a hand-held phone or portable hands-free device, or fiddling with them without any purposeful manipulation. • When the subject puts a hand-held cell phone into a case after holding it in his/her hand for 5 or more consecutive seconds (5,000 + consecutive timestamps) after other HH tasks have ended. Includes reaching for the separate case, maneuvering phone into the case, and then putting it down or holding it (coded as holding if longer than 5 seconds, or 5,000 consecutive timestamps). **NOTE**: If subject must remove a hand-held cell phone from the case before using it, code as "HH: Locating/Reaching/Answering." If the subject is putting the phone back INTO case immediately following a call or text, code it as "HH: End Task." If the subject is putting the phone back INTO a case after "HH: Holding," code as "Other Cell Phone Task." **NOTE**: Define the observed behaviors in the Comments section of Excel log.
Talking/singing/dancing (w/o passenger or cell)	Driver is moving lips as if in conversation or singing a song. Also use if driver is moving his/her arms, head, or other body part in time with the beat of music Mark this if driver is talking or singing or dancing and there is no obvious passenger component (either passenger is clearly not present or the driver is not looking in the direction of a passenger seat and does not turn head as if communicating with someone).
Reading/Writing	Driver is reading or writing on material that is in the vehicle, but not a part of the vehicle (i.e., not reading external signs, or radio display). This could be reading or writing on directions, paper material, packaging. If reading a phone number, record as dialing cell phone.
Cognitive, other	Driver is emotionally upset or angry, or engaged in another activity not included in other categories, that requires the driver to obviously be thinking about something other than driving Details about condition or emotional state should be specified in the appropriate questions.
Interacting with passenger	A passenger is visible or not visible, but the driver is clearly interacting with a passenger in either the adjacent or rear seat. This could be talking, listening, reacting to (e.g., laughing), moving toward or away from the passenger (i.e., reaching for the passenger, or avoiding a pat from the person).

Secondary Task	Description
Moving object in vehicle	An object inside the vehicle is in motion and causes the driver to look away from the driving task, either due to the motion of the vehicle or due to another passenger throwing the object. (Ex. object fell off seat when driver stopped hard at a traffic light)
Insect in vehicle	Interaction with any insect in the vehicle (e.g., swatting at insect, moving body to avoid insect, looking around trying to locate insect)
Pet in vehicle	Any interaction with pet, including petting, talking to, or moving pet or interacting with pet carrier. Only code if animal/pet is visible at some point in the trip file or if there is history/context with the driver and the driver is exhibiting behaviors that are appropriate to having a pet in the vehicle
Object dropped by driver	Driver is holding something and it drops and the driver then picks it back up This category supersedes other "reaching" categories in the situation of an object being dropped and immediately retrieved
Reaching for object, other	Driver reaches for an object not described in any other category. Once the driver has finished reaching for the object and has it in hand (if not being moved for intended usage), then it becomes "object in vehicle, other," as long as it doesn't fit into any of the other categories (e.g., eating, drinking, etc.)
Holding object, other	Driver is holding an object not described in other categories. Could be food, drink, pen, paper, etc. Must continue for at least 5 seconds without other manipulations. If less than 5 seconds, code as previous task (e.g., reaching for object, personal hygiene).
Object in vehicle, other	Driver clearly is looking at, handling, or manipulating an object (visible or not) or thing located in the vehicle, other than those listed in other categories
Operating other electronic device	Driver is manipulating some non-manufacturer-installed electronic device (PDA, laptop, mp3 player, etc.) either by pressing buttons, viewing, opening/closing, plugging in, etc. Reaching for this object should be coded as "Reaching for object, other"
Adjusting radio or HVAC	Driver interacts with climate control or radio either by touching the buttons on the center stack, dashboard, or steering wheel, or glancing at the controls. Includes inserting/retrieving CDs and adjusting vents.
Adjusting/monitoring other devices integral to vehicle	Driver interacts with a manufacturer-installed device other than those listed in other categories, either by touching or glancing at the device. Includes interaction with seat belt, door locks, sun visor, etc. Does NOT include interacting with driving-critical tasks such as turn signal, headlights, gear shift, and windshield wipers.
Looking at non-driving-related external object/event	Driver is looking outside of the vehicle in the direction of what is obviously an object or incident that is not related to the driving task. May include looking at an accident, aspects of construction sites/zones, animals/pedestrians that are not in or entering the path of travel. Only mark if it is clear that the driver is tracking a specific external distraction as they drive by. Other non-specific or driving-related glances should be coded as "Driving related inattention to forward roadway"

Secondary Task	Description
Eating/drinking	Driver has food or drink that will be put in his/her mouth with or without the use of a utensil. If driver is chewing (except gum) also code as Eating/drinking. If driver is simply holding food or drink for 5 or more seconds, code as Holding Object: Other
Smoking/tobacco	Lighting, smoking, or extinguishing cigar or cigarette. Also includes use of chewing tobacco or holding a lit cigarette. Reaching for tobacco products should be coded "Reaching for object: other"
Personal hygiene	Includes applying make-up (including lotion/chapstick), checking self in mirror, purposefully fixing/brushing hair, shaving, tweezing, brushing/flossing teeth, putting on/removing/adjusting jewelry (including watches), putting on/removing/adjusting contacts or glasses. Reaching for hygiene-related items should be coded as "Reaching for object: other." Does not include swiping hair from eyes or quick/thoughtless rubbing/scratching, twirling hair.
Driving-related inattention to forward roadway	Driver glances away from the direction of travel out a window or at a side or center mirror for a driving-related issue (i.e., changing lanes, crossing through an intersection). ***Exception:*** if the vehicle is backing and the driver is looking out of the left window to see the road in the direction of travel, this is not coded as a distraction.
Other Secondary Task (define in Text box)	Driver is looking in a location other than the direction of travel, in a manner not listed in other categories.
Unknown	Can't tell or make a judgment whether there is a distraction Ex. Part of the video is missing or there is insufficient information in the video to make a determination

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59. DriverExpectation: **If an external incident occurs within the 6-second window, describe the driver's reaction to it:** An external incident is anything unexpected or out of the ordinary that presents a safety hazard.

m. No external event occurs
n. Fully expects, drives appropriately/reacts in a timely manner
o. Somewhat caught off guard, but quickly reacts in appropriate manner
p. Very much caught off guard, has a delayed reaction (~ > 0.75 s or 750 timestamps)
q. Extremely caught off guard, does not react at all
r. Unable to determine

60. Emotion: **Prior to any external incident noted above, rate the driver's emotional state during the 6-second window:**

o. Neutral/No Emotion Shown
p. Happy
q. Angry/Frustrated/Impatient

r. Sad
s. Surprised
t. Other (Could Be Concerned/Opinionated/Apologetic/Guilt/Contempt)
u. Unable to Determine

Driver Emotion Reaction Definitions

Emotion	Operational Definition
Unable to Determine	• Cannot tell what emotion the driver is showing
Neutral/No Emotion Shown	• The driver has a straight face, does not smile or laugh, does not gesture
Happy	• The driver smiles or laughs • The driver gestures in excitement
Angry/Frustrated	• The driver lowers/squeezes eyebrows, wrinkling forehead • The driver clenches his/her teeth • The driver yells (opens mouth wide with eyebrows lowered) • The driver gestures in anger/frustration • The driver raises his/her upper lip or tightens lips
Sad	• The driver has droopy eyebrows (raises inner eyebrows, lowers outer eyebrows) • The driver frowns by lowering the outer corners of his/her lips
Surprised	• The driver's eyebrows raise • The driver's mouth opens • The driver gestures
Other	• Emotional reaction that does not fit into any other category • Please define in the Notes section on the Excel Log

61. EmotionIntensity: **Prior to any external incident noted above, rate the intensity of the driver's emotional state during the 6-second window:**

k. Neutral/No Emotion Shown
l. Slight (Emotion Somewhat Shown)
m. Marked or Pronounced (Emotion Very Much Shown)
n. Severe (Emotion Extremely Shown)
o. Unable to determine

Driver Emotional Intensity Reduction Definitions

Intensity of Emotion	Operational Definition
Unable to Determine	• Cannot tell the intensity of the emotion
Neutral/No Emotion Shown	• The driver has a straight face, does not smile or laugh, does not gesture • Note, will always be selected if Neutral/No Emotion is selected above

Intensity of Emotion	Operational Definition
Slight (Emotion Somewhat Shown)	• The driver no longer has a straight face • However, no gesturing or head movement is observed
Marked or Pronounced (Emotion Very Much Shown)	• The driver no longer has a straight face • The driver gestures one time in a reserved manner • The driver moves his head one time
Severe (Emotion Extremely Shown)	• The driver has wide eyes and a wide open mouth • The driver is screaming • The driver gestures wildly, or the driver moves his head frequently

62. RaterSurprise **As the analyst, how surprised/shocked/interested were you by the video captured during this event?**

k. No heightened level of surprise/shock/interest
l. Somewhat surprised/shocked/interested
m. Very much surprised/shocked/interested
n. Extremely surprised/shocked/interested
o. Unable to determine

63. NoteComments (text): **General Notes/Comments** – include descriptions of any instances where you coded "Unable to determine" or "Other" in the questions above. As well as notes about any other circumstances that help to explain your responses and/or better define the conditions and occurrences of this event. Other notes you should type in include (but are not limited to) when the driver gets out of the vehicle during an event and particularly extreme weather conditions.

A.10 Investigation of Drivers' Cell Phone Use

A.10.1 Duration of Calls and Text Messages by Cell Phone Type

The duration of the sampled phone interaction for call and text samples was tested across cell phone types using a series of Kruskal-Wallis tests. Below are the results for the follow-up tests comparing two cell phone types or text messaging/browsing at a time. All comparisons were found significant, except portable hands-free and integrated hands-free phone interactions when driving below 8 km/h.

Table 41. Results of Kruskal-Wallis Tests on Duration Between Phone Types

Comparison	Above 8 km/h χ^2	Above 8 km/h *p* value	Below 8 km/h χ^2	Below 8 km/h *p* value
Hand-Held Versus Portable Hands-Free	35.6	< .0001	8.9	.0028
Hand-Held Versus Integrated Hands-Free	4.0	.0453	6.9	.0084
Hand-Held Versus Text/Browse	180.9	< .0001	75.9	< .0001
Portable Hands-Free Versus Integrated Hands-Free	14.5	.0001	0.9	.3421
Portable Hands-Free Versus Text/Browse	179.0	< .0001	46.4	< .0001
Integrated Hands-Free Versus Text/Browse	149	< .0001	67.6	< .0001

Descriptive statistics for cell phone subtasks performed above 8 km/h are presented in Table 42. Results from inferential tests performed on subtask durations are presented in the following section.

Table 42. Descriptive Statistics for Cell Phone Subtask Durations

Cell Phone Type	Cell Phone Subtask	N	Mean (s)	SE	Max (s)	Min (s)	25th Percentile (s)	50th Percentile (s)	75th Percentile (s)	85th Percentile (s)
Hand-Held	HH: Talk/Listen	525	178.7	12.1	2045	0.9	35.3	68.5	184.9	328.1
Hand-Held	HH: Dial	309	12.4	0.5	64.8	0.6	6.5	10.3	16.1	19.9
Hand-Held	HH: Browse/Read, HH: Talk/Listen	133	4.4	0.8	68	0.3	1	1.6	2.9	5.4
Hand-Held	HH: Locate/Answer	331	4.3	0.2	20.3	0.5	2.3	3.5	5.3	6.5
Hand-Held	HH: End Task	461	4	0.1	21.2	0.1	1.9	3.3	5.1	6.2
Portable Hands-Free	PHF: Talk/Listen	156	297.7	27	1733.5	0.8	59.8	173.6	387.9	609.5
Portable Hands-Free	PHF: Locate/Put On	15	12	2.8	39.8	0.1	6.3	8.7	12.7	26.4
Portable Hands-Free	HH: Dial	29	10.4	1.2	27.8	2.3	5.6	8.5	14.5	16.9
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	35	4.1	0.8	17.4	0.5	1	2.7	5.5	9.1
Portable Hands-Free	HH: Locate/Answer	43	3.6	0.5	21.1	0.1	1.7	2.7	4.4	5.1
Portable Hands-Free	PHF: End Task	33	3	0.5	16.4	0.6	1.6	2.2	3.2	4.3
Portable Hands-Free	PHF: Begin/Answer	13	2.9	1.1	15.3	0.4	0.9	1.2	3.1	5.1
Integrated Hands-Free	IHF: Talk/Listen	237	226.8	21.6	2425.6	2.9	47.4	87.0	241.7	410.1
Integrated Hands-Free	HH: Dial	67	12.9	1.3	47.4	1.5	5.5	9.5	18.1	22.6
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	31	6.8	1	28.8	0.5	4	4.8	9.2	10.6
Integrated Hands-Free	IHF: Begin/Answer	120	4.6	0.6	37.6	0.5	1.6	2.6	4.6	7.5
Integrated Hands-Free	HH: Locate/Answer	72	3.9	0.4	15.3	0.1	2	2.7	4.8	7.5
Integrated Hands-Free	IHF: End Task	154	2.9	0.2	10	0.1	1.3	2.3	4	5.1
Text/Browse	HH: Text	207	34.6	2.5	302.2	0.7	11.8	23.7	44.7	63.9

Cell Phone Type	Cell Phone Subtask	N	Mean (s)	SE	Max (s)	Min (s)	25th Percentile (s)	50th Percentile (s)	75th Percentile (s)	85th Percentile (s)
Text/Browse	HH: Browse/Read	286	13.7	0.9	87.4	0.7	4.7	9.4	15.5	22.5
Text/Browse	HH: Locate/Answer	301	3.1	0.1	19.5	0.1	1.8	2.5	3.5	4.4
Text/Browse	HH: End Task	352	2	0.1	24.2	0.1	0.9	1.4	2.5	3.4

A.10.2 Frequency and Duration Talk/Listen Subtask

The count and average duration in seconds with standard error is listed for the talk/listen subtask across cell phone types by speed level in Table 43. Only talk/listen subtasks with a valid speed measure were included.

Table 43. Frequency and Average Duration of Talk/Listen Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type	N	Mean Duration (s)	SE	25th Percentile	75th Percentile	85th Percentile
Above 8 km/h	Hand-Held	525	178.7	12.1	35.3	184.9	328.1
Above 8 km/h	Portable Hands-Free	156	297.7	27.0	59.8	387.9	609.5
Above 8 km/h	Integrated Hands-Free	237	226.8	21.6	47.4	241.7	410.1
Below 8 km/h	Hand-Held	260	124.0	10.4	32.1	136.0	229.2
Below 8 km/h	Portable Hands-Free	60	302.6	56.8	38.0	432.2	683.5
Below 8 km/h	Integrated Hands-Free	97	221.3	32.4	49.0	258.6	394.8

Table 44. Results of ANOVA for Log Duration of Talk/Listen Subtask for Driving Speed Above 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	2	50.3	25.1	16.2	<.0001
Error	915	1418.7	1.6		
Corrected Total	917	1469.0			

Table 45. Results of ANOVA for Log Duration of Locate/Answer or Locate/Put on Subtask for Driving Speed Below 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	2	24.3	12.2	8.3	0.0003
Error	414	604.1	1.5		
Corrected Total	416	628.4			

Table 46. Confidence Intervals (95%) for Difference Between Log Means of Duration of Talk/Listen Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type Comparison	Difference Between Log Means	95% Confidence Lower Limits for Log Task Time	95% Confidence Upper Limits for Log Task Time
Above 8 km/h	HH: Talk/Listen Versus IHF: Talk/Listen*	-0.2693	-0.4980	-0.0405
Above 8 km/h	HH: Talk/Listen Versus PHF: Talk/Listen*	-0.6287	-0.8953	-0.3622
Above 8 km/h	PHF: Talk/Listen Versus IHF: Talk/Listen*	0.3594	0.0581	0.6608
Below 8 km/h	HH: Talk/Listen Versus IHF: Talk/Listen*	-0.5063	-0.8444	-0.1683
Below 8 km/h	HH: Talk/Listen Versus PHF: Talk/Listen*	-0.4855	-0.8925	-0.0786
Below 8 km/h	PHF: Talk/Listen Versus IHF: Talk/Listen	-0.0208	-0.4875	0.4459

A.10.3 Frequency and Duration of Subtasks

For the sampled cell phone calls and text messages, observed cell-phone-related subtasks were noted by reductionists. The frequency and duration of the following subtasks were calculated across cell phone types by speed level: (1) locate/answer or locate/put on, (2) hand-held dialing or portable hands-free/integrated hands-free begin/answer, (3) browse/read during talk/listen, and (4) end task. In Table 47, the frequency and average duration of the locate/answer or locate/put on subtask is displayed. The results of the ANOVA on the log transformation of task time for the subtask are shown in Table 48 (speed above 8 km/h) and Table 49 (speed below 8 km/h). Following, in Table 50, are confidence intervals for the difference in duration for the subtask when compared across two cell phone types at a time. If the confidence interval did not contain zero, the difference was considered statistically significant.

Table 47. Frequency and Average Duration of Locate/Answer or Locate/Put on Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type	N	Mean Duration (s)	SE Duration
Above 8 km/h	Hand-Held	331	4.3	331
Above 8 km/h	Integrated Hands-Free	72	3.9	72
Above 8 km/h	Portable Hands-Free	43	3.6	43
Above 8 km/h	Text/Browse	301	3.1	301
Below 8 km/h	Hand-Held	191	4.7	191
Below 8 km/h	Integrated Hands-Free	45	4.0	45
Below 8 km/h	Portable Hands-Free	27	4.2	27
Below 8 km/h	Text/Browse	168	3.2	168

Table 48. Results of ANOVA for Log Duration of Locate/Answer or Locate/Put on Subtask for Driving Speed Above 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	3	15.3	5.1	12.0	<.0001
Error	743	316.3	0.4		
Corrected Total	746	331.6			

Table 49. Results of ANOVA for Log Duration of Locate/Answer or Locate/Put on Subtask for Driving Speed Below 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	3	6.3	2.1	3.7	0.0112
Error	427	238.1	0.6		
Corrected Total	430	244.3			

Table 50. Confidence Intervals (95%) for Difference Between Log Means for Locate/Answer or Locate/Put on Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type Comparison	Difference Between Log Means	95% Confidence Lower Limits for Log Task Time	95% Confidence Upper Limits for Log Task Time
Above 8 km/h	Hand-Held Versus Portable Hands-Free*	0.2851	0.0128	0.5574
Above 8 km/h	Hand-Held Versus Integrated Hands-Free	0.1630	-0.0555	0.3814
Above 8 km/h	Hand-Held Versus Text/Browse*	0.3036	0.1698	0.4374
Above 8 km/h	Portable Hands-Free Versus Integrated Hands-Free	-0.1221	-0.4459	0.2016
Above 8 km/h	Portable Hands-Free Versus Text/Browse	0.0185	-0.2554	0.2923
Above 8 km/h	Integrated Hands-Free Versus Text/Browse	0.1406	-0.0798	0.3610
Below 8 km/h	Hand-Held Versus Portable Hands-Free	0.0933	-0.3027	0.4892
Below 8 km/h	Hand-Held Versus Integrated Hands-Free	0.1818	-0.1373	0.5001
Below 8 km/h	Hand-Held Versus Text/Browse*	0.2610	0.0573	0.4647
Below 8 km/h	Portable Hands-Free Versus Integrated Hands-Free	0.0885	-0.3803	0.5574
Below 8 km/h	Portable Hands-Free Versus Text/Browse	0.1677	-0.2316	0.5670
Below 8 km/h	Integrated Hands-Free Versus Text/Browse	0.0792	-0.2441	0.4024

In Table 51, the frequency and average duration of the dialing or begin/answer subtask is displayed. The results of the ANOVA on the log transformation of task time for the subtask are shown in Table 52 (speed above 8 km/h) and Table 53 (speed below 8 km/h). Following, in Table 54, are confidence intervals for the difference in duration for the subtask when compared across two cell phone types at a time. If the confidence interval did not contain zero, the difference was considered statistically significant.

Table 51. Frequency and Average Duration of Hand-Held Dialing or Portable Hands-Free/Integrated Hands-Free Begin/Answer Subtask Across Cell Phone Types by Speed Level

Speed Level	Subtask	N	Mean Duration (s)	SE Duration
Above 8 km/h	HH: Dial	309	12.4	0.5
Above 8 km/h	IHF: Begin/Answer	120	4.6	0.6
Above 8 km/h	PHF: Begin/Answer	13	2.9	1.0
Below 8 km/h	HH: Dial	201	15.9	0.9
Below 8 km/h	IHF: Begin/Answer	45	6.8	1.0
Below 8 km/h	PHF: Begin/Answer	3	0.7	2.3

Table 52. Results of ANOVA for Log Duration of Hand-Held Dialing or Portable Hands-Free/Integrated Hands-Free Begin/Answer Subtask for Driving Speed Above 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	2	148.3	74.1	119.5	<.0001
Error	439	272.2	0.6		
Corrected Total	441	420.5			

Table 53. Results of ANOVA for Log Duration of Hand-Held Dialing or Portable Hands-Free/Integrated Hands-Free Begin/Answer Subtask for Driving Speed Below 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	2	67.2	33.6	50.6	<.0001
Error	246	163.4	0.7		
Corrected Total	248	230.6			

Table 54. Confidence Intervals (95%) for Difference Between Log Means of Duration of Hand-Held Dialing or Portable Hands-Free/Integrated Hands-Free Begin/Answer Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type Comparison	Difference Between Log Means	95% Confidence Lower Limits for Log Task Time	95% Confidence Upper Limits for Log Task Time
Above 8 km/h	HH: Dial Versus IHF: Begin/Answer*	1.1898	0.9906	1.3890
Above 8 km/h	HH: Dial Versus PHF: Begin/Answer*	1.7656	1.2413	2.2900
Above 8 km/h	PHF: Begin/Answer Versus IHF: Begin/Answer*	-0.5759	-1.1166	-0.0351
Below 8 km/h	HH: Dial Versus IHF: Begin/Answer*	1.0044	0.6874	1.3213
Below 8 km/h	HH: Dial Versus PHF: Begin/Answer*	3.3705	2.2527	4.4884
Below 8 km/h	PHF: Begin/Answer Versus IHF: Begin/Answer*	-2.3662	-3.5122	-1.2202

In Table 55, the frequency and average duration of the browsing/reading while talking/listening subtask is displayed. The results of the ANOVA on the log transformation of task time for the subtask are shown in Table 56 (speed above 8 km/h) and Table 57 (speed below 8 km/h). Following, in Table 58, are confidence intervals for the difference in duration for the subtask when compared across two cell phone types at a time. If the confidence interval did not contain zero, the difference was considered statistically significant.

Table 55. Frequency and Average Duration of Browse/Read While Talking/Listening Subtask Across Cell Phone Types by Speed Level

Speed Level	Subtask	N	Mean (s)	SE
Above 8 km/h	HH: Browse/Read, HH: Talk/Listen	133	4.4	0.8
Above 8 km/h	HH: Browse/Read, IHF: Talk/Listen	31	6.8	1.0
Above 8 km/h	HH: Browse/Read, PHF: Talk/Listen	35	4.1	0.8
Below 8 km/h	HH: Browse/Read, HH: Talk/Listen	53	5.0	0.8
Below 8 km/h	HH: Browse/Read, IHF: Talk/Listen	23	12.2	3.1
Below 8 km/h	HH: Browse/Read, PHF: Talk/Listen	15	6.2	1.5

Table 56. Results of ANOVA for Duration of Browse/Read While Talking/Listening Subtask for Driving Speed Above 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	2	18.7	9.4	8.54	0.0003
Error	196	214.6	1.1		
Corrected Total	198	233.3			

Table 57. Results of ANOVA for Duration of Browse/Read While Talking/Listening Subtask for Driving Speed Below 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	2	11.3	5.6	5.4	0.0064
Error	88	92.7	1.1		
Corrected Total	90	104			

Table 58. Confidence Intervals (95%) for Difference Between Log Means of Duration of Browse/Read While Talking/Listening Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type Comparison	Difference Between Log Means	95% Confidence Lower Limits for Log Task Time	95% Confidence Upper Limits for Log Task Time
Above 8 km/h	IHF: Talk/Listen Versus PHF: Talk/Listen*	0.6854	0.0760	1.2949
Above 8 km/h	IHF: Talk/Listen Versus HH: Talk/Listen*	0.8625	0.3697	1.3553
Above 8 km/h	PHF: Talk/Listen Versus HH: Talk/Listen	-0.1771	-0.2924	0.6465
Below 8 km/h	IHF: Talk/Listen Versus PHF: Talk/Listen	0.6276	-0.1844	1.4396
Below 8 km/h	IHF: Talk/Listen Versus HH: Talk/Listen*	0.8377	0.2268	1.4486
Below 8 km/h	PHF: Talk/Listen Versus HHF: Talk/Listen	0.2101	-0.5054	0.9257

In Table 59, the frequency and average duration of the browsing/reading while talking/listening subtask is displayed. The results of the ANOVA on the log transformation of task time for the subtask are shown in Table 60 (speed above 8 km/h) and Table 61 (speed below 8 km/h). Following, in Table 62, are confidence intervals for the difference in duration for the subtask when compared across two cell phone types at a time. If the confidence interval did not contain zero, the difference was considered statistically significant.

Table 59. Frequency and Average Duration of End Task Subtask Across Cell Phone Types by Speed Level

Speed Level	Cell Phone Type	N	Mean Task Time (s)	SE Task Time
Above 8 km/h	Hand-Held	461	4.0	0.1
Above 8 km/h	Integrated Hands-Free	154	2.9	0.2
Above 8 km/h	Portable Hands-Free	33	3.0	0.5
Above 8 km/h	Text/Browse	352	2.0	0.1
Below 8 km/h	Hand-Held	226	3.7	0.2
Below 8 km/h	Integrated Hands-Free	47	2.6	0.2
Below 8 km/h	Portable Hands-Free	17	2.6	0.4
Below 8 km/h	Text/Browse	190	2.3	0.2

Table 60. Results of ANOVA for Log Duration of End Task Subtask for Driving Speed Above 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	3	133.0	44.3	61.0	<.0001
Error	996	723.6	0.7		
Corrected Total	999	856.6			

Table 61. Results of ANOVA for Log Duration of End Task Subtask for Driving Speed Below 8 km/h

Source	df	Sum of Squares	Mean Square	F Statistic	*p* value
Model	3	22.3	7.4	10.8	<.0001
Error	394	269.6	0.7		
Corrected Total	397	291.9			

Table 62. Confidence Intervals (95%) for Difference Between Log Means of End Task Subtask Across Cell Phone Types by Speed Level

Cell Phone Type Comparison	Difference Between Log Means	95% Confidence Lower Limits for Log Task Time	95% Confidence Upper Limits for Log Task Time
Hand-Held Versus Portable Hands-Free	0.2616	-0.1337	0.6569
Hand-Held Versus Integrated Hands-Free*	0.3500	0.1459	0.5542
Hand-Held Versus Text/Browse*	0.8155	0.6602	0.9707
Portable Hands-Free Versus Integrated Hands-Free	0.0884	-0.3323	0.5092
Portable Hands-Free Versus Text/Browse*	0.5539	0.1546	0.9532
Integrated Hands-Free Versus Text/Browse*	0.4655	0.2536	0.6774
Hand-Held Versus Portable Hands-Free	0.1792	-0.3552	0.7137
Hand-Held Versus Integrated Hands-Free	0.2877	-0.0530	0.6284
Hand-Held Versus Text/Browse*	0.4999	0.2908	0.7091
Portable Hands-Free Versus Integrated Hands-Free	0.1085	-0.4930	0.7099
Portable Hands-Free Versus Text/Browse	0.3207	-0.2173	0.8587
Integrated Hands-Free Versus Text/Browse	0.2123	-0.1340	0.5585

A.10.4 Frequency of Non-Cell Secondary Tasks

For the sampled cell phone calls and text messages, observed non-cell-phone-related secondary tasks were noted by reductionists. The frequency of the following secondary tasks was calculated across cell phone types: adjusting radio or HVAC, eating or drinking, reading/writing, and adjusting/monitoring other devices integral to vehicle. In Table 63, the frequency counts of the subtasks with and without the secondary task "adjusting radio/HVAC" are displayed. In Table 64, the frequency counts of the subtasks with and without the secondary task "eating or drinking" are displayed. In Table 65, the frequency counts of the subtasks with and without the secondary task "reading/writing" are displayed. In Table 66, the frequency counts of the subtasks with and without the secondary task "adjusting/monitoring other devices integral to vehicle" are displayed.

Table 63. Frequency Counts for Secondary Task "Adjusting Radio/HVAC Observed"

Cell Phone Type	Adjusting the Radio/HVAC Not Observed	Adjusting the Radio/HVAC Observed	Total
Hand-Held	2651	64	2715
Integrated Hands-Free	1009	20	1029
Portable Hands-Free	480	12	492
Text/Browse	1920	29	1949

Table 64. Frequency Counts for Secondary Task "Eating/Drinking"

Cell Phone Type	Eating/Drinking Not Observed	Eating/Drinking Observed	Total
Hand-Held	2711	4	2715
Integrated Hands-Free	1023	6	1029
Portable Hands-Free	489	3	492
Text/Browse	1945	4	1949

Table 65. Frequency Counts for Secondary Task "Reading/Writing"

Cell Phone Type	Reading/Writing Not Observed	Reading/Writing Observed	Total
Hand-Held	2702	3	2715
Integrated Hands-Free	1022	7	1029
Portable Hands-Free	489	3	492
Text/Browse	1944	5	1949

Table 66. Frequency Counts for Secondary Task "Adjusting/Monitoring Other Devices Integral to Vehicle"

Cell Phone Type	Adjusting/Monitoring Other Devices Integral to Vehicle Not Observed	Adjusting/Monitoring Other Devices Integral to Vehicle Observed	Total
Hand-Held	2704	11	2715
Integrated Hands-Free	1020	9	1029
Portable Hands-Free	490	2	492
Text/Browse	1943	6	1949

A.10.5 Percentage of Subtasks With Both Hands Removed From Steering Wheel

In sampled cell phone hand-held subtasks, reductionists recorded whether drivers had both, one, or no hands on the steering wheel while interacting with their cell phone. The position of a driver's hands was noted for all hand-held subtasks, even if a phone interaction was portable hands-free or integrated hands-free (assigned because of the talk/listen subtask). The results of a series of Fisher's tests investigating how the percentage of subtasks with both hands off the steering wheel changes across cell phone types are presented in Table 67. At both speed levels, hand-held phone interactions had a significantly lower percentage of subtasks with both hands off the steering wheel than did integrated hands-free phone interactions and text/browse interactions. Portable hands-free phone interactions had a significantly lower percentage of subtasks with both hands off the steering wheel than did integrated hands-free phone interactions and text/browse phone interactions when driving speed was below 8 km/h.

Table 67. Fisher's Exact Test Results for Percentage of Subtasks With Both Hands Removed From Steering Wheel Across Cell Phone Types by Speed Level

Cell Phone Type Comparison	Above 8 km/h Fisher's Exact test *p* value	Below 8 km/h Fisher's Exact test *p* value
Hand-Held Versus Portable Hands-Free	.0983	.2972
Hand-Held Versus Integrated Hands-Free	.0024	< .0001
Hand-Held Versus Text/Browse	< .0001	< .0001
Portable Hands-Free Versus Integrated Hands-Free	.7411	.0296
Portable Hands-Free Versus Text/Browse	.6049	< .0001
Integrated Hands-Free Versus Text/Browse	1.0000	.0777

In Table 68, the counts and percentage of subtasks with both hands off the steering wheel are listed for individual subtask categories by speed level. In nearly every subtask, the percentage of observations with both hands off the steering wheel is higher when driving below 8 km/h than when driving above 8 km/h.

Table 68. Count and Percentage of Observations With Both Hands Removed From Steering Wheel Across Cell Phone Subtasks by Speed Level

Cell Phone Type	Subtask	Above 8 km/h Count	Above 8 km/h Percentage With Both Hands Removed (%)	Below 8 km/h Count	Below 8 km/h Percentage With Both Hands Removed (%)
Hand-Held	HH: Locate/Answer	-	-	1	0.0
Hand-Held	HH: Dial	309	4.2	194	35.6
Hand-Held	HH: Browse/Read, HH: Talk/Listen	133	0.8	50	14.0
Hand-Held	HH: Talk/Listen	526	0.2	252	1.6
Hand-Held	HH: End Task	1	0.0	1	0.00
Portable Hands-Free	HH: Dial	-	-	1	0.0
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	0	0.0	30	26.7
Portable Hands-Free	PHF: Talk/Listen	34	5.9	14	14.3
Integrated Hands-Free	HH: Dial	2	50.0	-	-
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	-	-	1	0.0
Text/Browse	HH: Browse/Read	67	9.0	51	49.0
Text/Browse	HH: Text	30	3.3	23	30.4
Text/Browse	HH: End Task	286	2.8	176	42.6

The results of a series of Fisher's tests on the percentage of subtasks with both hands off the steering wheel during the browse/read during talking/listening subtask are listed in Table 69. When driving below 8 km/h, HH talk/listen and PHF-talk/listen had significantly lower percentages of observations of both hands off wheel than did text/browse subtasks. When driving below 8 km/h, IHF talk/listen had a significantly lower percentage of observations of both hands off wheel than did text messaging during text/browse sample. When driving below 8 km/h or above 8 km/h, browse/read during a text/browse sample had a significantly lower percentage of observations of both hands off wheel than did text messaging during text/browse sample. When driving above 8 km/h, HH talk/listen had a significantly lower percentage of observations of both hands off wheel than did text messaging during text/browse sample.

Table 69. Fisher's Exact Test Results for Percentage of Browse/Read During Talking/Listening Subtask With Both Hands Removed From Steering Wheel Across Cell Phone Types by Speed Level

Browse/Read Comparison	Above 8 km/h Fisher's Exact test *p* value	Below 8 km/h Fisher's Exact test *p* value
Hand-Held Talk/Listen Versus Integrated Hands-Free Talk/Listen	.3352	.1174
Hand-Held Talk/Listen Versus Portable Hands-Free Talk/Listen	.1057	1.000
Hand-Held Talk/Listen Versus Hand-Held Browse/Read During Text Sample	.2830	.0002
Hand-Held Talk/Listen Versus Hand-Held Text During Text Sample	< .0001	< .0001
Portable Hands-Free Talk/Listen Versus Integrated Hands-Free Talk/Listen	1.000	.4339
Portable Hands-Free Talk/Listen Versus Hand-Held Browse/Read During Text Sample	.2879	.0474
Portable Hands-Free Talk/Listen Versus Hand-Held Text During Text Sample	.3912	.0003
Integrated Hands-Free Talk/Listen Versus Hand-Held Browse/Read During Text Sample	.5974	.3681
Integrated Hands-Free Talk/Listen Versus Hand-Held Text During Text Sample	.2205	.0030
Hand-Held Browse/Read During Text Sample Versus Hand-Held Text During Text Sample	< .0001	< .0001

A.10.6 Where Phone Was Held During Subtask

When drivers were using a hand-held phone for any subtask, reductionists noted where the driver held the phone during use. For this analysis, the first hand-held phone subtask was chosen for each phone interaction with hand-held phone use. The phone location categories available for reductionists to choose from were grouped into visibility classifications. The visibility classifications refer to the visibility of phone use to a passing car. The visibility classifications included "high," "moderate," or "low" (Table 70). Phone use locations above the steering wheel or above the driver's side window line were labeled as high visibility. Phone use locations mid-steering wheel or at the driver's side window line were labeled moderate visibility. Phone use locations low on the steering wheel or below the driver's side window line were labeled low visibility.

Table 70. Reduction Categories for Phone Location During Use and Corresponding Visibility Classification

Phone Location During Subtask From Reduction	Visibility Classification
In both hands resting on steering wheel (high)	High Visibility
In both hands resting on steering wheel (low)	Low Visibility
In both hands resting on steering wheel (middle)	Moderate Visibility
In both hands to side of/in front of steering wheel	Moderate Visibility
In left hand against left ear	High Visibility
In one hand below steering wheel	Low Visibility
In one hand placed in front of mouth	High Visibility
In one hand resting on steering wheel (high)	High Visibility
In one hand resting on steering wheel (middle)	Moderate Visibility
In one hand to side of/in front of steering wheel	Moderate Visibility
In one hand on steering wheel (low)	Low Visibility
In one hand raised out in front of forward view	High Visibility
In one hand to side of steering wheel	Moderate Visibility
In right hand against left ear (cross body)	High Visibility
In left hand against right ear (cross body)	High Visibility
In both hands below steering wheel	Low Visibility
In right hand against right ear	High Visibility
In both hands placed in front of mouth	High Visibility

A.10.7 Where Phone Was Kept Prior to Reaching

When a driver reached for his/her cell phone prior to use, reductionists noted the reaching location. The observed locations and the percentage of reaching instances are plotted in Figure 9. The category "Other" includes reaching onto the floor, to the instrument panel, or to the window visor.

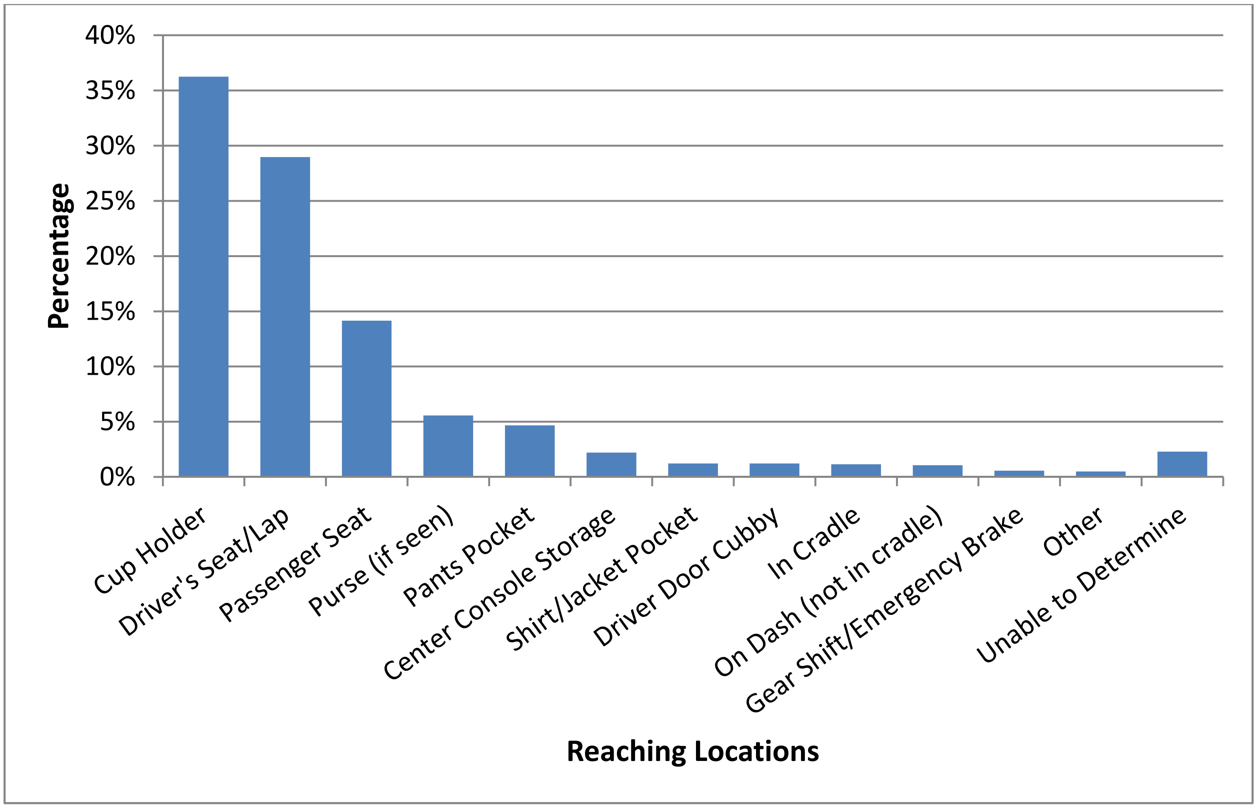

Figure 9. Phone Reaching Locations and Observed Percentages

A.10.8 Low and High Task Demand Analyses

The average duration, with standard error, for all cell phone subtasks in low and high task demand environments is listed in Table 71. For each subtask, the difference in duration between low and high task demand environments was tested using a Kruskal-Wallis test. Subtasks with a significant difference included portable hands-free end task, integrated hands-free end task, and browsing/reading in a text/browse sample.

Table 71. Cell Phone Subtask Duration in Low and High Task Demands With Significance Test Results

Subtask	Low Task Demand Mean Duration (s)	Low Task Demand SE	High Task Demand Mean Duration (s)	High Task Demand SE	χ^2	*p* value
Hand-Held: Locate/Answer	3.9	0.2	3.7	0.2	0.12	.7247
Hand-Held: Dialing	12.4	0.8	13.1	0.7	0.79	.3748
Hand-Held: Talk/Listen	148.5	16.6	194.7	19.4	0.45	.5018
Hand-Held: Browse/Read & Talk/Listen	5.8	2.0	4.2	0.7	1.01	.3144
Hand-Held: End Task	2.8	0.2	3.5	0.2	5.55	.0185
Portable Hands-Free: Locate/Put On	10.6	3.7	6.2	1.6	0.19	.6644
Portable Hands-Free: Begin/Answer	3.0	2.0	1.0	0.4	1.93	.1649
Portable Hands-Free: Talk/Listen	259.8	51.0	365.1	57.2	0.27	.6012
Portable Hands-Free: Browse/Read & Talk/Listen	3.7	1.0	5.6	1.6	<0.01	.9733
Portable Hands-Free: End Task	4.2	1.1	2.3	0.2	4.40	.0360
Integrated Hands-Free: Begin/Answer	5.0	1.3	5.5	0.8	2.75	.0972
Integrated Hands-Free: Talk/Listen	235.0	41.1	235.5	34.5	1.32	.2505
Integrated Hands-Free: Browse/Read & Talk/Listen	7.	1.5	7.4	1.5	0.24	.6276
Integrated Hands-Free: End Task	3.1	0.3	2.4	0.2	4.19	.0407
Text/Browse: Browse/Read	17.3	2.2	12.3	2.2	4.69	.0303
Text/Browse: Text	36.8	4.2	28.6	2.5	4.06	.0439

A.11 Risk Rate Approach Estimation Details

All data used in the risk rate estimates were above 8 km/h.

A.11.1 Estimating Overall Talk/Listen Time

The amount of time drivers spent talking on a cell phone while driving was estimated as follows. First, the difference between the call duration as specified in the cell phone records and the duration of the reduced talking/listening subtask was determined for each call in the sample of reduced cell phone calls. The average amount of time lost per call (i.e., the mean difference) was computed by stratifying across:

- The original cell phone groupings that drivers were assigned when they were recruited (HH, PHF, and IHF)
- The call direction (inbound, outgoing, and unknown)

Average lost time per call = average of (cell-record-based call time – reduction based talk/listen time)

Table 72 shows the mean time lost per call stratified by originally assigned cell phone grouping and call direction. Note: selection criteria were used to include only differences greater or equal to 0 and less than 2 minutes. Calls with negative differences or large positive differences were likely the result of multiple calls occurring within a very short time of each other.

Table 72. Average Time Lost per Call in the Cell Phone Records Stratified by Call Direction and Cell Phone Type Group Drivers Were Originally Assigned

Originally Assigned Group	Mean Time Lost per Incoming Call (Min)	Mean Time Lost per Outgoing Call (Min)	Mean Time Lost per Call of Unknown Direction (Min)
HH	0.583	0.418	0.483
PHF	0.568	0.432	0.483
IHF	0.541	0.438	0.445

The total estimated talk time was then computed by applying the above weights to the number of calls made by each driver in the cell phone records.

Total estimated talk time for driver *i* in group *y* = Total estimated incoming talk time + Total estimated outgoing talk time + Total estimated talk time for calls of unknown direction

= (total records-based incoming talk time – #incoming calls*mean time lost per incoming call for group *y*) + (total records-based outgoing talk time - #outgoing calls*mean time lost per outgoing call for group *y*) + (total records-based talk time for calls of unknown direction - #calls of unknown direction*mean time lost per call of unknown direction for group *y*)

A.11.2 Estimating Talk/Listen Time for the Three Cell Phone Types

The goal of this step was to estimate how much time drivers in an assigned cell phone type group spent talking on the various types of cell phones. This was done as follows. For each originally assigned cell phone type group, the total talk/listen time spent by drivers on each cell phone type was computed using the reduced cell phone interaction data. The proportion of time spent on each cell phone type was then computed for each group. The tables below present the proportion of time spent talking on the three types of cell phones computed by stratifying across each group (Table 73, Table 74, and Table 75). Note: every row sums to 1.

Table 73. Proportion of Talk Time Spent on an HH, PHF, or IHF Cell Phone During Incoming Calls in the Cell Phone Records

Originally Assigned Group	Proportion of Total Incoming Talk Time on HH Cell Phone	Proportion of Total Incoming Talk Time on IHF Cell Phone	Proportion of Total Incoming Talk Time on PHF Cell Phone
HH	0.835	0.012	0.153
PHF	0.520	0.082	0.399
IHF	0.351	0.626	0.023

Table 74. Proportion of Talk Time Spent on an HH, PHF, or IHF Cell Phone During Outgoing Calls in the Cell Phone Records

Originally Assigned Group	Proportion of Total Outgoing Talk Time on HH Cell Phone	Proportion of Total Outgoing Talk Time on IHF Cell Phone	Proportion of Total Outgoing Talk Time on PHF Cell Phone
HH	0.974	0.000	0.026
PHF	0.483	0.099	0.418
IHF	0.180	0.762	0.058

Table 75. Proportion of Talk Time Spent on an HH, PHF, or IHF Cell Phone During Calls of Unknown Direction in the Cell Phone Records

Originally Assigned Group	Proportion of Total Unknown Direction Talk Time on HH Cell Phone	Proportion of Total Unknown Direction Talk Time on IHF Cell Phone	Proportion of Total Unknown Direction Talk Time on PHF Cell Phone
HH	1.000	0.000	0.000
PHF	0.554	0.216	0.229
IHF	0.224	0.776	0.000

Total estimated talk time on cell phone type *x* for a driver *i* in group *y* =

> Total estimated incoming call time for driver *i* * proportion of cell phone type *x*, incoming, group *y* + Total estimated outgoing call time for driver *i* * proportion of cell phone type *x*, outgoing, group y + Total estimated unknown call time for driver *i* * proportion of cell phone type *x*, unknown, group *y*

A.11.3 Estimating Visual-Manual Subtask Time During Calls

The time spent performing visual-manual subtasks during a call was estimated as follows. First, the amount of time spent performing visual-manual subtasks for a given HH, PHF, or IHF interaction was computed by subtracting the reduced talk time from the overall length of the reduced cell phone interaction. The average visual-manual time per call was then computed by stratifying by the originally assigned cell phone group and the call direction.

Table 76. Average Amount of Time Spent Performing Visual-Manual Subtasks per Call

Originally Assigned Group	Mean Visual-Manual Subtask Time for Incoming Calls (Min)	Mean Visual-Manual Subtask Time for Outgoing Calls (Min)	Mean Visual-Manual Subtask Time for Calls of Unknown Direction (Min)
HH	0.170	0.340	0.220
PHF	0.152	0.317	0.267
IHF	0.112	0.251	0.288

Total estimated time spent performing visual-manual subtasks during calls = (#incoming calls * mean visual-manual subtask time for incoming calls) + (#outgoing calls * mean visual-manual subtask time for outgoing calls) + (#unknown calls * mean visual-manual subtask time for calls of unknown direction)

A.11.4 Estimating Visual-Manual Subtask Time During Text Messages

The time spent performing visual-manual subtasks during a text message was estimated. The procedure used considers that there were drivers that provided text records, and drivers that did not provide text records. The total duration of the visual-manual subtasks performed in the sampled text messages was computed. The average total visual-manual subtask duration was then computed by stratifying by originally assigned cell phone type group and the direction of the text message.

Table 77. Average Amount of Time Spent Performing Visual-Manual Subtasks per Text

Originally Assigned Group	Mean Visual-Manual Subtask Time for Incoming Text messages (Min)	Mean Visual-Manual Subtask Time for Outgoing Text messages (Min)	Mean Visual-Manual Subtask Time for Text messages of Unknown Direction (Min)
HH	0.627	0.718	0.535
PHF	0.819	1.046	0.000
IHF	0.465	0.699	0.398

The estimation equation used for the drivers that provided text records is as follows:

Total estimated time spent performing visual-manual subtasks during text messages = (# incoming text messages * mean visual-manual subtask time for incoming text messages) + (#outgoing text messages * mean visual-manual subtask time for outgoing text messages) + (#unknown text messages * mean visual-manual subtask time for text messages of unknown direction)

The estimation equation used for the drivers that did not provide text records is as follows. First, the text messaging rate (as measured by duration of text messaging per driving hour) was computed by originally assigned cell phone group using the available text records. The text messaging rates were then applied to the drivers without text records. The equation is shown below and the text messaging rates are shown in Table 78.

Total estimated time spent performing visual-manual subtasks during text messages = total driving hours * average time of text messaging per hour of driving

Table 78. Average Text Messaging Duration by Cell Phone Group

Originally Assigned Group	Number of Drivers	Total Driving Time Above 8 km/h (Hr)	Total Text Time (Min)	Average Text Messaging Duration per hour of driving (Min)
HH	34	49997.1	777.3	0.93
PHF	42	93662.7	3001.0	1.92
IHF	45	83205.8	807.1	0.58

Note that there are five drivers (three in the PHF group, two in the IHF group) with an extraordinarily high text messaging rate. Their rates were larger than the mean rate plus three standard deviations. Nevertheless, were kept in the estimates.

A.11.5 Estimating Overall Visual-Manual Time

The total estimated time spent performing visual-manual subtasks was computed by adding the total estimated visual-manual time for calls to the total estimated visual-manual time for text messages.

Total estimated visual-manual time = total call-based visual-manual time + total text-based visual-manual time

A.11.6 Estimating the Visual-Manual Time for the Three Cell Phone Types

In determining how to distribute the total visual-manual subtask time across the three cell phone types, the time spent performing visual-manual subtasks when text messaging was exclusively assigned to HH cell phone use. Next, the total time spent performing visual-manual subtasks during HH, PHF, and IHF calls was computed using the reduced cell phone samples (computed for each call as the duration of the cell phone interaction minus the duration of the talk/listen time). This was done separately for the drivers in each of the originally assigned cell phone type groups.

The proportion of the total time spent performing visual-manual subtasks during calls was then determined as follows. For each group, the total visual-manual time for a call was computed for each type of cell phone. The proportion of time for a given cell phone type was computed by dividing into the total visual-manual time. Note: every row sums up to 1 when full precision numbers are used.

Table 79. Proportion of Visual-Manual Time Spent on an HH, PHF, or IHF Cell Phone During Incoming Calls

Originally Assigned Group	Proportion of Total Incoming Visual-Manual Time on HH Cell Phone	Proportion of Total Incoming Visual-Manual Time on IHF Cell Phone	Proportion of Total Incoming Visual-Manual Time on PHF Cell Phone
HH	0.911	0.004	0.085
PHF	0.396	0.074	0.531
IHF	0.214	0.776	0.010

Table 80. Proportion of Visual-Manual Time Spent on an HH, PHF, or IHF Cell Phone During Outgoing Calls

Originally Assigned Group	Proportion of Total Outgoing Visual-Manual Time on HH Cell Phone	Proportion of Total Outgoing Visual-Manual Time on IHF Cell Phone	Proportion of Total Outgoing Visual-Manual Time on PHF Cell Phone
HH	0.975	0.000	0.025
PHF	0.577	0.024	0.399
IHF	0.219	0.648	0.133

Table 81. Proportion of Visual-Manual Time Spent on an HH, PHF, or IHF Cell Phone During Calls of Unknown Direction

Originally Assigned Group	Proportion of Total Unknown Direction Visual-Manual Time on HH Cell Phone	Proportion of Total Unknown Direction Visual-Manual Time on IHF Cell Phone	Proportion of Total Unknown Direction Visual-Manual Time on PHF Cell Phone
HH	1.000	0.000	0.000
PHF	0.653	0.143	0.205
IHF	0.717	0.283	0.000

Total VM time on an HH cell phone for a driver *i* in group *y*	=	Total incoming call-based VM time for driver *i* * proportion of time on HH cell phone, incoming, group *y* + Total outbound call-based VM time for driver *i* * proportion of time on HH cell phone, outgoing, group *y* + Total unknown direction call-based VM time for driver *i* * proportion of time on HH cell phone, unknown, group *y* + Total text-based VM time for driver *i*
Total VM time on a PHF cell phone for a driver *i* in group *y*	=	Total incoming call-based VM time for driver *i* * proportion of time on PHF cell phone, incoming, group *y* + Total outbound call-based VM time for driver *i* * proportion of time on PHF cell phone, outgoing, group *y* + Total unknown direction call-based VM time for driver *i* * proportion of time on PHF cell phone, unknown, group *y*
Total VM time on an IHF cell phone for a driver *i* in group *y*	=	Total incoming call-based VM time for driver *i* * proportion of time on IHF cell phone, incoming, group *y* + Total outbound call-based VM time for driver *i* * proportion of time on IHF cell phone, outgoing, group *y* + Total unknown direction call-based VM time for driver *i* * proportion of time on IHF cell phone, unknown, group *y*

A.11.7 Estimating the Total Cell Phone Use Time

Total Estimated cell phone use time = total estimated talk time + total estimated visual-manual time

A.11.8 Estimating the Total Cell Phone Use Time for the Three Cell Phone Types

Total Estimated cell phone use time on HH cell phone = total estimated talk time on HH cell phone + total estimated visual-manual time on HH cell phone

Total Estimated cell phone use time on PHF cell phone = total estimated talk time on PHF cell phone + total estimated visual-manual time on PHF cell phone

Total Estimated cell phone use time on IHF cell phone = total estimated talk time on IHF cell phone + total estimated visual-manual time on IHF cell phone

A.11.9 Estimating the Total General Driving Time

The total estimated time spent not using a cell phone was computed as follows.
Total estimated general driving time = total driving time – total estimated cell phone use time

A.12 Driver Performance ANOVA Results

A.12.1 Percent TEORT

Figure 10 shows the mean percent TEORT when drivers initiated various cell phone subtasks above 8 km/h. Figure 10, as well as the other analyses of driver performance in this appendix, only plot the call samples that were categorized as one of the three cell phone types or were a sampled text message. They also plot all the data that were available for each subtask, and are not graphical representations of the matched samples that were tested in the inferential tests.

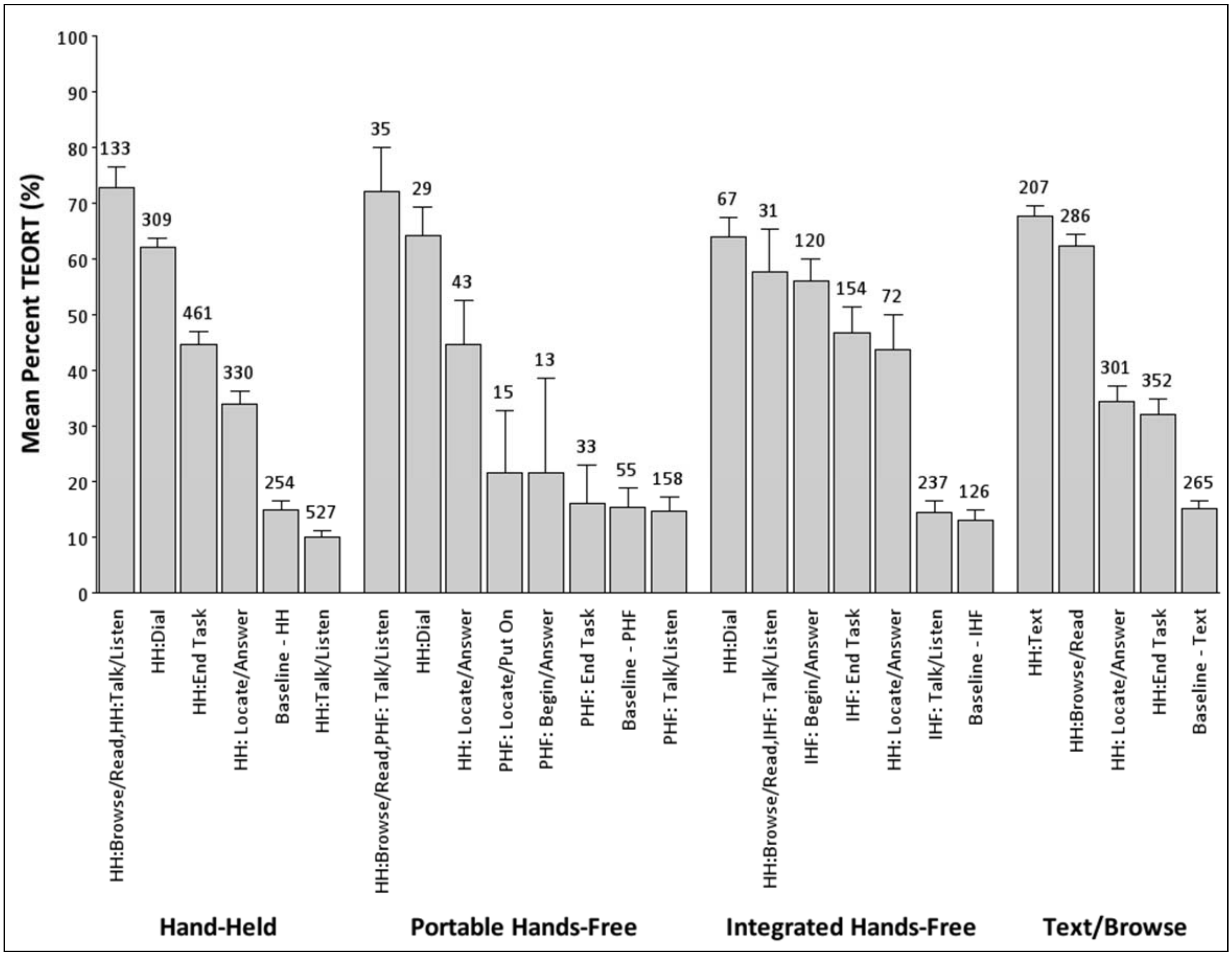

Figure 10. Drivers' Mean Percent TEORT When Initiating a Cell Phone Subtask Above 8 km/h

A.12.2 TEORT Duration

Figure 11 shows the mean TEORT duration when drivers initiated various cell phone subtasks above 8 km/h.

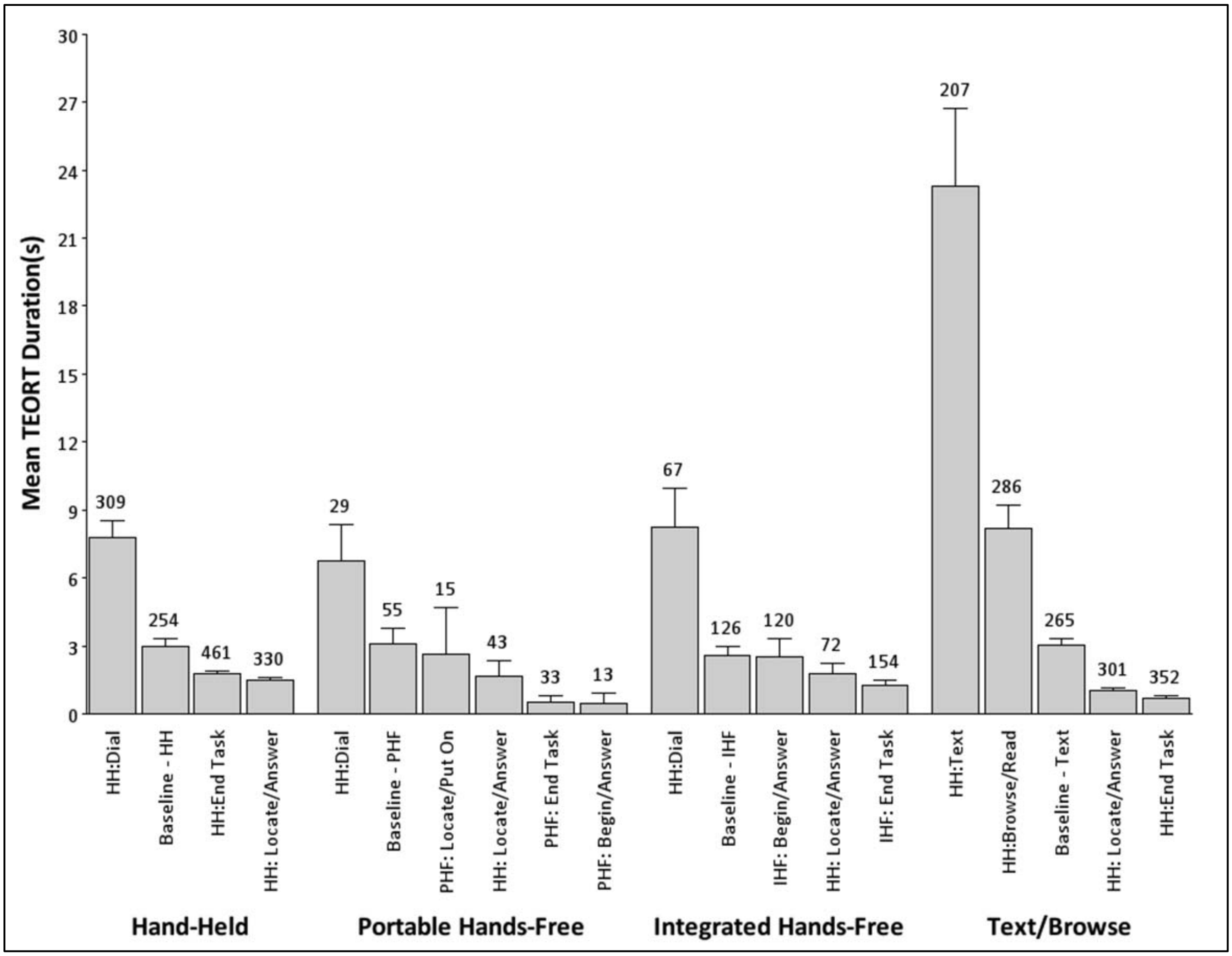

Figure 11. Drivers' Mean TEORT Duration When Initiating a Cell Phone Subtask Above 8 km/h.

Table 82 presents the ANOVA results for the between-subjects comparisons of TEORT durations for subtasks that perform a similar function. Tukey-Kramer tests were performed to identify where the significant differences existed.

Table 82. ANOVA Results for Between-Subject Comparisons of TEORT Durations for Subtasks that Perform a Similar Function

Action	Subtask	Mean EORT Duration (s)	SE	n	df_1	df_2	F Statistic	*p*-value
Locate Device	HH: Locate/Answer	1.5	0.1	1.5	2	169	1.84	.1624
Locate Device	HH: Locate/Answer for PHF	1.6	0.6	1.6	2	169	1.84	.1624
Locate Device	HH: Locate/Answer for IHF	2.5	0.4	2.5	2	169	1.84	.1624
Initiate Call	HH: Dial	7.8[A]	0.4	309	4	200	11.94	< .0001
Initiate Call	HH: Dial for PHF	6.8[A]	0.8	29	4	200	11.94	< .0001
Initiate Call	HH: Dial for IHF	8.3[A]	0.8	67	4	200	11.94	< .0001

Action	Subtask	Mean EORT Duration (s)	SE	n	df_1	df_2	F Statistic	*p*-value
Initiate Call	PHF: Begin/Answer	0.5^B	0.2	13	4	200	11.94	< .0001
Initiate Call	IHF: Begin/Answer	2.5^B	0.4	120	4	200	11.94	< .0001
End Use	HH: End Task	1.8^A	0.1	461	2	191	4.18	.0166
End Use	PHF: End Task	0.5^B	0.1	33	2	191	4.18	.0166
End Use	IHF: End Task	1.3^A	0.1	154	2	191	4.18	.0166

A.12.3 Speed Standard Deviation

Figure 12 shows the mean speed standard deviation of the vehicle when drivers initiated various cell phone subtasks above 8 km/h.

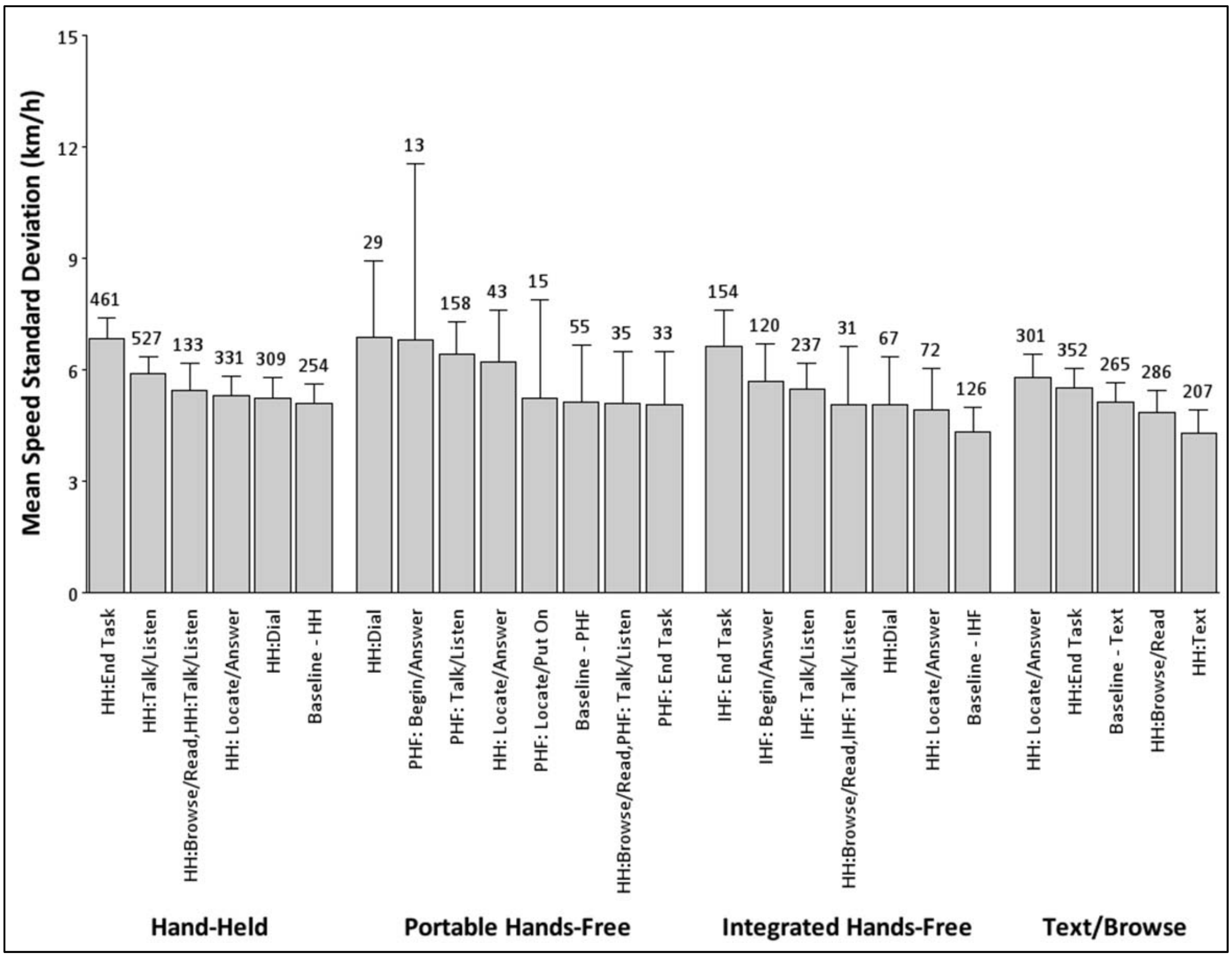

Figure 12. Drivers' Mean Speed Standard Deviation When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid speed measure, a one-way within-subject ANOVA was performed to investigate whether the mean speed standard deviation when initiating the subtask differed from the mean speed standard deviation during the baseline sample. Table 83 presents the ANOVA summary results for each test.

Table 83. ANOVA Results for Within-Subject Comparisons of Speed Standard Deviation Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	4.81	0.29	5.05	0.32	202	1	87	0.38	.5387
Hand-Held	HH: Dial	4.75	0.36	4.61	0.42	131	1	64	3.08	.0842
Hand-Held	HH: Talk/Listen	4.79	0.28	5.09	0.33	207	1	91	0.03	.8528
Hand-Held	HH: Browse/Read, HH: Talk/Listen	3.81	0.42	4.57	0.50	56	1	34	0.82	.3706
Hand-Held	HH: End Task	4.96	0.31	6.32	0.46	179	1	84	4.50	.0368
Portable Hands-Free	PHF: Locate/Put On	4.28	0.70	3.67	0.83	4	1	2	0.68	.4950
Portable Hands-Free	PHF: Begin/Answer	6.98	3.28	7.55	3.44	8	1	5	0.00	.9654
Portable Hands-Free	HH: Locate/Answer	4.80	0.93	6.67	1.12	23	1	12	1.78	.2066
Portable Hands-Free	HH: Dial	5.75	1.53	7.06	1.72	13	1	7	0.49	.5078
Portable Hands-Free	PHF: Talk/Listen	5.01	0.84	5.95	0.80	49	1	22	0.86	.3647
Portable Hands-Free	PHF: End Task	4.63	2.09	5.84	1.80	9	1	6	0.61	.4648
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	3.43	1.18	5.86	1.10	16	1	12	3.30	.0945
Integrated Hands-Free	IHF: Begin/Answer	4.51	0.47	4.66	0.70	69	1	36	0.22	.6433
Integrated Hands-Free	HH: Locate/Answer	4.87	0.69	3.65	0.66	39	1	25	3.94	.0582
Integrated Hands-Free	HH: Dial	4.47	0.75	3.89	1.03	31	1	21	0.42	.5256
Integrated Hands-Free	IHF: Talk/Listen	4.29	0.38	4.60	0.53	109	1	49	0.07	.7862
Integrated Hands-Free	IHF: End Task	3.95	0.41	5.19	0.72	77	1	43	4.39	.0422
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	2.95	0.54	3.90	1.01	14	1	11	1.15	.3075
Text/Browse	HH: Locate/Answer	4.54	0.32	5.22	0.41	192	1	55	2.08	.1545
Text/Browse	HH: Browse/Read	4.43	0.35	4.70	0.44	157	1	47	0.01	.9320
Text/Browse	HH: Text	4.24	0.41	3.84	0.40	112	1	26	0.06	.8150
Text/Browse	HH: End Task	4.62	0.33	5.15	0.36	178	1	49	1.25	.2696

To investigate whether changes in speed standard deviation when performing a subtask differed across cell phone types, speed difference scores were created by subtracting the matched baseline speed standard deviation from the subtask speed standard deviation. The difference scores were grouped by cell phone type and compared using one-way between-subjects ANOVAs. Table 84 presents the mean speed standard deviation differences for the subtasks and their respective test statistics. No significant differences were found.

Table 84. Mean Speed Standard Deviation Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Locate Device	HH: Locate/Answer	0.24	0.38	202	2	127	2.21	.1143
Locate Device	HH: Locate/Answer for PHF	1.50	1.07	27	2	127	2.21	.1143
Locate Device	HH: Locate/Answer for IHF	-1.22	0.96	39	2	127	2.21	.1143
Initiate Call	HH: Dial	-0.13	0.52	131	4	133	0.79	.5367
Initiate Call	HH: Dial for PHF	1.31	2.35	13	4	133	0.79	.5367
Initiate Call	HH: Dial for IHF	-0.58	1.26	31	4	133	0.79	.5367
Initiate Call	PHF: Begin/Answer	0.57	4.23	8	4	133	0.79	.5367
Initiate Call	IHF: Begin/Answer	0.15	0.76	69	4	133	0.79	.5367
Talk/Listen	HH: Talk/Listen	0.31	0.39	207	2	162	0.41	.6649
Talk/Listen	PHF: Talk/Listen	0.94	1.07	49	2	162	0.41	.6649
Talk/Listen	IHF: Talk/Listen	0.32	0.56	109	2	162	0.41	.6649
Browse and Talk	HH: Browse/Read, HH: Talk/Listen	0.67	0.67	56	2	57	0.40	.6695
Browse and Talk	HH: Browse/Read, PHF: Talk/Listen	2.43	1.40	16	2	57	0.40	.6695
Browse and Talk	HH: Browse/Read, IHF: Talk/Listen	0.95	1.08	14	2	57	0.40	.6695
End Use	HH: End Task	1.35	0.55	179	2	133	0.23	.7921
End Use	PHF: End Task	1.21	1.60	9	2	133	0.23	.7921
End Use	IHF: End Task	1.24	0.77	77	2	133	0.23	.7921

A.12.4 Headway Standard Deviation

Figure 13 shows the mean headway standard deviation of the vehicle when drivers initiated various cell phone subtasks above 8 km/h. Similarly to speed standard deviation, headway standard deviation was computed over the first 20 s from the start of the subtask.

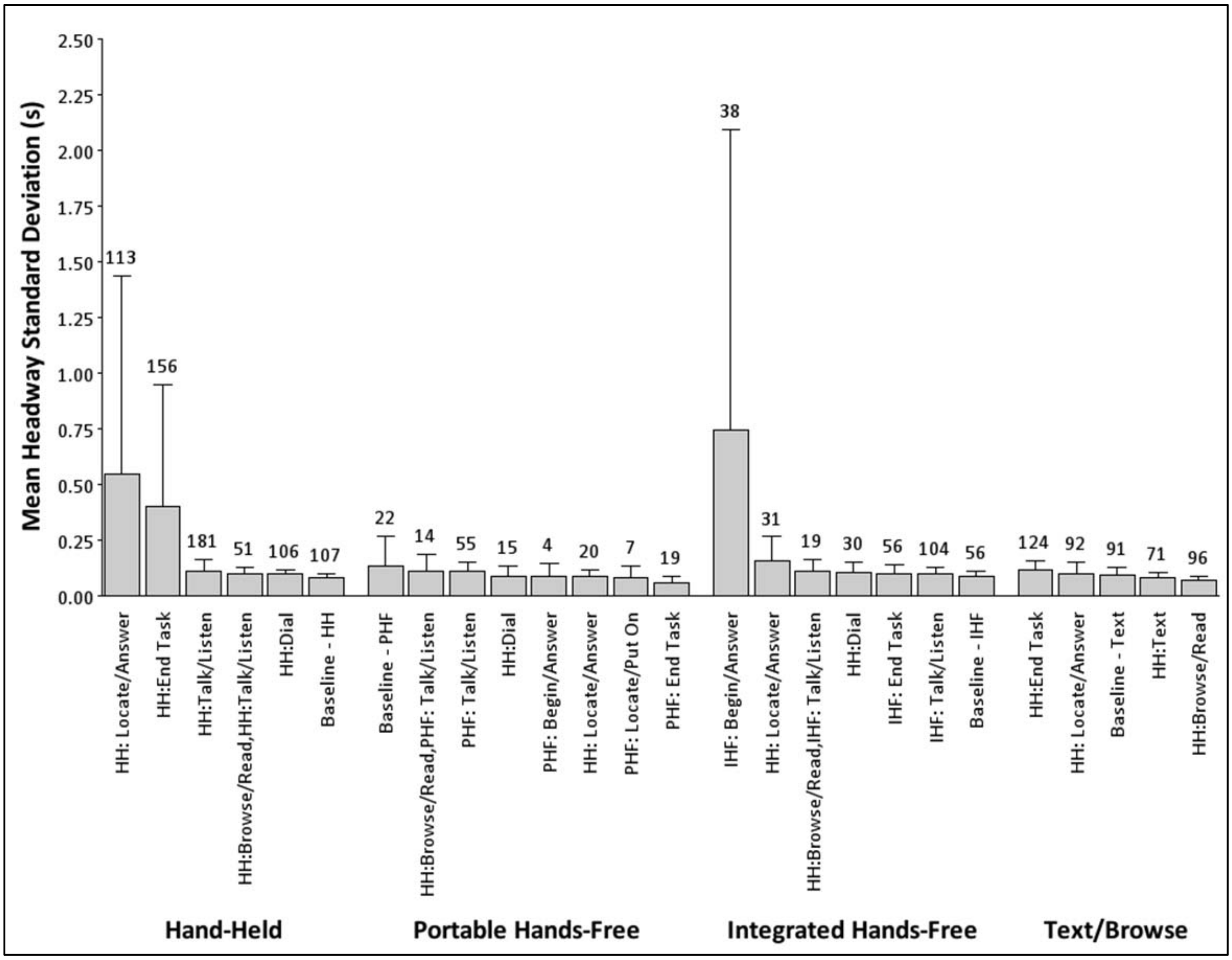

Figure 13. Drivers' Mean Headway Standard Deviation When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid headway measure, a one-way within-subject ANOVA was performed to investigate whether the mean headway standard deviation when initiating the subtask differed from the mean headway standard deviation during the baseline sample. Table 85 presents the ANOVA summary results for each test.

Table 85. ANOVA Results for Within-Subject Comparisons of Headway Standard Deviation Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	0.06	0.01	1.09	0.99	51	1	32	0.39	.5346
Hand-Held	HH: Dial	0.07	0.01	0.12	0.02	36	1	23	3.94	.0593
Hand-Held	HH: Talk/Listen	0.06	0.01	0.07	0.01	50	1	32	0.25	.6184
Hand-Held	HH: Browse/Read, HH: Talk/Listen	0.05	0.01	0.07	0.02	18	1	12	0.51	.4893
Hand-Held	HH: End Task	0.06	0.01	0.11	0.02	40	1	25	3.92	.0587

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Portable Hands-Free	PHF: Locate/Put On	0.06	0.00	0.07	0.03	2	-	-	-	-
Portable Hands-Free	PHF: Begin/Answer	0.52	0.40	0.09	0.03	3	-	-	-	-
Portable Hands-Free	HH: Locate/Answer	0.03	0.01	0.09	0.03	5	-	-	-	-
Portable Hands-Free	HH: Dial	0.03	0.02	0.08	0.03	4	-	-	-	-
Portable Hands-Free	PHF: Talk/Listen	0.15	0.09	0.08	0.04	14	1	10	0.91	.3627
Portable Hands-Free	PHF: End Task	0.05	0.02	0.05	0.02	3	-	-	-	-
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	0.15	0.10	0.11	0.06	6	-	-	-	-
Integrated Hands-Free	IHF: Begin/Answer	0.07	0.01	0.08	0.02	16	1	12	0.47	.5060
Integrated Hands-Free	HH: Locate/Answer	0.09	0.02	0.12	0.04	15	1	11	0.55	.4754
Integrated Hands-Free	HH: Dial	0.08	0.03	0.14	0.04	10	1	8	1.70	.2291
Integrated Hands-Free	IHF: Talk/Listen	0.07	0.01	0.07	0.01	32	1	23	0.09	.7634
Integrated Hands-Free	IHF: End Task	0.09	0.02	0.09	0.03	17	1	14	0.05	.8206
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	0.06	0.02	0.07	0.02	8	1	6	0.53	.4955
Text/Browse	HH: Locate/Answer	0.08	0.03	0.06	0.01	34	1	23	0.65	.4273
Text/Browse	HH: Browse/Read	0.05	0.01	0.05	0.01	35	1	22	0.00	.9502
Text/Browse	HH: Text	0.08	0.02	0.06	0.02	18	1	12	2.24	.1606
Text/Browse	HH: End Task	0.08	0.03	0.09	0.02	32	1	19	0.00	.9761

To investigate whether changes in headway standard deviation when performing a subtask differed across cell phone types, headway standard deviation difference scores were created by subtracting the matched baseline headway standard deviation from the subtask headway standard deviation. The difference scores were grouped by cell phone type and compared using one-way between-subjects ANOVAs. Table 86 presents the mean headway standard deviation differences for the subtasks and their respective test statistics. No significant differences were found.

Table 86. Mean Headway Standard Deviation Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Locate Device	HH: Locate/Answer	1.03	0.99	51	2	46	0.08	.9189
Locate Device	HH: Locate/Answer for PHF	0.04	0.02	9	2	46	0.08	.9189
Locate Device	HH: Locate/Answer for IHF	0.03	0.04	15	2	46	0.08	.9189
Initiate Call	HH: Dial	0.05	0.02	36	-	-	-	-
Initiate Call	HH: Dial for PHF	0.07	0.05	4	-	-	-	-
Initiate Call	HH: Dial for IHF	0.06	0.06	10	-	-	-	-
Initiate Call	PHF: Begin/Answer	-0.43	0.38	3	-	-	-	-

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Initiate Call	IHF: Begin/Answer	0.00	0.02	16	4	47	4.63	.0031
Talk/Listen	HH: Talk/Listen	0.01	0.01	50	2	65	2.34	.1048
Talk/Listen	PHF: Talk/Listen	-0.07	0.09	14	2	65	2.34	.1048
Talk/Listen	IHF: Talk/Listen	0.00	0.01	32	2	65	2.34	.1048
Browse and Talk	HH: Browse/Read, HH: Talk/Listen	0.01	0.02	18	2	23	1.24	.3067
Browse and Talk	HH: Browse/Read, PHF: Talk/Listen	-0.05	0.04	6	2	23	1.24	.3067
Browse and Talk	HH: Browse/Read, IHF: Talk/Listen	0.01	0.03	8	2	23	1.24	.3067
End Use	HH: End Task	0.05	0.02	40	2	41	1.06	.3571
End Use	PHF: End Task	0.00	0.02	3	2	41	1.06	.3571
End Use	IHF: End Task	0.01	0.04	16	2	41	1.06	.3571

A.12.5 Unintentional Lane Bust Rate

Figure 14 shows the mean unintentional lane bust rate when drivers initiated various cell phone subtasks above 8 km/h. The unintentional lane bust rate was computed as the number of unintentional lane busts that occurred during the sample interval divided by the duration of the sample interval.

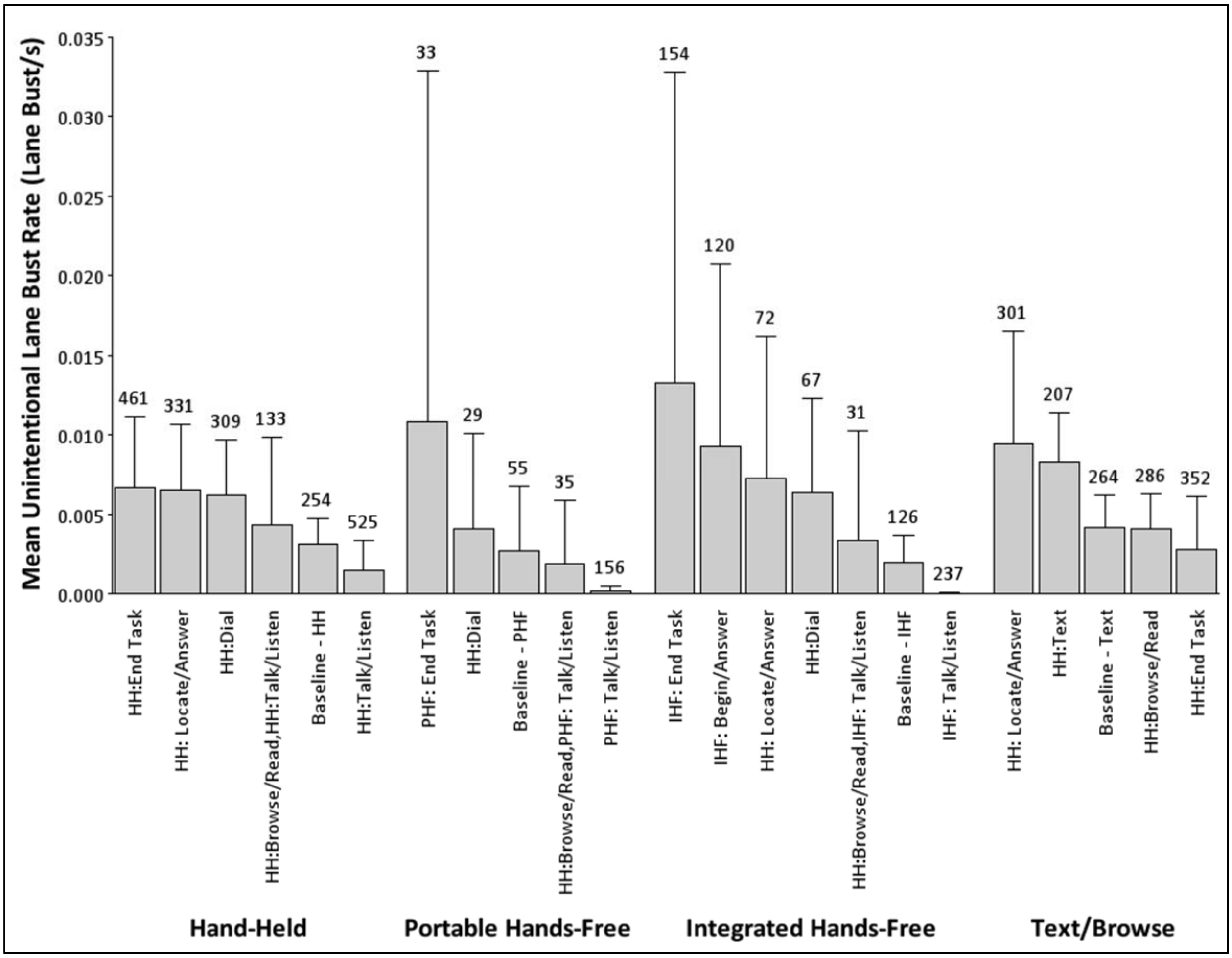

Figure 14. Drivers' Mean Unintentional Lane Bust Rate When Performing a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid unintentional lane bust rate, a one-way within-subject ANOVA was performed to investigate whether the mean unintentional lane bust rate when initiating the subtask differed from the mean unintentional lane bust rate during the baseline sample. Table 87 presents the ANOVA summary results for each test.

Table 87. ANOVA Results for Within-Subject Comparisons of Unintentional Lane Bust Rate Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	.003	.001	0.005	0.002	202	1	87	1.62	.2065
Hand-Held	HH: Dial	.005	.001	0.003	0.001	131	1	64	2.29	.1350
Hand-Held	HH: Talk/Listen	.003	.001	0.001	0.000	207	1	91	5.90	.0171
Hand-Held	HH: Browse/Read, HH: Talk/Listen	.005	.002	0.009	0.007	56	1	34	0.04	.8480
Hand-Held	HH: End Task	.003	.001	0.004	0.003	179	1	84	0.18	.6746

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Portable Hands-Free	PHF: Locate/Put On	.000	.000	0.000	0.000	4	-	-	-	-
Portable Hands-Free	PHF: Begin/Answer	.000	.000	0.000	0.000	8	1	5	-	-
Portable Hands-Free	HH: Locate/Answer	.002	.002	0.000	0.000	23	1	12	1.38	.2627
Portable Hands-Free	HH: Dial	.000	.000	0.006	0.006	13	1	7	0.75	.4146
Portable Hands-Free	PHF: Talk/Listen	.003	.002	0.000	0.000	47	1	21	2.14	.1581
Portable Hands-Free	PHF: End Task	.000	.000	0.000	0.000	9	1	6	-	-
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	.009	.007	0.000	0.000	16	1	12	2.12	.1714
Integrated Hands-Free	IHF: Begin/Answer	.003	.001	0.015	0.010	69	1	36	1.17	.2871
Integrated Hands-Free	HH: Locate/Answer	.001	.001	0.011	0.008	39	1	25	1.26	.2719
Integrated Hands-Free	HH: Dial	.000	.000	0.006	0.004	31	1	21	1.77	.1973
Integrated Hands-Free	IHF: Talk/Listen	.002	.001	0.000	0.000	109	1	49	3.19	.0801
Integrated Hands-Free	IHF: End Task	.003	.001	0.027	0.020	77	1	43	0.94	.3366
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	.000	.000	0.000	0.000	14	1	11	-	-
Text/Browse	HH: Locate/Answer	.005	.001	0.009	0.005	191	1	55	0.58	.4482
Text/Browse	HH: Browse/Read	.005	.001	0.005	0.002	156	1	47	0.07	.7891
Text/Browse	HH: Text	.004	.001	0.005	0.002	112	1	26	0.05	.8200
Text/Browse	HH: End Task	.004	.001	0.005	0.003	177	1	49	2.42	.1262

To investigate whether changes in unintentional lane bust rate when performing a subtask differed across cell phone types, unintentional lane bust rate difference scores were created by subtracting the matched baseline unintentional lane bust rate from the subtask unintentional lane bust rate. The difference scores were grouped by cell phone type and compared using one-way between-subjects ANOVAs. Table 88 presents the mean unintentional lane bust rate differences for the subtasks and their respective test statistics. No significant differences were found.

Table 88. Mean Unintentional Lane Bust Rate Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Locate Device	HH: Locate/Answer	0.001	0.002	202	2	127	0.82	.4434
Locate Device	HH: Locate/Answer for PHF	-0.002	0.002	27	2	127	0.82	.4434
Locate Device	HH: Locate/Answer for IHF	0.009	0.008	39	2	127	0.82	.4434
Initiate Call	HH: Dial	-0.002	0.002	131	4	133	0.99	.4131
Initiate Call	HH: Dial for PHF	0.006	0.006	13	4	133	0.99	.4131
Initiate Call	HH: Dial for IHF	0.006	0.004	31	4	133	0.99	.4131
Initiate Call	PHF: Begin/Answer	0.000	0.000	8	4	133	0.99	.4131
Initiate Call	IHF: Begin/Answer	0.012	0.009	69	4	133	0.99	.4131
Talk/Listen	HH: Talk/Listen	-0.003	0.001	207	2	161	0.50	.6094
Talk/Listen	PHF: Talk/Listen	-0.003	0.002	47	2	161	0.50	.6094
Talk/Listen	IHF: Talk/Listen	-0.002	0.001	109	2	161	0.50	.6094
Browse and Talk	HH: Browse/Read, HH: Talk/Listen	0.005	0.006	56	2	57	1.59	.2130
Browse and Talk	HH: Browse/Read, PHF: Talk/Listen	-0.009	0.007	16	2	57	1.59	.2130
Browse and Talk	HH: Browse/Read, IHF: Talk/Listen	0.000	0.000	14	2	57	1.59	.2130
End Use	HH: End Task	0.001	0.002	179	2	133	0.92	.3996
End Use	PHF: End Task	0.000	0.000	9	2	133	0.92	.3996
End Use	IHF: End Task	0.024	0.020	77	2	133	0.92	.3996

A.12.6 Peak Deceleration

Figure 15 shows the mean peak deceleration of the vehicle within 10 seconds of the driver initiating a cell phone subtask above 8 km/h.

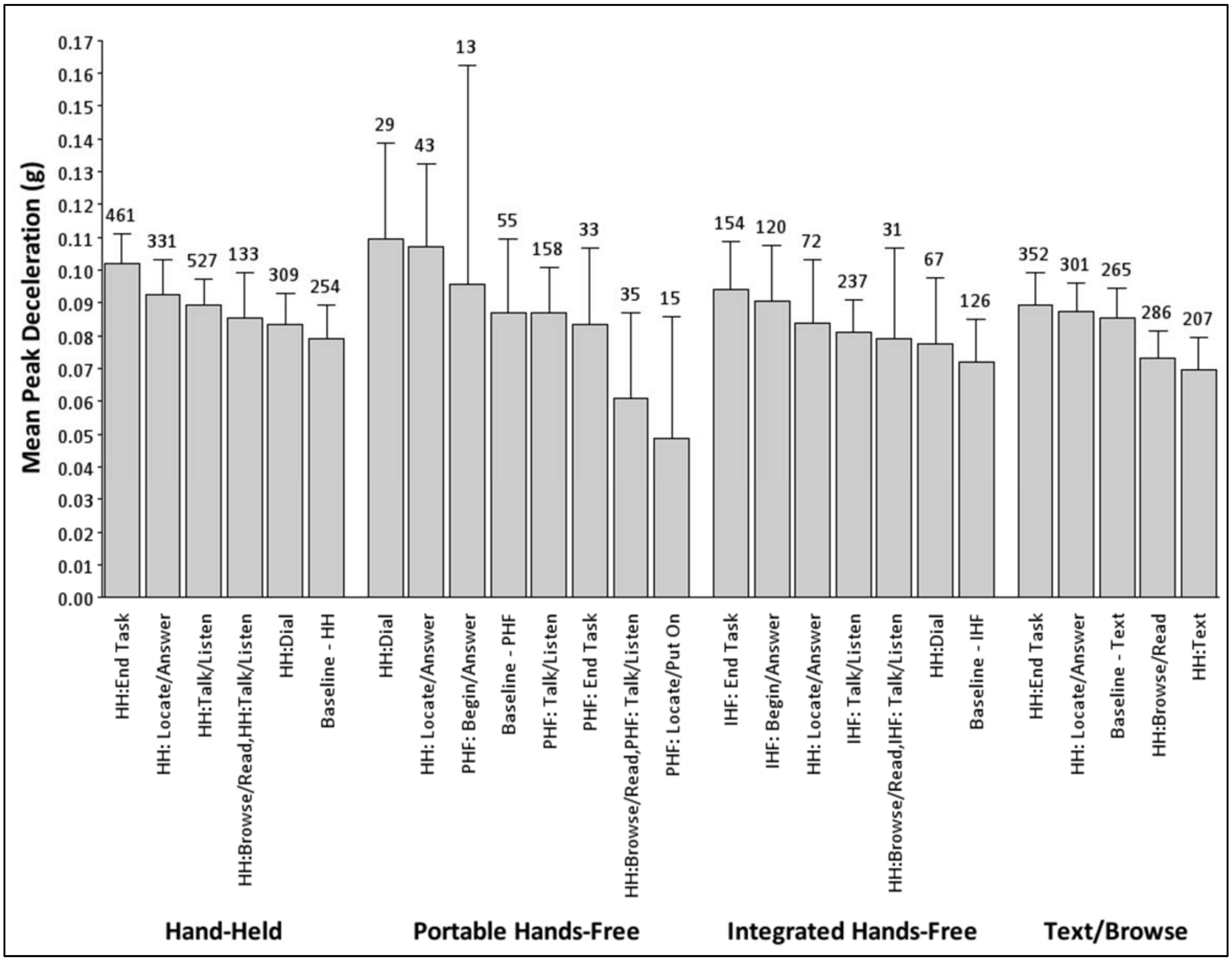

Figure 15. Drivers' Mean Peak Deceleration When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid acceleration measure, a one-way within-subject ANOVA was performed to investigate whether the mean peak deceleration when initiating the subtask differed from the mean peak deceleration during the baseline sample. Table 89 presents the ANOVA summary results for each test.

Table 89. ANOVA Results for Within-Subject Comparisons of Peak Deceleration Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	0.077	0.006	0.088	0.007	202	1	87	0.21	.6490
Hand-Held	HH: Dial	0.073	0.007	0.076	0.007	131	1	64	0.40	.5300
Hand-Held	HH: Talk/Listen	0.079	0.006	0.084	0.006	207	1	91	0.26	.6114
Hand-Held	HH: Browse/Read, HH: Talk/Listen	0.079	0.011	0.083	0.011	56	1	34	0.49	.4907
Hand-Held	HH: End Task	0.078	0.007	0.105	0.008	179	1	84	5.51	.0212
Portable Hands-Free	PHF: Locate/Put On	0.054	0.040	0.030	0.009	4	1	2	1.07	.4102
Portable Hands-Free	PHF: Begin/Answer	0.096	0.033	0.073	0.046	8	1	5	0.07	.8054
Portable Hands-Free	HH: Locate/Answer	0.102	0.018	0.110	0.016	23	1	12	0.00	.9811
Portable Hands-Free	HH: Dial	0.111	0.031	0.085	0.017	13	1	7	0.12	.7367
Portable Hands-Free	PHF: Talk/Listen	0.087	0.012	0.092	0.013	49	1	22	0.02	.8919
Portable Hands-Free	PHF: End Task	0.078	0.027	0.077	0.029	9	1	6	0.28	.6174
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	0.059	0.017	0.089	0.020	16	1	12	2.51	.1391
Integrated Hands-Free	IHF: Begin/Answer	0.074	0.009	0.072	0.009	69	1	36	0.05	.8287
Integrated Hands-Free	HH: Locate/Answer	0.061	0.013	0.073	0.009	39	1	25	0.21	.6513
Integrated Hands-Free	HH: Dial	0.061	0.015	0.059	0.008	31	1	21	0.22	.6448
Integrated Hands-Free	IHF: Talk/Listen	0.067	0.007	0.073	0.007	109	1	49	0.03	.8567
Integrated Hands-Free	IHF: End Task	0.067	0.008	0.076	0.009	77	1	43	0.23	.6311
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	0.060	0.007	0.063	0.019	14	1	11	0.04	.8468
Text/Browse	HH: Locate/Answer	0.078	0.005	0.087	0.006	192	1	55	3.27	.0759
Text/Browse	HH: Browse/Read	0.080	0.006	0.078	0.006	157	1	47	0.32	.5734
Text/Browse	HH: Text	0.078	0.006	0.072	0.007	112	1	26	0.17	.6848
Text/Browse	HH: End Task	0.078	0.005	0.079	0.007	178	1	49	0.33	.5655

To investigate whether changes in peak deceleration when performing a subtask differed across cell phone types, peak deceleration difference scores were created by subtracting the matched baseline peak deceleration from the subtask peak deceleration. The difference scores were grouped by cell phone type and compared using one-way between-subjects ANOVAs. Table 90 presents the mean peak deceleration differences for the subtasks and their respective test statistics. No significant differences were found.

Table 90. Mean Peak Deceleration Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Locate Device	HH: Locate/Answer	0.011	0.007	202	2	127	0.07	.9312
Locate Device	HH: Locate/Answer for PHF	0.003	0.019	27	2	127	0.07	.9312
Locate Device	HH: Locate/Answer for IHF	0.012	0.015	39	2	127	0.07	.9312
Initiate Call	HH: Dial	0.003	0.009	131	4	133	0.06	.9936
Initiate Call	HH: Dial for PHF	-0.026	0.031	13	4	133	0.06	.9936
Initiate Call	HH: Dial for IHF	-0.002	0.015	31	4	133	0.06	.9936
Initiate Call	PHF: Begin/Answer	-0.023	0.063	8	4	133	0.06	.9936
Initiate Call	IHF: Begin/Answer	-0.002	0.012	69	4	133	0.06	.9936
Talk/Listen	HH: Talk/Listen	-0.003	0.001	207	2	161	0.50	.6094
Talk/Listen	PHF: Talk/Listen	-0.003	0.002	47	2	161	0.50	.6094
Talk/Listen	IHF: Talk/Listen	-0.002	0.001	109	2	161	0.50	.6094
Browse and Talk	HH: Browse/Read, HH: Talk/Listen	0.000	0.011	56	2	57	1.29	.2831
Browse and Talk	HH: Browse/Read, PHF: Talk/Listen	0.030	0.019	16	2	57	1.29	.2831
Browse and Talk	HH: Browse/Read, IHF: Talk/Listen	0.002	0.020	14	2	57	1.29	.2831
End Use	HH: End Task	0.027	0.009	179	2	133	0.77	.4640
End Use	PHF: End Task	-0.002	0.040	9	2	133	0.77	.4640
End Use	IHF: End Task	0.010	0.012	77	2	133	0.77	.4640

A.12.7 Driver Performance When Using a Cell Phone near Intersections

Figure 16 shows the percentage of subtasks in which the driver scanned before entering the intersection.

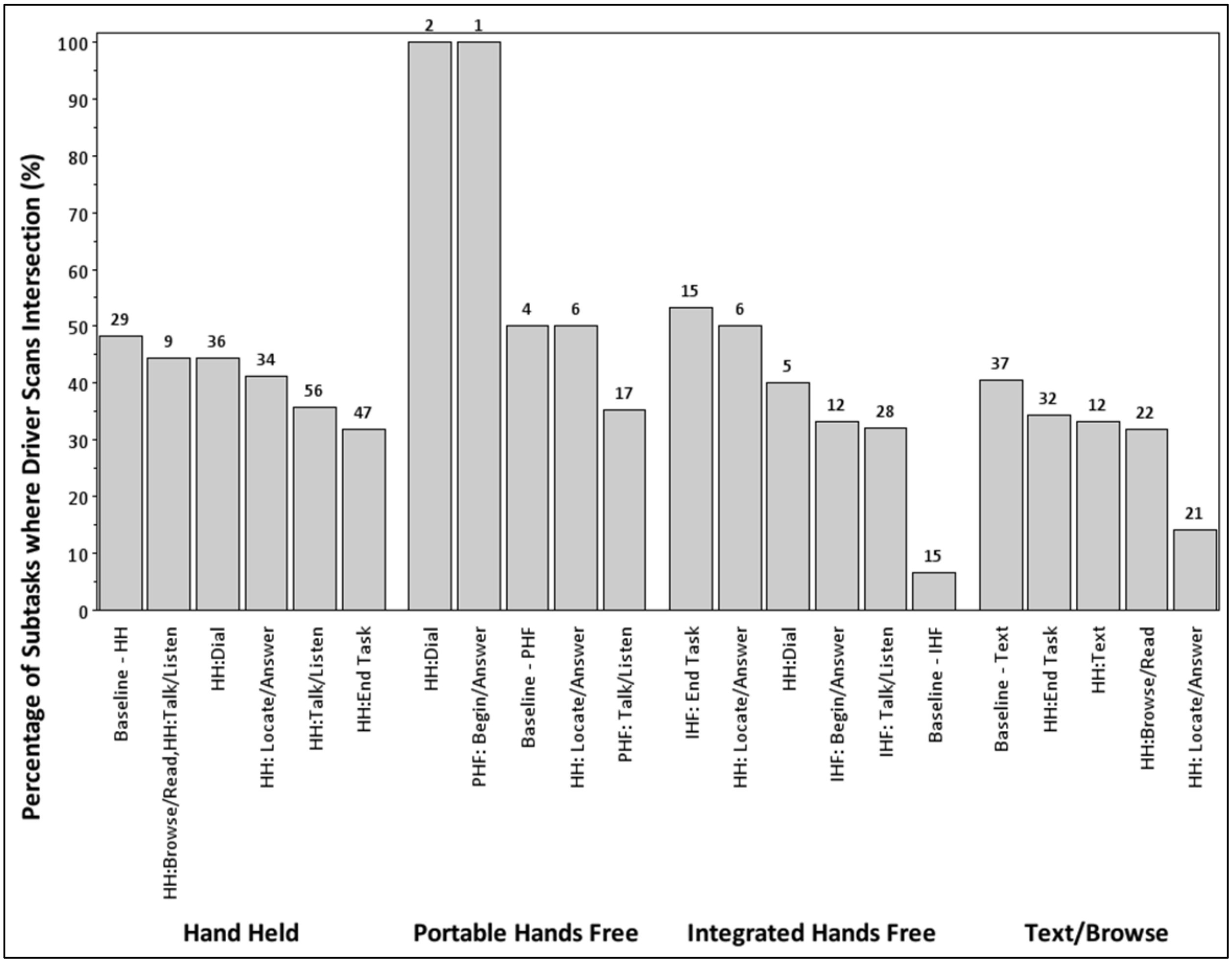

Figure 16. Percentage of Cell Phone Subtask Above 8 km/h Where Driver Scanned Intersection

A.13 Driver Adaptation ANOVA Results

A.13.1 Speed

Figure 17 shows the mean speed of the vehicle when drivers initiated various cell phone subtasks above 8 km/h.

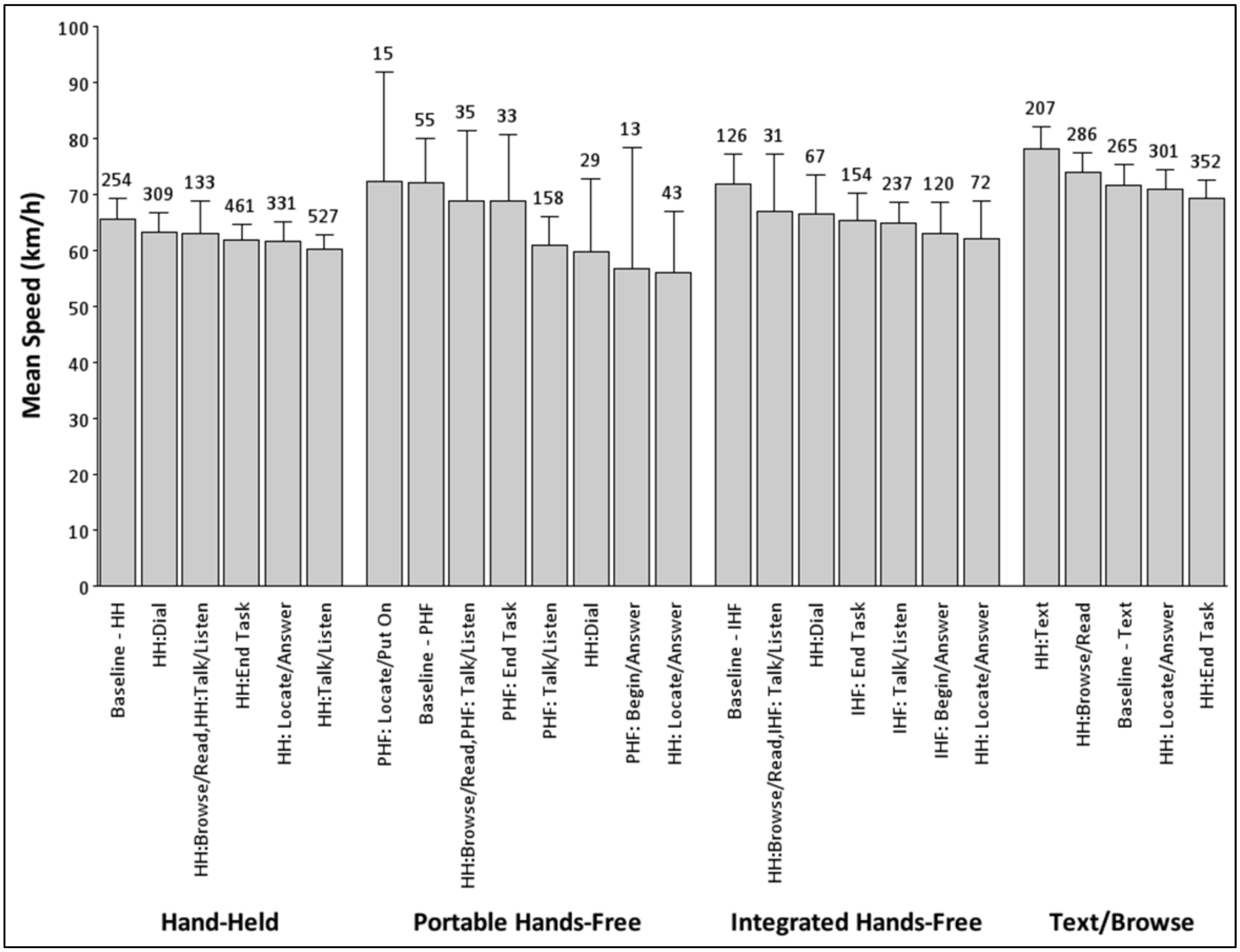

Figure 17. Drivers' Mean Speed When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid speed measure, a one-way within-subject ANOVA was performed to investigate whether the mean speed when initiating the subtask differed from the mean speed during the baseline sample. Table 91 presents the ANOVA summary results for each test.

Table 91. ANOVA Results for Within-Subject Comparisons of Mean Speed Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	69.0	2.1	69.5	2.1	202	1	87	0.43	.5122
Hand-Held	HH: Dial	70.1	2.7	72.2	2.6	131	1	64	2.39	.1268
Hand-Held	HH: Talk/Listen	68.8	2.1	67.4	2.1	207	1	91	0.83	.3645
Hand-Held	HH: Browse/Read, HH: Talk/Listen	74.4	4.2	69.6	4.3	56	1	34	1.60	.2152
Hand-Held	HH: End Task	69.6	2.3	68.2	2.3	179	1	84	0.02	.8852
Portable Hands-Free	PHF: Locate/Put On	89.0	7.5	93.3	8.5	4	1	2	0.49	.5558
Portable Hands-Free	PHF: Begin/Answer	82.2	10.1	70.2	13.6	8	1	5	1.14	.3347
Portable Hands-Free	HH: Locate/Answer	70.9	5.6	61.1	7.4	23	1	12	3.09	.1040
Portable Hands-Free	HH: Dial	73.5	6.9	68.0	9.3	13	1	7	2.35	.1693
Portable Hands-Free	PHF: Talk/Listen	74.8	4.0	68.1	4.7	49	1	22	2.88	.1038
Portable Hands-Free	PHF: End Task	80.7	10.7	68.5	11.1	9	1	6	0.38	.5590
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	80.2	6.5	75.5	9.3	16	1	12	0.82	.3826
Integrated Hands-Free	IHF: Begin/Answer	72.7	3.7	75.4	3.1	69	1	36	2.18	.1483
Integrated Hands-Free	HH: Locate/Answer	67.9	4.7	71.3	3.9	39	1	25	0.87	.3588
Integrated Hands-Free	HH: Dial	72.5	5.6	78.7	4.1	31	1	21	2.56	.1249
Integrated Hands-Free	IHF: Talk/Listen	74.9	2.9	75.0	2.7	109	1	49	1.85	.1798
Integrated Hands-Free	IHF: End Task	73.5	3.3	74.6	3.4	77	1	43	1.08	.3051
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	91.5	6.2	77.5	7.1	14	1	11	12.64	.0045
Text/Browse	HH: Locate/Answer	79.3	2.1	79.6	2.1	192	1	55	0.06	.8134
Text/Browse	HH: Browse/Read	82.5	2.3	81.8	2.2	157	1	47	1.25	.2687
Text/Browse	HH: Text	81.1	2.9	81.3	2.7	112	1	26	0.14	.7101
Text/Browse	HH: End Task	78.4	2.3	75.5	2.3	178	1	49	1.67	.2027

To investigate whether changes in speed when performing a subtask differed across cell phone types, speed difference scores were created by subtracting the matched baseline speed from the subtask speed. The difference scores were grouped by cell phone type and compared using one-way between-subjects ANOVAs. Table 92 presents the mean speed differences for the subtasks and their respective test statistics.

Table 92. Mean Speed Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Locate Device	HH: Locate/Answer	0.5	1.3	202	2	127	1.42	.2446
Locate Device	HH: Locate/Answer for PHF	-7.6	4.3	27	2	127	1.42	.2446
Locate Device	HH: Locate/Answer for IHF	3.4	3.7	39	2	127	1.42	.2446
Initiate Call	HH: Dial	2.1	1.6	131	4	133	2.34	.0584
Initiate Call	HH: Dial for PHF	-5.5	4.0	13	4	133	2.34	.0584
Initiate Call	HH: Dial for IHF	6.2	4.1	31	4	133	2.34	.0584
Initiate Call	PHF: Begin/Answer	-12.0	10.4	8	4	133	2.34	.0584
Initiate Call	IHF: Begin/Answer	2.6	2.1	69	4	133	2.34	.0584
Talk/Listen	HH: Talk/Listen	-1.5	1.6	207	2	162	3.09	.0481
Talk/Listen	PHF: Talk/Listen	-6.7	4.2	49	2	162	3.09	.0481
Talk/Listen	IHF: Talk/Listen	0.2	2.1	109	2	162	3.09	.0481
Browse and Talk	HH: Browse/Read, HH: Talk/Listen	-4.7	2.9	56	2	57	0.97	.3847
Browse and Talk	HH: Browse/Read, PHF: Talk/Listen	-4.7	7.1	16	2	57	0.97	.3847
Browse and Talk	HH: Browse/Read, IHF: Talk/Listen	-13.9	3.8	14	2	57	0.97	.3847
End Use	HH: End Task	-1.4	1.9	179	2	133	0.79	.4570
End Use	PHF: End Task	-12.2	13.7	9	2	133	0.79	.4570
End Use	IHF: End Task	2.0	2.8	77	2	133	0.79	.4570

A.13.2 Headway

Figure 18 shows the mean headway of the vehicle when drivers initiated various cell phone subtasks above 8 km/h.

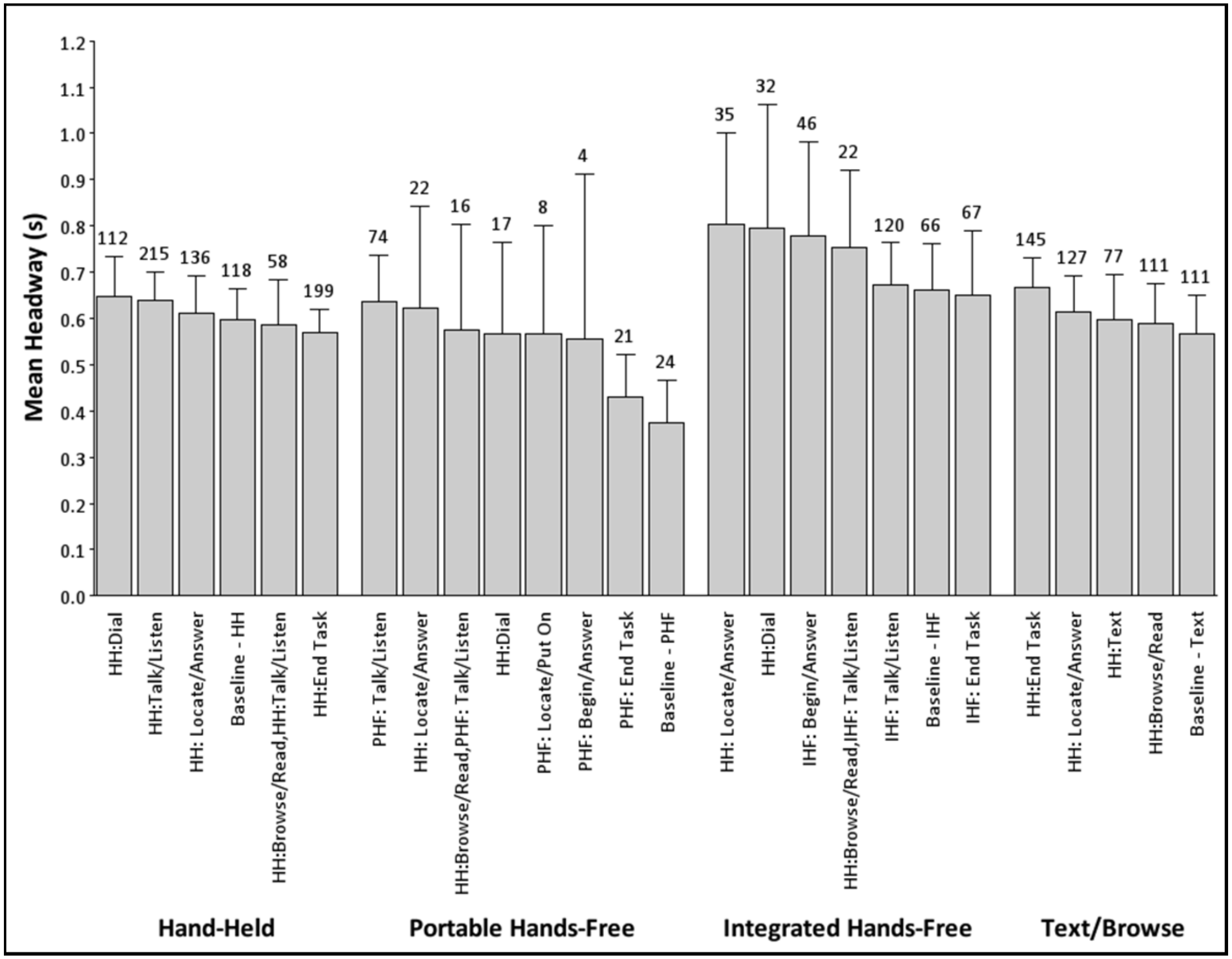

Figure 18. Drivers' Mean Headway When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid headway measure, a one-way within-subject ANOVA was performed to investigate whether the mean headway when initiating the subtask differed from the mean headway during the baseline sample. Table 93 presents the ANOVA summary results for each test.

Table 93. ANOVA Results for Within-Subject Comparisons of Mean Headway Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	0.5	0.0	0.6	0.0	72	1	43	1.16	.2866
Hand-Held	HH: Dial	0.5	0.0	0.7	0.1	42	1	27	3.06	.0915
Hand-Held	HH: Talk/Listen	0.6	0.0	0.6	0.0	65	1	40	2.26	.1406
Hand-Held	HH: Browse/Read, HH: Talk/Listen	0.5	0.1	0.5	0.1	22	1	15	0.00	.9781
Hand-Held	HH: End Task	0.5	0.0	0.5	0.0	58	1	34	0.75	.3932
Portable Hands-Free	PHF: Locate/Put On	0.2	0.0	0.3	0.1	2	-	-	-	-
Portable Hands-Free	PHF: Begin/Answer	0.4	0.1	0.6	0.2	3	-	-	-	-
Portable Hands-Free	HH: Locate/Answer	0.3	0.1	0.5	0.1	9	1	4	2.80	.1696
Portable Hands-Free	HH: Dial	0.3	0.0	0.4	0.1	5	-	-	-	-
Portable Hands-Free	PHF: Talk/Listen	0.4	0.1	0.5	0.1	18	1	12	1.44	.2527
Portable Hands-Free	PHF: End Task	0.4	0.2	0.3	0.1	3	-	-	-	-
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	0.5	0.1	0.6	0.1	8	1	6	0.09	.7707
Integrated Hands-Free	IHF: Begin/Answer	0.5	0.1	0.5	0.1	23	1	18	0.95	.3438
Integrated Hands-Free	HH: Locate/Answer	0.7	0.1	0.7	0.1	19	1	14	0.45	.5117
Integrated Hands-Free	HH: Dial	0.6	0.1	0.6	0.1	14	1	11	0.05	.8320
Integrated Hands-Free	IHF: Talk/Listen	0.7	0.1	0.6	0.1	42	1	28	2.50	.1253
Integrated Hands-Free	IHF: End Task	0.6	0.1	0.6	0.1	22	1	18	0.10	.7585
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	0.7	0.2	0.8	0.1	10	1	8	0.43	.5308
Text/Browse	HH: Locate/Answer	0.5	0.0	0.5	0.1	62	1	33	0.42	.5230

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Text/Browse	HH: Browse/Read	0.5	0.0	0.5	0.1	49	1	29	0.09	.7660
Text/Browse	HH: Text	0.4	0.1	0.6	0.1	29	1	15	5.03	.0405
Text/Browse	HH: End Task	0.5	0.1	0.6	0.1	52	1	27	0.04	.8363

To investigate whether changes in headway when performing a subtask differed across cell phone types, headway difference scores were created by subtracting the matched baseline headway from the subtask headway. The difference scores were grouped by cell phone type and compared using one-way between-subjects ANOVAs. Table 94 presents the mean headway differences for the subtasks and their respective test statistics.

Table 94. Mean Headway Difference Scores for Various Subtasks Across Cell Phone Types

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
Locate Device	HH: Locate/Answer	0.0	0.0	72	2	62	1.11	.3352
Locate Device	HH: Locate/Answer for PHF	0.2	0.1	11	2	62	1.11	.3352
Locate Device	HH: Locate/Answer for IHF	0.0	0.1	19	2	62	1.11	.3352
Initiate Call	HH: Dial	0.1	0.1	42	-	-	-	-
Initiate Call	HH: Dial for PHF	0.1	0.1	5	-	-	-	-
Initiate Call	HH: Dial for IHF	0.0	0.1	14	-	-	-	-
Initiate Call	PHF: Begin/Answer	0.1	0.3	3	-	-	-	-
Initiate Call	IHF: Begin/Answer	-77.4	6.0	26	-	-	-	-
Talk/Listen	HH: Talk/Listen	0.1	0.1	65	2	80	2.42	.0954
Talk/Listen	PHF: Talk/Listen	0.1	0.1	18	2	80	2.42	.0954
Talk/Listen	IHF: Talk/Listen	-0.1	0.1	42	2	80	2.42	.0954
Browse and Talk	HH: Browse/Read, HH: Talk/Listen	0.0	0.1	22	2	29	0.22	.8028
Browse and Talk	HH: Browse/Read, PHF: Talk/Listen	0.1	0.1	8	2	29	0.22	.8028
Browse and Talk	HH: Browse/Read, IHF: Talk/Listen	0.1	0.2	10	2	29	0.22	.8028

Action	Subtask	Mean Difference	SE	n	df_1	df_2	F Statistic	*p* value
End Use	HH: End Task	0.0	0.1	58	2	54	0.37	.6912
End Use	PHF: End Task	-0.1	0.1	3	2	54	0.37	.6912
End Use	IHF: End Task	0.0	0.1	21	2	54	0.37	.6912

A.13.3 TTC

Figure 19 shows the mean TTC of the vehicle when drivers initiated various cell phone subtasks above 8 km/h.

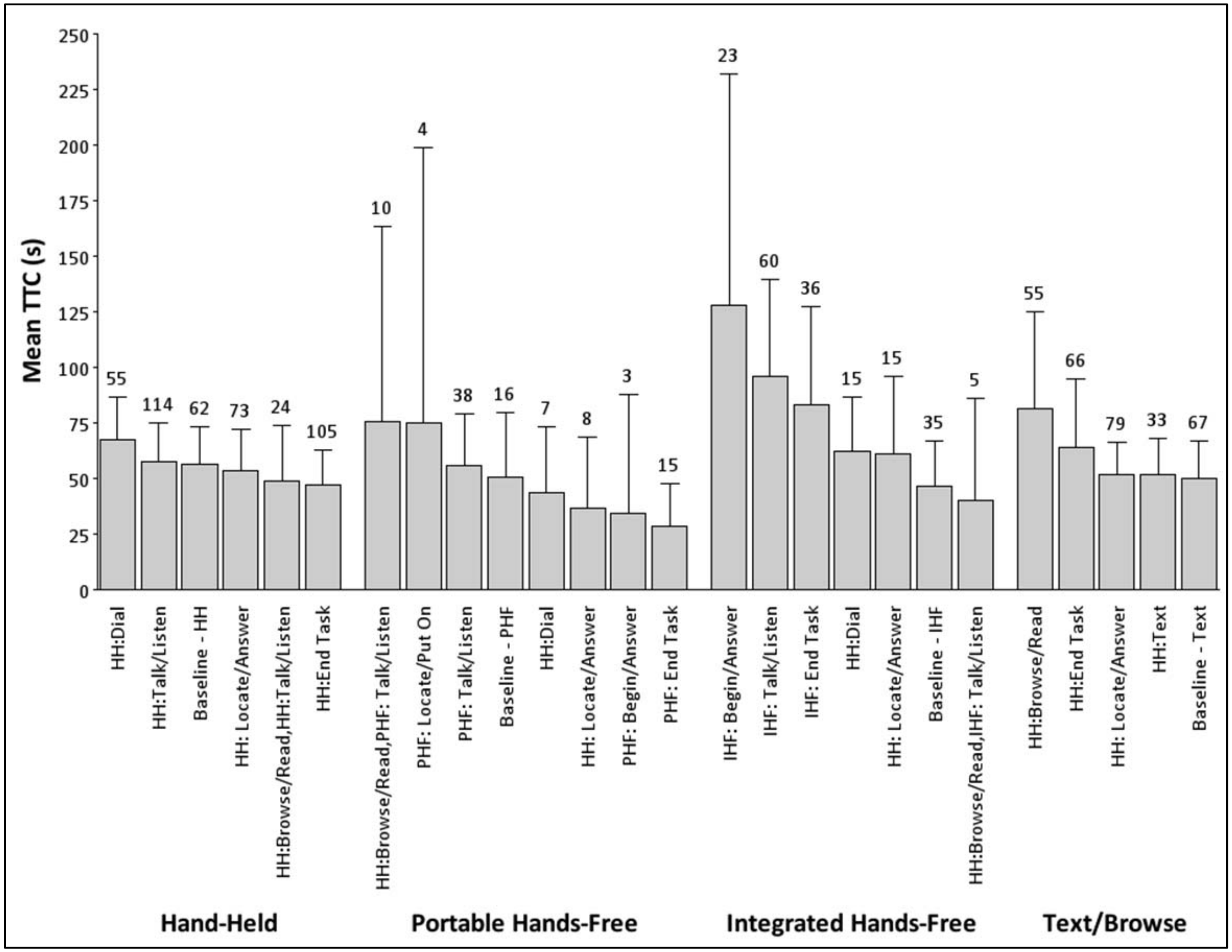

Figure 19. Drivers' Mean TTC When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample that had a valid TTC measure, a one-way within-subject ANOVA was performed to investigate whether the mean TTC when initiating the subtask differed from the mean TTC during the baseline sample. Table 95 presents the ANOVA summary results for each test.

Table 95. ANOVA Results for Within-Subject Comparisons of Mean TTC Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Mean	SE	Subtask Mean	SE	n	df_1	df_2	F Statistic	*p* value
Hand-Held	HH: Locate/Answer	50.8	10.8	73.2	24.2	24	1	18	0.85	.3675
Hand-Held	HH: Dial	53.4	18.4	50.9	12.8	12	1	11	0.01	.9228
Hand-Held	HH: Talk/Listen	62.2	15.6	101.7	28.8	20	1	15	1.21	.2890
Hand-Held	HH: Browse/Read, HH: Talk/Listen	115.6	38.1	70.2	40.1	5	-	-	-	-
Hand-Held	HH: End Task	60.0	12.2	43.5	12.4	22	1	17	0.46	.5072
Portable Hands-Free	PHF: Locate/Put On	195.2	.	18.7	-	1	-	-	-	-
Portable Hands-Free	PHF: Begin/Answer	43.2	37.1	24.2	12.8	2	-	-	-	-
Portable Hands-Free	HH: Locate/Answer	58.4	45.4	8.3	0.2	2	-	-	-	-
Portable Hands-Free	HH: Dial	-	-	-	-	-	-	-	-	-
Portable Hands-Free	PHF: Talk/Listen	65.0	29.5	52.3	19.7	6	-	-	-	-
Portable Hands-Free	PHF: End Task	-	-	-	-	-	-	-	-	-
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	61.3	27.8	22.2	8.2	4	-	-	-	-
Integrated Hands-Free	IHF: Begin/Answer	24.9	8.4	112.4	94.3	5	-	-	-	-
Integrated Hands-Free	HH: Locate/Answer	54.4	22.2	131.7	49.1	3	-	-	-	-
Integrated Hands-Free	HH: Dial	12.1	8.9	83.1	47.0	2	-	-	-	-
Integrated Hands-Free	IHF: Talk/Listen	41.5	8.2	67.6	20.8	13	1	10	2.45	.1486
Integrated Hands-Free	IHF: End Task	25.5	5.3	130.7	62.6	9	1	7	2.96	.1291
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	93.7	2.7	69.3	35.2	2	-	-	-	-
Text/Browse	HH: Locate/Answer	78.0	17.7	61.7	15.3	26	1	18	0.42	.5250
Text/Browse	HH: Browse/Read	59.6	18.6	46.5	11.8	19	1	14	0.62	.4441
Text/Browse	HH: Text	56.7	17.1	74.9	28.1	6	-	-	-	-
Text/Browse	HH: End Task	52.1	24.0	35.1	6.8	13	1	9	0.54	.4822

A.13.4 SV Lane Change Behavior

Figure 20 shows the percentage of subtasks performed above 8 km/h where the SV was observed to change lanes in the 10-second interval spanning 5 seconds prior to the start of the subtask up to 5 seconds after the start of the subtask.

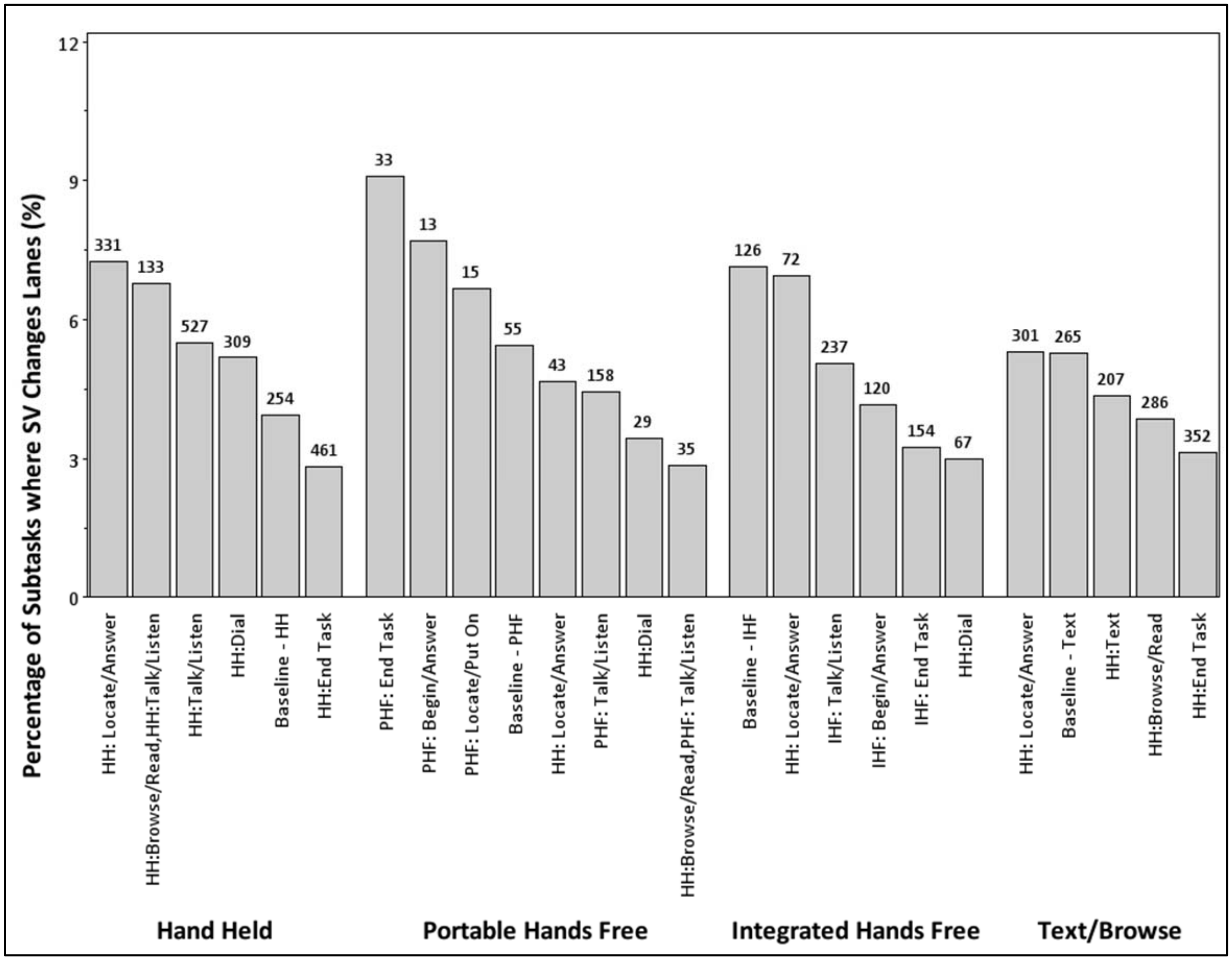

Figure 20. Drivers' Mean Headway When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample, a McNemar Change test was performed to investigate whether the proportion of subtasks in which the SV changed lanes differed from the proportion of baseline periods in which the SV changed lanes. Table 96 presents the summary results for each test.

Table 96. Results for Within-Subject Comparisons of SV Lane Change Behavior Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Percent	Subtask Percent	n	$\chi^2_{McNemar}$	*p*-value
Hand-Held	HH: Locate/Answer	3.96	9.90	202	6.00000	.0227
Hand-Held	HH: Dial	4.58	8.40	131	1.66667	.3018
Hand-Held	HH: Talk/Listen	3.38	6.28	207	2.00000	.2379
Hand-Held	HH: Browse/Read, HH: Talk/Listen	1.85	1.79	56	0.00000	1.0000
Hand-Held	HH: End Task	3.91	2.79	179	0.33333	.7744
Portable Hands-Free	PHF: Locate/Put On	0.00	0.00	4	-	-
Portable Hands-Free	PHF: Begin/Answer	12.50	12.50	8	0.00000	1.0000
Portable Hands-Free	HH: Locate/Answer	4.35	4.35	1	-	-
Portable Hands-Free	HH: Dial	0.00	0.00	13	.	.
Portable Hands-Free	PHF: Talk/Listen	6.12	4.08	49	0.20000	1.0000
Portable Hands-Free	HH: Locate/Answer	4.35	4.35	1	-	-
Integrated Hands-Free	IHF: Begin/Answer	5.80	2.90	69	1.00000	.6250
Integrated Hands-Free	HH: Locate/Answer	7.69	10.26	39	0.14286	1.0000
Integrated Hands-Free	HH: Dial	6.45	3.23	31	0.33333	1.0000
Integrated Hands-Free	IHF: Talk/Listen	8.33	5.56	108	0.81818	.5488
Integrated Hands-Free	IHF: End Task	8.00	3.95	76	1.00000	.5078
Text/Browse	HH: Locate/Answer	5.21	7.81	192	1.08696	.4049
Text/Browse	HH: Browse/Read	5.10	4.46	157	0.09091	1.0000

Cell Phone Type	Subtask	Baseline Percent	Subtask Percent	n	$\chi^2_{McNemar}$	*p*-value
Text/Browse	HH: Text	3.30	5.49	91	0.66667	.6875
Text/Browse	HH: End Task	4.40	1.26	159	2.77778	.1797

To investigate whether changes in SV lane change behavior when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. SV changed lanes during subtask, but not during baseline
2. SV changed lanes in both baseline and subtask, or SV did not change lanes in both baseline and subtask
3. SV changed lanes during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Table 97 presents the percentage of samples for each of the three categories and the respective chi-square p-value.

Table 97. Results for Between-Subjects Comparisons of SV Lane Change Behavior Across Cell Phone Types

Action	Subtask	SV LC During Subtask, but Not During Baseline	Same LC Behavior During Baseline and Subtask	SV LC During Baseline, but Not During Subtask	n	*df*	χ^2	*p*-value
Locate Device	HH: Locate/Answer	8.91	88.12	2.97	202	6	3.3517	.76358
Locate Device	PHF: Locate/Put On	0.00	100.00	0.00	4	6	3.3517	.76358
Locate Device	HH: Locate/Answer on PHF	4.35	91.30	4.35	23	6	3.3517	.76358
Locate Device	HH: Locate/Answer on IHF	10.26	82.05	7.69	39	6	3.3517	.76358
Initiate Call	HH: Dial	7.63	88.55	3.82	131	8	7.8083	.45241
Initiate Call	HH: Dial on PHF	0.00	100.00	0.00	13	8	7.8083	.45241
Initiate Call	HH: Dial on IHF	3.23	90.32	6.45	31	8	7.8083	.45241
Initiate Call	PHF: Begin/Answer	12.50	75.00	12.50	8	8	7.8083	.45241
Initiate Call	IHF: Begin/Answer	1.45	94.20	4.35	69	8	7.8083	.45241
Talk/Listen	HH: Talk/Listen	5.80	91.30	2.90	207	4	3.1932	.52603
Talk/Listen	PHF: Talk/Listen	4.08	89.80	6.12	49	4	3.1932	.52603
Talk/Listen	IHF: Talk/Listen	3.70	89.81	6.48	108	4	3.1932	.52603
Talk and Browse	HH: Browse/Read, HH: Talk/Listen	1.79	96.43	1.79	56	4	3.3149	.50658
Talk and Browse	HH: Browse/Read, PHF: Talk/Listen	6.25	93.75	0.00	16	4	3.3149	.50658
Talk and Browse	HH: Browse/Read, IHF: Talk/Listen	0.00	92.86	7.14	14	4	3.3149	.50658
End Use	HH: End Task	1.40	96.65	1.96	358	4	11.7721	.01913
End Use	PHF: End Task	0.00	88.89	11.11	9	4	11.7721	.01913
End Use	IHF: End Task	3.95	88.16	7.89	76	4	11.7721	.01913

A.13.5 SV Lane Position

Figure 21 shows the percentage of subtasks performed above 8 km/h where the SV was traveling in the right-most lane when initiating the subtask.

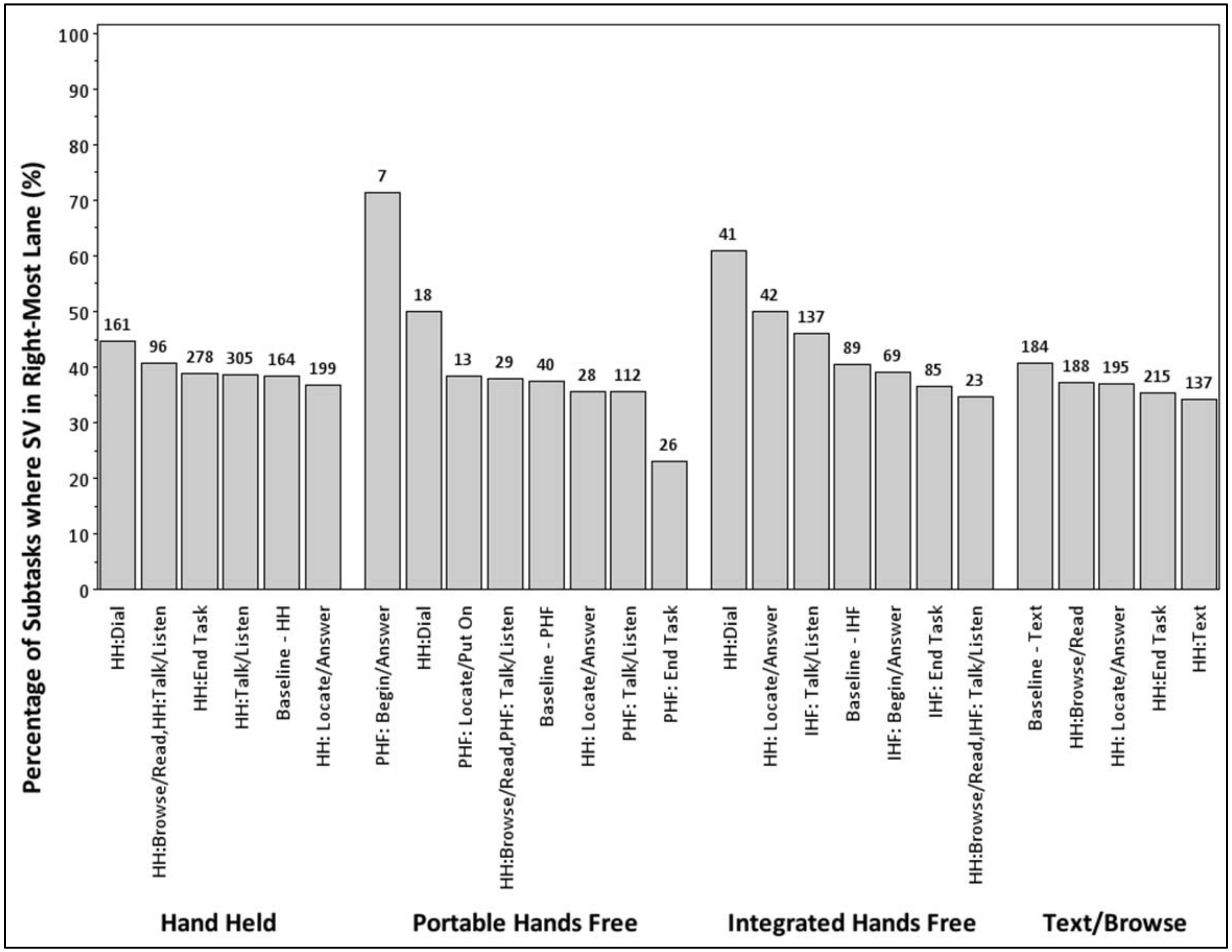

Figure 21. Percentage of Samples in Which Vehicle Traveled in Right-Most Lane When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample, a McNemar Change test was performed to investigate whether the proportion of subtasks in which the SV traveled in the right-most lane differed from the proportion of baseline periods in which the SV traveled in the right-most lane. Table 98 presents the summary results for each test.

Table 98. Results for Within-Subject Comparisons of SV Right Lane Position Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Percent	Subtask Percent	n	$\chi^2_{McNemar}$	*p*-value
Hand-Held	HH: Locate/Answer	40.65	33.33	123	3.00000	.1221
Hand-Held	HH: Dial	42.25	42.25	71	0.00000	1.0000
Hand-Held	HH: Talk/Listen	38.39	41.07	112	0.24324	.7428
Hand-Held	HH: Browse/Read, HH: Talk/Listen	25.64	31.71	41	0.81818	.5488
Hand-Held	HH: End Task	34.62	40.38	104	1.00000	.4050
Portable Hands-Free	HH: Text, PHF: Talk/Listen	0.00	66.67	3	-	-
Portable Hands-Free	PHF: Begin/Answer	83.33	83.33	6	-	-
Portable Hands-Free	HH: Dial	55.56	44.44	9	1.00000	1.0000
Portable Hands-Free	PHF: Talk/Listen	37.14	34.29	35	0.14286	1.0000
Portable Hands-Free	PHF: End Task	28.57	28.57	7	-	-
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	58.33	50.00	12	1.00000	1.0000
Integrated Hands-Free	IHF: Begin/Answer	38.64	29.55	44	2.00000	.2891
Integrated Hands-Free	HH: Locate/Answer	30.43	43.48	23	1.28571	.4531
Integrated Hands-Free	HH: Dial	40.00	55.00	20	1.28571	.4531
Integrated Hands-Free	IHF: Talk/Listen	37.68	37.68	69	0.00000	1.0000
Integrated Hands-Free	IHF: End Task	45.00	35.00	40	1.60000	.3438
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	18.18	45.45	11	3.00000	.2500
Text/Browse	HH: Locate/Answer	39.68	38.10	126	0.14286	.8506
Text/Browse	HH: Browse/Read	32.35	35.29	102	0.39130	.6776

Cell Phone Type	Subtask	Baseline Percent	Subtask Percent	n	$\chi^2_{McNemar}$	*p*-value
Text/Browse	HH: Text	31.88	28.99	69	0.28571	.7905
Text/Browse	HH: End Task	38.00	34.00	100	0.88889	.4807

To investigate whether changes in SV lane position behavior when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. SV in right-most lane during subtask, but not during baseline
2. SV in right-most lane for both baseline and subtask, or SV not in right-most lane for both baseline and subtask
3. SV in right-most lane during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Table 99 presents the percentage of samples for each of the three categories and the respective chi-square p-value.

Table 99. Results for Between-Subjects Comparisons of SV Lane Change Behavior Across Cell Phone Types

Action	Subtask	SV LC During Subtask, but Not During Baseline	Same LC Behavior During Baseline and Subtask	SV LC During Baseline, but Not During Subtask	n	*df*	χ^2	*p*-value
Locate Device	HH: Locate/Answer	7.32	78.05	14.63	123	-	-	-
Locate Device	PHF: Locate/Put On	66.67	33.33	0.00	3	-	-	-
Locate Device	HH: Locate/Answer on PHF	0.00	94.12	5.88	17	-	-	-
Locate Device	HH: Locate/Answer on IHF	21.74	69.57	8.70	23	-	-	-
Initiate Call	HH: Dial	11.27	77.46	11.27	71	-	-	-
Initiate Call	HH: Dial on PHF	0.00	88.89	11.11	9	-	-	-
Initiate Call	HH: Dial on IHF	25.00	65.00	10.00	20	-	-	-
Initiate Call	PHF: Begin/Answer	0.00	100.00	0.00	6	-	-	-

Action	Subtask	SV LC During Subtask, but Not During Baseline	Same LC Behavior During Baseline and Subtask	SV LC During Baseline, but Not During Subtask	n	*df*	χ^2	*p*-value
Initiate Call	IHF: Begin/Answer	4.55	81.82	13.64	44	-	-	-
Talk/Listen	HH: Talk/Listen	17.86	66.96	15.18	112	4	2.8718	.57951
Talk/Listen	PHF: Talk/Listen	8.57	80.00	11.43	35	4	2.8718	.57951
Talk/Listen	IHF: Talk/Listen	17.39	65.22	17.39	69	4	2.8718	.57951
Talk and Browse	HH: Browse/Read, HH: Talk/Listen	17.07	73.17	9.76	41	4	4.3872	.35613
Talk and Browse	HH: Browse/Read, PHF: Talk/Listen	0.00	91.67	8.33	12	4	4.3872	.35613
Talk and Browse	HH: Browse/Read, IHF: Talk/Listen	27.27	72.73	.	11	4	4.3872	.35613
End Use	HH: End Task	10.10	82.69	7.21	208	-	-	-
End Use	PHF: End Task	28.57	42.86	28.57	7	-	-	-
End Use	IHF: End Task	7.50	75.00	17.50	40	-	-	-

A.14 Downstream Effects From Drivers Using a Cell Phone ANOVA Results

A.14.1 Range to Rear Vehicle

Figure 22 shows the percentage of subtasks performed above 8 km/h where the Rear Vehicle (RV) was rated to be traveling closely behind the SV (less than 20 m) at the start of the subtask.

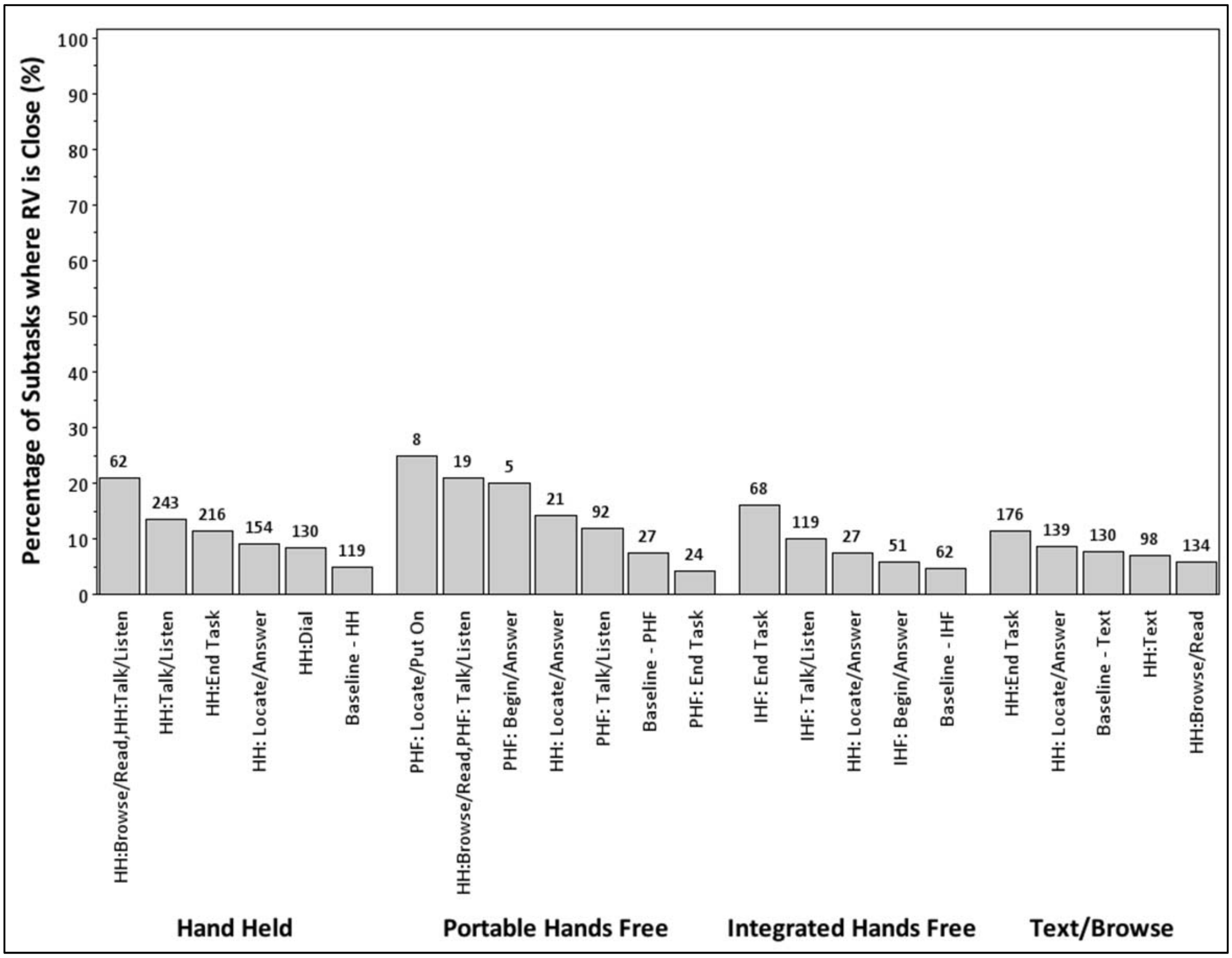

Figure 22. Percentage of Samples in Which the RV Traveled Closely Behind the SV When Initiating a Cell Phone Subtask Above 8 km/h

For each subtask and matched baseline sample, a McNemar Change test was performed to investigate whether the proportion of subtasks in which the RV was close to the SV differed from the proportion of baseline periods in which the RV was close to the SV. Table 100 presents the ANOVA summary results for each test.

Table 100. Results for Within-Subject Comparisons of RV Tailgating Behavior Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Percent	Subtask Percent	n	$\chi^2_{McNemar}$	*p*-value
Hand-Held	HH: Locate/Answer	3.90	6.49	77	1.00000	.6250
Hand-Held	HH: Dial	6.00	6.00	50	0.00000	1.0000
Hand-Held	HH: Talk/Listen	4.35	7.25	69	1.00000	.6250
Hand-Held	HH: Browse/Read, HH: Talk/Listen	0.00	30.00	20	0.81818	.5488
Hand-Held	HH: End Task	5.36	14.29	56	2.27273	.2266
Portable Hands-Free	PHF: Locate/Put On	0.00	0.00	1	-	-
Portable Hands-Free	HH: Locate/Answer	0.00	10.00	10	-	-
Portable Hands-Free	HH: Dial	16.67	0.00	6	-	-
Portable Hands-Free	PHF: Talk/Listen	4.76	9.52	21	0.33333	1.0000
Portable Hands-Free	PHF: End Task	0.00	0.00	1	-	-
Portable Hands-Free	HH: Locate/Answer	25.00	25.00	4	-	-
Integrated Hands-Free	HH: Locate/Answer	8.70	0.00	23	-	-
Integrated Hands-Free	HH: Dial	0.00	0.00	15	-	-
Integrated Hands-Free	IHF: Talk/Listen	0.00	0.00	13	-	-
Integrated Hands-Free	IHF: End Task	5.56	0.00	36	-	-
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	9.09	13.64	22	0.20000	1.0000
Text/Browse	HH: Locate/Answer	9.09	7.58	66	0.14286	1.0000
Text/Browse	HH: Browse/Read	12.50	7.14	56	1.28571	.4531
Text/Browse	HH: Text	10.26	10.26	39	0.00000	1.0000
Text/Browse	HH: End Task	11.48	9.84	61	0.11111	1.0000

To investigate whether the likelihood of the RV traveling close to the SV when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. RV traveling close to SV during subtask, but not during baseline
2. RV traveling close to SV for both baseline and subtask, or RV not traveling close to SV for both baseline and subtask
3. RV traveling close to SV during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Table 101 presents the percentage of samples for each of the three categories and the respective chi-square p-value.

Table 101. Results for Between-Subjects Comparisons of RV Tailgating Behavior Across Cell Phone Types

Action	Subtask	RV Close During Subtask, but Not During Baseline	Same RV Distance During Baseline and Subtask	RV Close During Baseline, but Not During Subtask	n	*df*	χ^2	*p*-value
Locate Device	HH: Locate/Answer	3.90	94.81	1.30	77	6	1.99080	.92054
Locate Device	PHF: Locate/Put On	0.00	100.00	0.00	1	6	1.99080	.92054
Locate Device	HH: Locate/Answer on PHF	10.00	90.00	0.00	10	6	1.99080	.92054
Locate Device	HH: Locate/Answer on IHF	0.00	100.00	0.00	15	6	1.99080	.92054
Initiate Call	HH: Dial	4.00	92.00	4.00	50	8	4.81741	.77690
Initiate Call	HH: Dial on PHF	0.00	83.33	16.67	6	8	4.81741	.77690
Initiate Call	HH: Dial on IHF	0.00	100.00	0.00	13	8	4.81741	.77690
Initiate Call	PHF: Begin/Answer	0.00	100.00	0.00	2	8	4.81741	.77690
Initiate Call	IHF: Begin/Answer	0.00	91.30	8.70	23	8	4.81741	.77690
Talk/Listen	HH: Talk/Listen	4.35	94.20	1.45	69	4	4.68209	.32150
Talk/Listen	PHF: Talk/Listen	9.52	85.71	4.76	21	4	4.68209	.32150
Talk/Listen	IHF: Talk/Listen	0.00	94.44	5.56	36	4	4.68209	.32150
Talk and Browse	HH: Browse/Read, HH: Talk/Listen	17.07	73.17	9.76	41	4	4.38724	.35613
Talk and Browse	HH: Browse/Read, PHF: Talk/Listen	0.00	91.67	8.33	12	4	4.38724	.35613
Talk and Browse	HH: Browse/Read, IHF: Talk/Listen	27.27	72.73	0.00	11	4	4.38724	.35613
End Use	HH: End Task	7.14	90.18	2.68	112	4	3.47589	.48155
End Use	PHF: End Task	0.00	100.00	0.00	1	4	3.47589	.48155
End Use	IHF: End Task	13.64	77.27	9.09	22	4	3.47589	.48155

A.14.2 Rear Vehicle Lane Change Behavior

Figure 23 shows the percentage of subtasks performed above 8 km/h where the Rear Vehicle (RV) executed a lane change to pass the SV within 5 seconds prior to the start of the subtask up to 5 seconds after initiating the subtask.

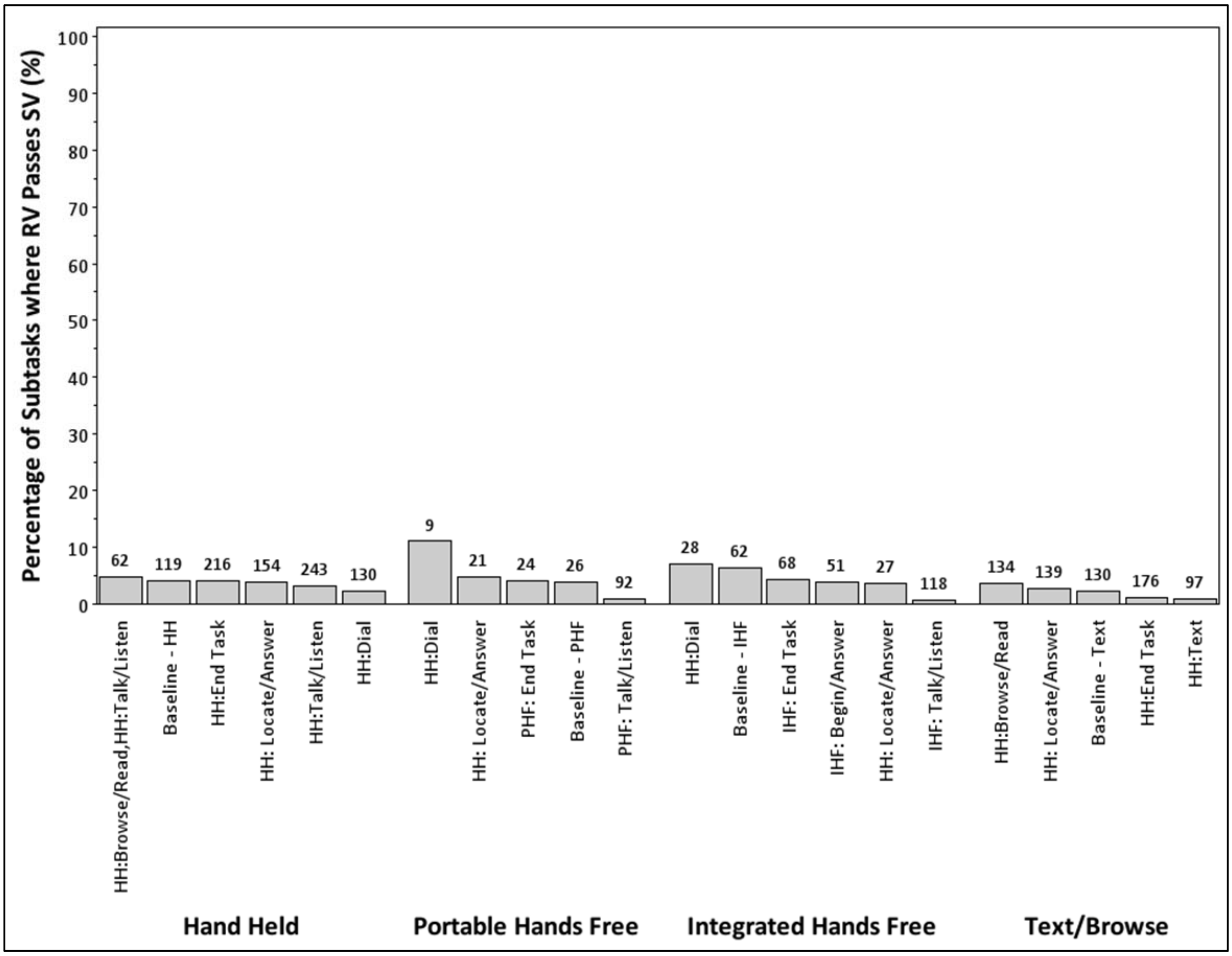

Figure 23. Percentage of Subtasks Performed Above 8 km/h Where the RV Executed a Lane Change to Pass the SV

For each subtask and matched baseline sample that had a valid speed measure, a one-way within-subject ANOVA was performed to investigate whether the mean speed when initiating the subtask differed from the mean speed during the baseline sample. Table 102 presents the ANOVA summary results for each test.

Table 102. Results for Within-Subject Comparisons of RV Lane Change Behavior Between Each Subtask and Its Matched Baseline

Cell Phone Type	Subtask	Baseline Percent	Subtask Percent	n	$\chi^2_{McNemar}$	*p*-value
Hand-Held	HH: Locate/Answer	3.90	2.60	77	0.20000	1.0000
Hand-Held	HH: Dial	6.00	6.00	50	0.00000	1.0000
Hand-Held	HH: Talk/Listen	7.25	4.35	69	0.50000	.7266
Hand-Held	HH: Browse/Read, HH: Talk/Listen	10.53	5.00	20	1.00000	1.0000
Hand-Held	HH: End Task	5.36	7.14	56	0.14286	1.0000
Portable Hands-Free	PHF: Locate/Put On	0.00	0.00	2	.	.
Portable Hands-Free	PHF: Begin/Answer	0.00	0.00	2	.	.
Portable Hands-Free	HH: Locate/Answer	0.00	0.00	10	.	.
Portable Hands-Free	HH: Dial	0.00	16.67	6	.	.
Portable Hands-Free	PHF: Talk/Listen	0.00	4.76	21	.	.
Portable Hands-Free	PHF: End Task	0.00	0.00	1	.	.
Portable Hands-Free	HH: Browse/Read, PHF: Talk/Listen	0.00	0.00	4	.	.
Integrated Hands-Free	IHF: Begin/Answer	0.00	0.00	23	.	.
Integrated Hands-Free	HH: Locate/Answer	13.33	0.00	15	.	.
Integrated Hands-Free	HH: Dial	23.08	0.00	13	.	.
Integrated Hands-Free	IHF: Talk/Listen	8.57	0.00	35	.	.
Integrated Hands-Free	IHF: End Task	18.18	4.55	22	3.00000	.2500
Integrated Hands-Free	HH: Browse/Read, IHF: Talk/Listen	9.09	0.00	11	.	.
Text/Browse	HH: Locate/Answer	0.00	4.55	66	.	.
Text/Browse	HH: Browse/Read	0.00	8.93	56	.	.
Text/Browse	HH: Text	0.00	0.00	39	.	.
Text/Browse	HH: End Task	0.00	3.28	61	.	.

To investigate whether the likelihood of the RV passing the SV when performing a subtask differed across cell phone types, the samples were grouped into the following three categories:

1. RV passed the SV during subtask, but not during baseline
2. RV passed the SV for both baseline and subtask, or RV did not pass the SV for both baseline and subtask
3. RV passed the SV during baseline but not during subtask

The distribution of samples across these three categories was compared across cell phone types using a chi-squared test. Table 103 presents the percentage of samples for each of the three categories and the respective chi-square p-value. No significant differences were found.

Table 103. Results for Between-Subjects Comparisons of RV Tailgating Behavior Across Cell Phone Types

Action	Subtask	RV LC During Subtask, but Not During Baseline	Same RV LC Behavior During Baseline and Subtask	RV LC During Baseline, but Not During Subtask	n	*df*	χ^2	*p*-value
Locate Device	HH: Locate/Answer	2.60	93.51	3.90	77	6	3.7005	.71713
Locate Device	PHF: Locate/Put On	0.00	100.00	0.00	1	6	3.7005	.71713
Locate Device	HH: Locate/Answer on PHF	0.00	100.00	0.00	10	6	3.7005	.71713
Locate Device	HH: Locate/Answer on IHF	0.00	86.67	13.33	15	6	3.7005	.71713
Initiate Call	HH: Dial	6.00	88.00	6.00	50	8	12.3893	.13466
Initiate Call	HH: Dial on PHF	16.67	83.33	0.00	6	8	12.3893	.13466
Initiate Call	HH: Dial on IHF	0.00	76.92	23.08	13	8	12.3893	.13466
Initiate Call	PHF: Begin/Answer	0.00	100.00	0.00	2	8	12.3893	.13466
Initiate Call	IHF: Begin/Answer	0.00	100.00	0.00	23	8	12.3893	.13466
Talk/Listen	HH: Talk/Listen	4.35	88.41	7.25	69	4	3.3321	.50386
Talk/Listen	PHF: Talk/Listen	4.76	95.24	0.00	21	4	3.3321	.50386
Talk/Listen	IHF: Talk/Listen	0.00	91.43	8.57	35	4	3.3321	.50386
Talk and Browse	HH: Browse/Read, HH: Talk/Listen	17.07	73.17	9.76	41	4	4.3872	.35613
Talk and Browse	HH: Browse/Read, PHF: Talk/Listen	0.00	91.67	8.33	12	4	4.3872	.35613
Talk and Browse	HH: Browse/Read, IHF: Talk/Listen	27.27	72.73	0.00	11	4	4.3872	.35613
End Use	HH: End Task	3.57	93.75	2.68	112	4	5.9483	.20304
End Use	PHF: End Task	0.00	100.00	0.00	1	4	5.9483	.20304
End Use	IHF: End Task	0.00	86.36	13.64	22	4	5.9483	.20304

A.15 Exploratory Analyses

A.15.1 SCE Risk Associated With Emotional Conversation

A case-control analysis was performed to explore whether emotional conversation was associated with an increased risk of an SCE. For each SCE and baseline sample, reductionists rated the emotion and intensity of the driver during the 6-s interval (making sure only emotions prior to the precipitating event were coded in the SCE samples). Emotions were coded using the rating scales that were based off of FACS and described in the section on drivers cell phone use. Samples where the driver was talking on a cell phone were grouped into emotional and neutral conversations (pronounced and severe emotions were classified as emotional conversation, while neutral and slight emotions were classified as neutral conversations). The SCE risk of emotional conversation was first assessed relative to neutral conversation. However, only 289 samples (SCEs and baseline periods) existed where the driver was observed to be talking on a cell phone. An exact OR of 0 was computed because no SCEs had emotional conversation take place on a cell phone. Another analysis (i.e., a computation of an exact OR) was performed to examine the SCE risk of emotional conversation relative to "just driving." However, a significant relationship was not found.

Table 104. Exact Odds Ratios for the Emotional Conversation

Subtask	OR	LCL	UCL	SCE	BL	SCE Total	BL Total	N
Emotional conversation relative to neutral conversation	0	0	5.01	0	7	28	258	286
Emotional conversation relative to "just driving"	0	0	3.74	0	7	154	1075	1229

A.15.2 Likelihood of Scanning Intersection When Using a Cell Phone While Stopped

Since all SCE and baseline samples had a minimum speed of 8 km/h, reductionists were instructed to indicate when the driver was stopped at an intersection (as first in cue) 6 seconds prior to the sample. If the driver was stopped, the reductionists looked further back to see if any cell phone subtasks were performed while the vehicle was stopped. They then coded whether the driver properly scanned the intersection prior to advancing. With these data, a Fisher's test was performed to investigate whether the likelihood of scanning the intersection differed between using a cell phone and not using a cell phone while stopped. Although very few samples existed for this analysis (n = 23), drivers that performed any cell phone use while stopped were less likely to properly scan the intersection prior to advancing than drivers who did not use a cell phone while stopped (Fisher's test $p = 0.04$). Too few samples were observed to assess the likelihood of scanning when performing visual-manual subtasks or talking subtasks. The same limitation prevented the assessment of SCE risk as well (no SCEs were observed 6 seconds after the subject vehicle was stopped).

Table 105. Frequencies of Observed Intersection Scanning

No Cell Phone Used	2 (12.5%)	14 (87.5%)	16
Cell Phone Used	4 (57.1%)	3 (42.86%)	7
Total	6	17	23

A.15.3 Drivers' Mean Trip Time by Location

Drivers' mean trip time is shown in Figure 24. Drivers' trips are binned according to the time of day they were performed. "AM Rush" comprises trips made between 6:00 AM and 10:00 AM. "Day" comprises trips made between 10:00 AM and 4:00 PM. "PM Rush" comprises trips made between 4:00 PM and 8:00 PM. "Night" comprises trips made between 8:00 PM and 6:00 AM.

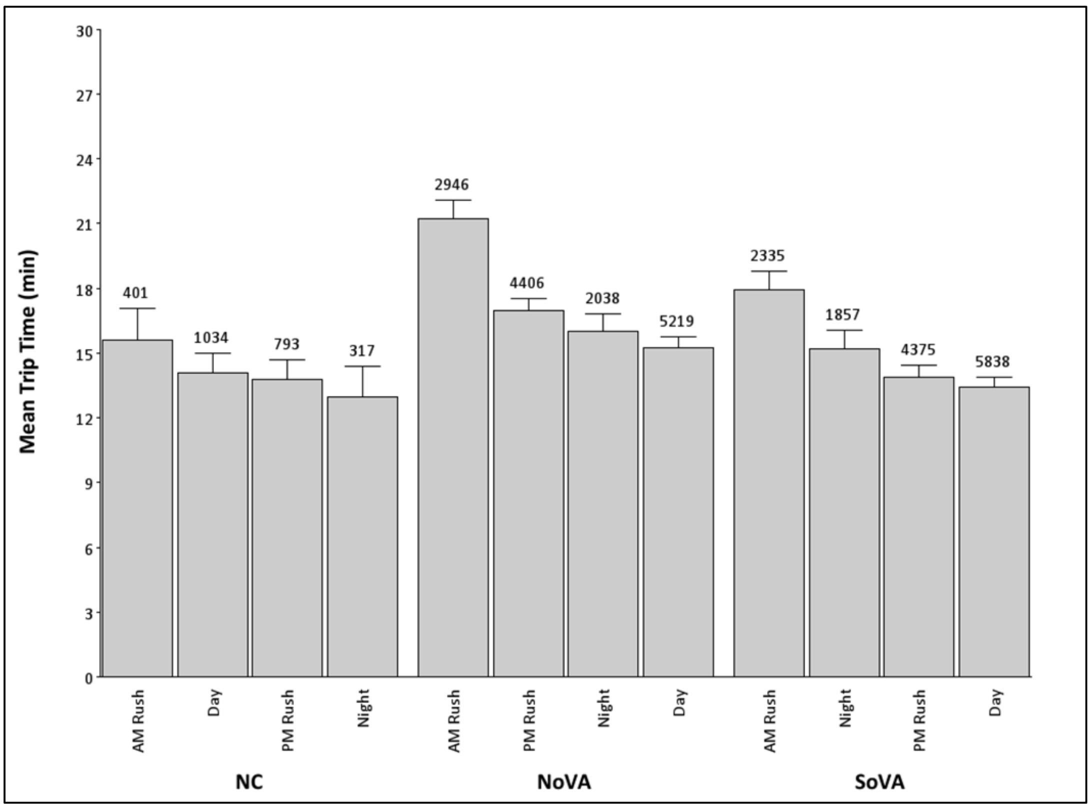

Figure 24. Drivers' Mean Trip Time by Location

DOT HS 811 757
April 2013

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9515-042313-v2