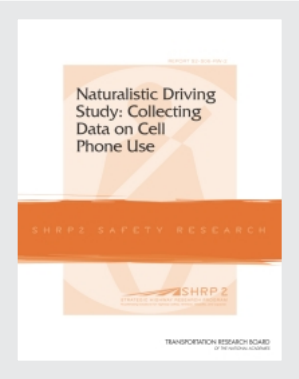

Naturalistic Driving Study: Collecting Data on Cell Phone Use

DETAILS

24 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-31496-1 | DOI 10.17226/22199

AUTHORS

Julie K. Cook, Jonathan F. Antin, Whitney M. Atkins, and Jonathan M. Hankey; Strategic Highway Research Program; Strategic Highway Research Program Safety Focus Area; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

The Second
STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP 2 REPORT S2-S06-RW-2

Naturalistic Driving Study: Collecting Data on Cell Phone Use

JULIE K. COOK, JONATHAN F. ANTIN, WHITNEY M. ATKINS, AND JONATHAN M. HANKEY
Virginia Tech Transportation Institute
Blacksburg, Virginia

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2015
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Data and Information Technology
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The Second Strategic Highway Research Program

America's highway system is critical to meeting the mobility and economic needs of local communities, regions, and the nation. Developments in research and technology—such as advanced materials, communications technology, new data collection technologies, and human factors science—offer a new opportunity to improve the safety and reliability of this important national resource. Breakthrough resolution of significant transportation problems, however, requires concentrated resources over a short time frame. Reflecting this need, the second Strategic Highway Research Program (SHRP 2) has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that have been the mainstay of the highway research industry for half a century.

The need for SHRP 2 was identified in *TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life,* published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, management-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruptions and produce lasting facilities; Reliability, to reduce congestion through incident reduction, management, response, and mitigation; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

SHRP 2 was authorized in August 2005 as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The program is managed by the Transportation Research Board (TRB) on behalf of the National Research Council (NRC). SHRP 2 is conducted under a memorandum of understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the National Academy of Sciences, parent organization of TRB and NRC. The program provides for competitive, merit-based selection of research contractors; independent research project oversight; and dissemination of research results.

SHRP 2 Report S2-S06-RW-2

ISBN: 978-0-309-31496-1

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The members of the technical committee selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical committee and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

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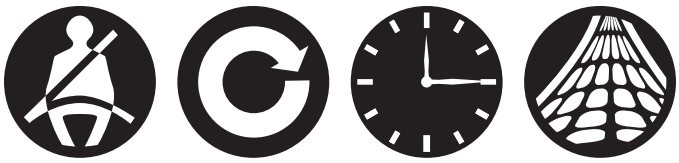

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ACKNOWLEDGMENTS

This work was sponsored by the Federal Highway Administration in cooperation with the American Association of State Highway and Transportation Officials. It was conducted in the second Strategic Highway Research Program (SHRP 2), which is administered by the Transportation Research Board of the National Academies. The project was managed by Kenneth Campbell, Chief Program Officer for SHRP 2 Safety, and James Hedlund, SHRP 2 Special Consultant for Safety Coordination.

The authors acknowledge Mike Altschul with CTIA, The Wireless Association, for his assistance coordinating and serving as a liaison with the various wireless carriers at the onset of the study. The authors also greatly appreciate Tim Johnson of the National Highway Traffic Safety Administration, who assisted with reviewing study documents and served as a liaison with the Federal Communications Commission. A study of this scale would not have been possible without the assistance of the two collaborating wireless carriers, AT&T and Verizon. Special thanks to Colleen Thompson of AT&T for serving as our point of contact and ensuring that all data were securely transferred. John Scott and Kim Brown of Verizon were both instrumental in Verizon's collaboration with the study team. John Profaca of Verizon and his team were incredibly helpful in processing the requests of our participants for their records and ensuring data were securely transferred.

Several Virginia Tech Transportation Institute (VTTI) staff assisted throughout the project. Brian Daily, Doug McGraw, and Joel Kady were key staff involved in incorporating Cell Phone Records Study (CPRS) data within the SHRP 2 NDS database. Brian Wotring organized and tracked the flow of the record reduction and integration into the database. The authors are grateful to Heather Brown, Liz Hager, Kelly Stulce, Ryan Weaver, and Lisa Eichelberger for providing much attention to detail while processing the participant-provided records. Marilynn King and Melissa Hulse assisted participants with the enrollment process, and Susan Willis and her team at the Center for Survey Research assisted with recruitment efforts.

FOREWORD

James H. Hedlund, *SHRP 2 Special Consultant, Safety Coordination*

This report details the methodology used to acquire cell phone use records from a subset of participants in the SHRP 2 Naturalistic Driving Study (NDS) during the time when they were enrolled in the study. The cell phone records were then matched with participants' NDS driving data to identify the times while they were driving when they may have been using their cell phones.

These data will help researchers quickly and accurately identify events of interest in the NDS database related to cell phone use, from which researchers can learn crucial information about driver behavior and changes in crash risk when drivers choose to use or not to use cell phones. This report provides researchers with essential information about the Cell Phone Records Study (CPRS) data and how the data were collected. It describes the methods used to recruit and enroll CPRS participants, the collaboration with the cell phone carriers, and the processes of obtaining data from the carriers and directly from the participants. It also provides summary information on the data collected and discusses some limitations of the data.

SHRP 2 NDS participants were invited to participate in the Cell Phone Records Study (CPRS) when they exited the NDS study. CPRS participants were required to be 18 years old or older at the time they agreed to join the CPRS and to have been enrolled in the NDS for at least 3 months. CPRS participants were compensated. Call and text data were limited to the date, time, duration, and direction (incoming or outgoing). No personally identifiable data were included. AT&T and Verizon provided electronic records for their customers, as authorized by the account holders. Participants with other cell phone carriers were able to provide their own records.

Cell phone records were acquired from 620 drivers. The records contain approximately 1.4 million individual call events, approximately 209,000 of which overlap with NDS driving data. Approximately 4.9 million text events were collected, and approximately 274,000 overlap with driving data.

The SHRP 2 NDS is the first large-scale study focused on collision prevention (as opposed to injury prevention once a collision occurs) since the Indiana Tri-Level Study (*Tri-Level Study of the Causes of Traffic Accidents: Final Report*, DOT HS-805 085, U.S. Department of Transportation, May 1979). Vehicle use was recorded continuously during the SHRP 2 NDS. Information on vehicle travel, or exposure, can be extracted at the same level of detail as for safety-related events, such as crashes and near crashes. Hence, the SHRP 2 NDS is the first large-scale study to support detailed estimates of collision risk. Moreover, crashes are a leading cause of nonrecurring congestion, so collision prevention has added benefits in terms of reduced delay, fuel consumption, and emissions. The NDS provides objective information on the role of driver behavior and performance in traffic collisions and on the interrelationship of the driver with vehicle, roadway, and environmental factors.

The SHRP 2 Safety research program was carried out under the guidance of the Safety Technical Coordinating Committee (TCC), which was composed of volunteer experts. The Safety TCC developed and approved all project descriptions and budgets and met semiannually to review progress and approve any program modifications. The Oversight Committee approved all budget allocations and contract awards. Assistance was provided by expert task groups, which developed requests for proposals, evaluated proposals and recommended contractors, and provided expert guidance on many issues, such as data access policies and procedures. The decisions and recommendations of the governing committees were implemented by SHRP 2 staff as they carried out day-to-day management of the research projects.

CONTENTS

CHAPTER 1

Background

The number of wireless (cell phone) subscribers has been growing exponentially. According to CTIA, The Wireless Association, the number of wireless subscribers increased from 33.8 million in 1995 to approximately 315.9 million in 2011 (CTIA 2014). With CTIA reporting that subscribers in the United States used more than 2.295 trillion call minutes and sent more than 2.303 trillion text messages in 2011, it is clear that cell phone use has become a significant factor in day-to-day lives. This increase in cell phone use is of particular interest to scientists studying driver distraction.

McCartt et al. (2006) conducted a review of approximately 125 studies related to cell phone use and driving. The study noted both in simulated and on-road driving studies that the results may be compromised by examining replicated or mock phone conversations as opposed to conversations that might occur naturally. Other research methods have involved obtaining cell phone billing records for a driver only after a crash has occurred. The cell phone records that corresponded to the time of the crash were then compared with records for the same driver from a comparable time period previous to the crash (Redelmeier and Tibshirani 1997). While this case-crossover approach provides data regarding crash risk associated with cell phone use, it is not able to provide a clear picture of what was actually taking place in the vehicle at the time of the crash. Data from recent naturalistic driving studies that include video of the vehicle interior have also examined cell phone use in vehicles (Klauer et al. 2010; Olson et al. 2009). Such naturalistic data allowed researchers to examine what was happening inside the vehicle and in the surrounding environment just before, as well as during, crash-related events. These earlier efforts did not obtain the cell phone records of the driver, requiring researchers to search in a fairly cumbersome manner through the video data for instances, in which it was clear the participant was using a cell phone. A recent approach tied participants' cell phone records with naturalistic driving data (Fitch et al. 2013). The study recruited drivers who reported talking on a cell phone while driving at least once per day, and the results provided valuable information about drivers with a history of cell phone use while driving.

The Second Strategic Highway Research Program (SHRP 2) Naturalistic Driving Study (NDS) provided the perfect opportunity to create a database that would allow scientists to expand on previous research and further investigate cell phone use and the role it plays in driver distraction. The SHRP 2 NDS collected approximately 50 million miles of naturalistic driving data from more than 3,100 different drivers over more than 3 years. The data collected included vehicle kinematic data, as well as video data of the exterior driving environment and video data of the driver. Adding driver cell phone records to this large database of participants across the driving age spectrum would provide researchers with a unique opportunity to explore research questions surrounding cell phone use and driving. It was decided that a substudy would be added to the SHRP 2 NDS—the Cell Phone Records Study (CPRS). The purpose of the CPRS was to obtain as many cell phone records as possible from SHRP 2 NDS participants with the intention of adding these data to the SHRP 2 NDS database.

The purpose of this report is to provide future researchers who wish to incorporate CPRS data into their analyses with essential information about these data and how they were collected. The report describes the methods used to recruit and enroll participants in the CPRS. The details surrounding the collaboration with the cell phone carriers and the processes of obtaining data from the wireless carriers and directly from the participants are also explained. Summary information about the data collected and the limitations of the data are discussed as well.

CHAPTER 2

Research Approach

Collaboration with Cell Phone Carriers

When considering the pool of participants in the SHRP 2 NDS who could be recruited for the CPRS, it became apparent that there was potential for a large amount of cell phone data to be collected. Acquiring and processing the cell phone records directly from the participants would be a daunting process, requiring participants to obtain their own cell phone records for the correct dates and send them to the research team. This would be no small task, considering that instructions and guidance from the research team would need to take place remotely. The process would also need to allow for records from different carriers and in different formats to be scanned and cleaned of identifiable information. Millions of cell phone events would potentially need to be standardized and entered into a database manually. It was decided that given the scale of the research effort, it would be worthwhile to acquire the data electronically from the major cell phone carriers if possible and if all security, privacy, and authentication issues could be successfully addressed.

With the assistance of CTIA, The Wireless Association, the research team contacted representatives from Sprint, AT&T, Verizon, and T-Mobile, the four leading carriers with a combined market share of approximately 90%, and provided each carrier with information about the CPRS effort. The carriers were asked if they would be able to assist the research team by providing electronic call and text records for consented participants who were willing to complete an authorization form allowing the release of their records to the research team. It was clarified that the participants would only request records for the time period during which they were enrolled in the SHRP 2 NDS and that the records released would only include the date, time, and duration of the calls and texts. The records would also include whether the texts and calls were incoming or outgoing. The content of the calls or texts and the associated cell phone numbers of incoming and outgoing calls and texts would neither be necessary nor included.

Each of the four carriers indicated interest in collaboration, but they all agreed that the research team should first receive confirmation from the Federal Communications Commission (FCC) that the carriers' involvement would comply with rules regarding the protection of customer information. The research team then provided the FCC with the research protocol, consent documents, and authorization forms for review, after which the FCC confirmed that the protocols in place were indeed in compliance with their rules and regulations.

At this point, the research team began to schedule meetings with each carrier to discuss the particular process that the carrier preferred to use for secure data transfer. Arrangements were made with Verizon and AT&T. Neither AT&T nor Verizon requested or received reimbursement for their assistance with this effort. Despite their original expressed interest in participating in the research effort, neither T-Mobile nor Sprint was able to directly and electronically provide cell phone records from their customers who were participants in the SHRP 2 NDS.

Eligibility Requirements

To be eligible for the CPRS, participants had to be 18 years old or older at the time they consented to participate in CPRS. Use of minors in a study requires parental consent in addition to the minor's assent, both of which typically must be given in person to ensure freedom from parental coercion. The CPRS design called for consent to be provided remotely (researchers were located in Virginia and participants were located throughout the country). Therefore, including minors in the CPRS was deemed infeasible. To be eligible, participants had to have been enrolled in the SHRP 2 NDS for a minimum of 3 months. Three months was selected by the research team as the minimum amount of driving data that

would make recruiting, enrolling, processing, and compensating participants in the CPRS worthwhile. Also, if participants were not the authorized account holders of the wireless accounts, they had to be able to obtain permission from the authorized account holders to release the records. Although participants had to be willing to provide at least 3 months of cell phone records, no minimum cell phone usage volume was specified to qualify for participation. In addition, a participant's cell phone could not be a prepaid phone plan (e.g., TracFone) and the cell phone could not be issued by an employer or borrowed from a friend or a family member. Participants also had to be willing to complete a Virginia Tech W-9 form for payment purposes.

The wireless carriers made it clear that they could provide electronic records for only those participants with whom the SHRP 2 NDS research team had met face to face and confirmed their identities via driver's license inspections. This meant that only the SHRP 2 NDS "primary" participants would be eligible for the CPRS. Primary participants were defined as those who had enrolled as the primary driver of the instrumented vehicle. Primary participants met with the SHRP 2 NDS researchers, provided proof of a valid driver's license, and completed a variety of assessments. Other participants, deemed "secondary" participants, were those who drove the instrumented vehicle on a regular basis and had consented to allow the research team to keep their driving data. However, these secondary participants may have never met with the SHRP 2 NDS researchers, and their interaction with the research team may have been limited to mailing in a signed consent form.

As previously noted, it was originally decided that only primary SHRP 2 NDS participants would be eligible. However, when the research team was unable to establish a collaborative relationship with two of the four major wireless carriers, it was decided to amend the protocols to allow participants to provide their own cell phone records to the research team for processing, regardless of carrier. Once this decision was made, it also allowed SHRP 2 NDS secondary participants to be similarly enrolled, since the carriers would not be requested to process data for this special class of participant.

Recruitment

Primary Participants in the SHRP 2 NDS

In March 2013, personnel at the SHRP 2 sites began handing out CPRS packets to primary participants as they exited the driving study. The process of securing study protocol review and approval from the FCC, Virginia Tech Institutional Review Board (IRB), and the National Academy of Sciences IRB, along with collaboration with the carriers that had agreed to provide electronic data, prevented the team from beginning this process as the first round of SHRP 2 NDS participants exited the study. By the time site personnel were permitted to begin handing out CPRS packets, approximately 1,200 participants had already exited the SHRP 2 NDS. Once a participant exited the SHRP 2 NDS, contact information was only accessible for those who indicated interest in being contacted for future research projects. Seven hundred and seventy of those who had already completed the SHRP 2 NDS met the eligibility criteria. These were participants in the driving study who had also indicated that they were interested in being contacted for future research projects, were at least 18 years old at the time of the mailing, and had been enrolled in the driving study for at least 3 months. CPRS information packets were mailed to these primary participants.

The packets informed participants to contact the Virginia Tech Center for Survey Research (CSR) to be screened for eligibility if they were interested in participating. If there was no response from a given participant, CSR followed up by calling to confirm that the packet had been received and asking if the participant had questions or would like more information about the study.

Secondary Drivers in the SHRP 2 NDS

Flyers directed at secondary drivers were included in the primary driver packets, and the primary participants were asked to provide these flyers to their secondary drivers. Secondary drivers who had agreed to be contacted for future studies were also contacted and provided with information about the CPRS.

Recruitment Response

CPRS participants were recruited from a selected pool of 2,529 SHRP 2 NDS participants (those who had agreed to be contacted for future studies, were 18 years old or older at exit, and had participated in SHRP 2 NDS for at least 3 months). Figure 2.1 shows the response of this subset of NDS participants to the CPRS recruitment efforts. It should also be noted that the research team was not able to obtain cell phone records for all 805 of the participants recruited and enrolled in the CPRS.

Enrollment Process

Interested participants were screened for eligibility during a phone call with CSR. If participants were determined to be eligible, CSR would answer any questions and go through the consent form with them. Participants consented to participate in the CPRS by returning a signed copy of the consent form to the Virginia Tech Transportation Institute (VTTI). Participants were also provided with a consent form to keep for their records.

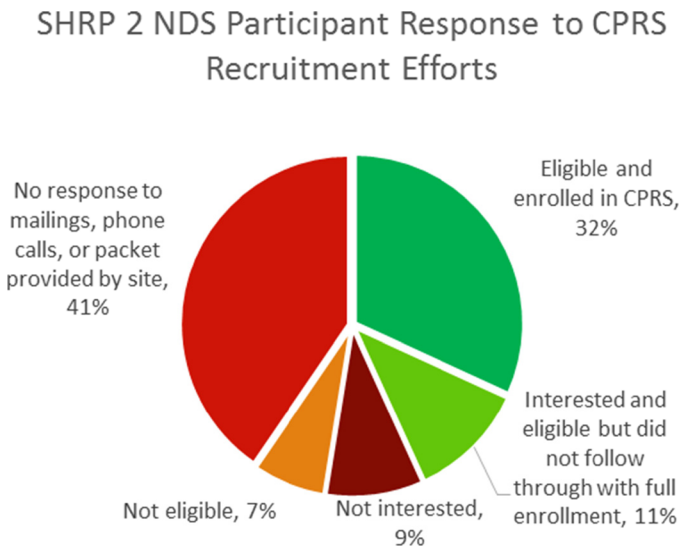

Figure 2.1. CPRS recruitment responses from SHRP 2 NDS participants.

Study Procedures and Tasks for Participants

There were two different sets of study procedures depending on which cell phone carrier the participant had and whether the individual was a primary or a secondary participant.

All those who were eligible and who indicated an interest in participating were asked to sign, date, and return one copy of the informed consent form and complete and return the Virginia Tech W-9 form.

In addition, primary participants with AT&T or Verizon, the two carriers providing electronic data records, were asked to complete an authorization release of cell phone records form. If a participant was not the account holder for the cell phone account, then the participant had to obtain the signature of the account holder.

On the other hand, all secondary participants and those primary participants who did not use AT&T or Verizon as their cell phone carrier were asked to obtain their cell phone records and send them to VTTI via any one of several media options.

Processing Packets Received from Participants (VTTI Staff)

Once packets were received at VTTI, staff reviewed all the documents for completeness. Consent forms were reviewed for correct dates and signatures, and then filed in a secure safe. Verizon authorization release forms were reviewed, scanned, and submitted to Verizon for processing. Verizon allowed authorization release forms to be submitted as the forms came in. AT&T authorization release forms were reviewed and stored until they could be submitted to AT&T on one of the two agreed-on batch submission dates.

Cell phone records that were received directly from the participant were reviewed and stored on a secure server. Those that arrived in paper format were scanned and stored electronically on that same secure server. Paper originals were stored securely for the duration of the project, with the intent of shredding them once it was verified that all data were entered correctly.

Participants with AT&T or Verizon who provided a completed authorization release form were paid $50 when the dates on the authorization release form covered a span of 6 months or less. When the dates covered more than a 6-month span, the participants were paid $100.

Participants who provided their own records were compensated $10 for each month of calls and an additional $10 for each month of texts. For example, if a participant had been enrolled in the Naturalistic Driving Study for 24 months and was able to provide call and text message records for all 24 months, the participant would have received $480.

Obtaining Records from Carriers

Verizon finalized the agreement and process for assisting with the CPRS after participants had already been enrolled and compensated. Study personnel held on to the authorization release forms, waiting for the final agreement with Verizon to be in place. When the first set of authorization release forms were submitted to Verizon, only 41% of them were able to be processed because Verizon only allowed access to data dating back a maximum of 1 year from the date of the request.

Once the agreement was in place, requests for records from Verizon were made as VTTI received the authorization release forms from participants. At this point, participants were paid when the records were returned. If the form was not signed by the authorized account holder, Verizon would not process the request but would notify VTTI. Research staff would then contact the participant and ask for a revised authorization release form.

As previously noted, AT&T agreed to process up to two batches of requests for data. AT&T data were available for up to 2 years before the request date. In an effort to capture as much data as possible before the data became unavailable, VTTI selected a study midpoint (August 2013) and a point after all data collection had concluded (February 2014) to submit the two requests. The last request date was not selected until the participant response to recruitment began to slow. At that time, the amount of data from the currently enrolled participants that was becoming unavailable because of the rolling window of data availability was weighed against the potential records that a new enrollee might bring to the study.

There were 95 requests made in August 2013. If AT&T did not provide data for a given participant in response to this initial request, VTTI staff contacted the participant and asked

for a revised authorization release form, ensuring it was signed by the authorized account holder. Seven revised forms were submitted with the second batch.

In February 2014, 149 requests were sent to AT&T. Due to the limited number of batch requests that VTTI staff could make to AT&T, there was not an opportunity to have participants revise incorrectly completed authorization release forms at this second and final batch submission (e.g., the form was not signed by the authorized account holder, the cell phone number was incorrect, the cell phone number was not in service). A total of 472 unique cell phone records were requested from Verizon; 139 of these requests were unable to be processed. AT&T was unable to process 55 out of 237 unique requests.

Processing Records Received Directly from Participants

Participants who opted to provide their own cell phone records to the research team could do so in a number of ways. Some were able to log in to the carrier's customer service portal and download electronic records, while others provided paper copies or scanned copies of phone bills. On receipt of the records, the dates of phone calls were compared with SHRP 2 NDS participation dates, and time periods of available and unavailable data were noted. A variety of carriers were represented in these records. Each carrier presented the data of interest in a different manner and format, and sometimes differently for each customer type. Care was taken to examine each cell phone bill for idiosyncrasies that would need to be addressed when standardizing the data (e.g., duration of calls being documented in seconds versus minutes, time of call being documented in Coordinated Universal Time instead of in local time). Information from all scanned bills and paper files was then transferred into a standard electronic spreadsheet. In some cases, it was possible to run optical character recognition (OCR) software to assist with this transformation. However, the majority of the records required careful and exhaustive visual scrutiny followed by manual data transcription. Approximately 119 years of call data and 44 years of text data were received directly from the participants.

Table 2.1 shows the breakdown of cell phone carriers represented in the records provided directly by participants. Note that some participants changed wireless carriers during participation in the SHRP 2 NDS. Therefore, some participants may have provided records from more than one carrier.

Table 2.1. Participant-Provided Records Received by Carrier

Carrier	Number of Participant-Provided Records
Sprint	44
T-Mobile	33
Verizon	14
AT&T	11
Consumer Cellular	7
CREDO Mobile	3
Republic Wireless	1
U.S. Cellular	1
Total	**114**

Tying Cell Phone Record Data to SHRP 2 NDS Driving Data

The cell phone records were matched to the correct SHRP 2 NDS participant and then loaded into the SHRP 2 NDS database. It became apparent when working with data provided by different carriers, which had different customer types and different billing centers, that the time of day of calls and texts in a given cell phone record may have been recorded in a time zone different from the participant's actual time zone. For example, T-Mobile's standard procedure is to record the time of all texts sent and received in Pacific Standard Time (PST), regardless of the location of the customer. Video verification was conducted to confirm that the cell phone records were converted to the correct time zone and were matched correctly with the driving data.

The video verification process involved finding a sample cell phone record event (single call or text) that appeared to overlap with the SHRP 2 NDS driving data, on the basis of date and time that the call or text appeared to take place. Then, research staff viewed the video data to confirm that it appeared that the driver had indeed interacted with his or her cell phone at that time. To assist with this effort, researchers referred to the SHRP 2 NDS participant questionnaire data indicating whether the participant reported having Bluetooth for hands-free phone use in the vehicle and the location of the interface in the vehicle (e.g., steering wheel, center dash).

Efforts were made to match both a text message and a phone call for each participant. It should be noted that the purpose of the video verification process was not to verify that every call and text that overlapped with a participant's driving data represented actual cell phone use while driving. The purpose was to ensure that the cell phone records were assigned to the correct SHRP 2 NDS participant and that the assignment of time zone was correct. All cell phone events made or received during a participant's enrollment in the SHRP 2 NDS are stored in the SHRP 2 NDS database, regardless of whether she or he was driving or regardless of who was using the participant's phone. Cell phone events that overlap with the SHRP 2 NDS driving data are of highest interest, and these are flagged with the start time of the overlap noted.

CHAPTER 3

Findings and Applications

Cell phone records were obtained from 620 participants. Thirty-four of the 620 CPRS participants were classified as secondary drivers in the SHRP 2 NDS. Figure 3.1 shows the age and gender distribution of all 620 CPRS participants. The ages reported are the ages of the participants at the onset of participation in the SHRP 2 NDS.

A total of 492 years of text data were collected and a total of 567 years of call data were collected. Figure 3.2 shows the number of months of call and text data collected by age.

Approximately 209,000 calls and 274,000 texts overlap with the driving data. Figure 3.3 shows the number of calls and texts that overlap with the driving data by age. Tables have been created to provide summary data at the participant level regarding the data received. These tables provide details about each participant's average calls, texts, and pictures/videos per month and the average of these calls, texts, and pictures/videos that overlap with the driving data. The total number of calls, texts, and pictures/videos overlapping the driving data are also included at the participant level. A sample cell phone summary data table can be found in Appendix A.

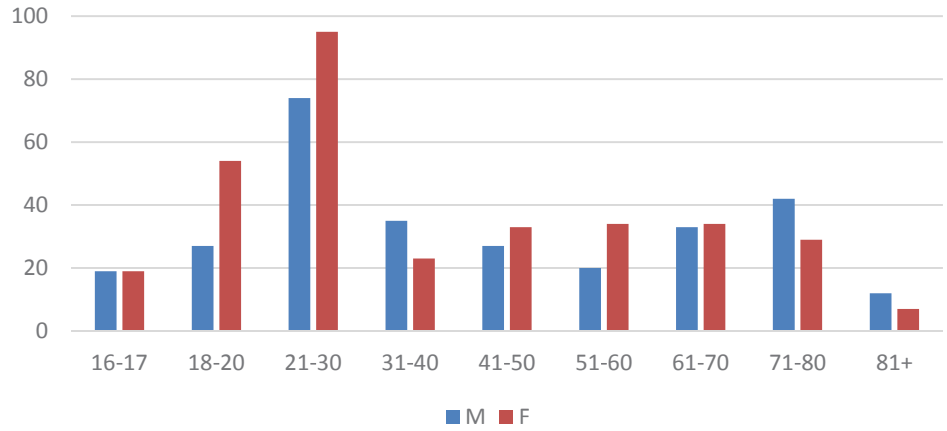

Figure 3.1. Number of CPRS participants who contributed records, by age and gender.

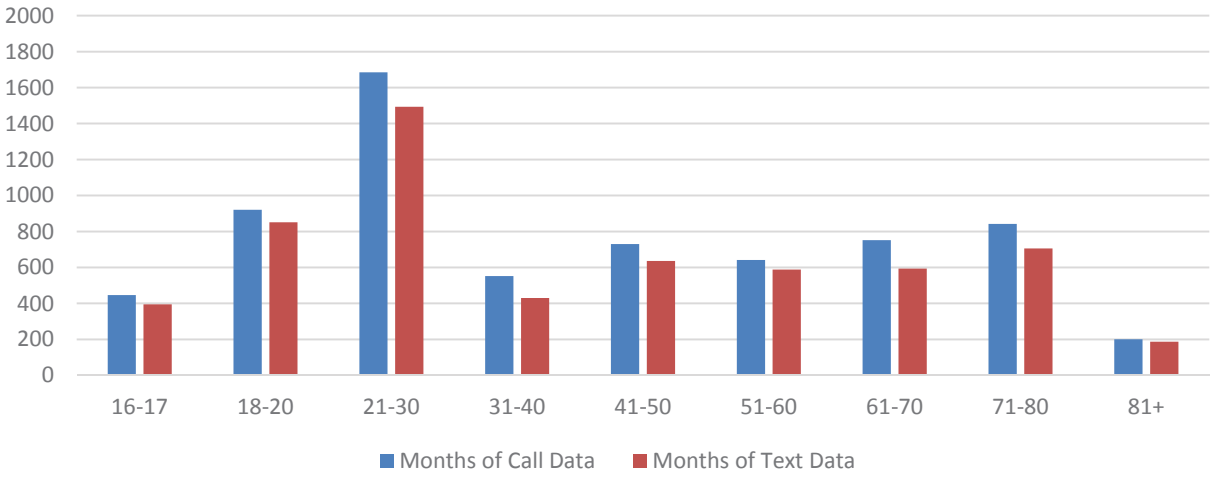

Figure 3.2. Total months of call and text records received, by age.

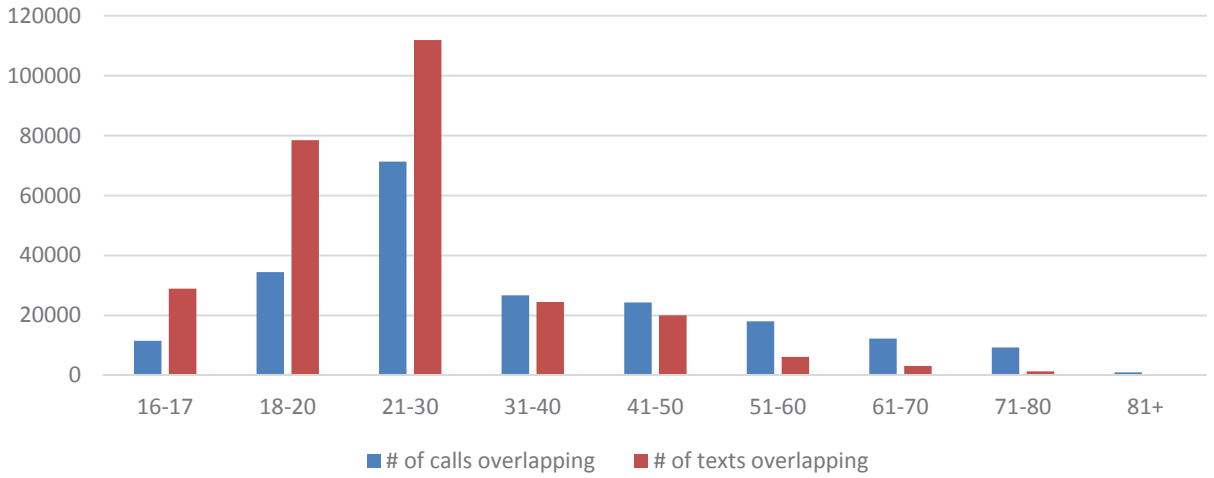

Figure 3.3. Number of cell phone calls and texts overlapping driving data, by age.

CHAPTER 4

Data Use Considerations

A convenience sample of 620 participants provided cell phone records for the CPRS, comprising less than 20% of the total number of participants in the SHRP 2 NDS. Antin, Stulce, Eichelberger, and Hankey (2015) described how the NDS sample was collected and how it compared along a variety of dimensions to the overall driving population in the United States.

It became apparent during the video verification process that even when the team believed the cell phone records matched to the correct participant and that the assignment of time zone was correct, this did not ensure that the participant was the one using his or her phone for a given event. For example, research staff may view video footage corresponding to the date and time of a cell phone call and document that the participant (driver) is not on the phone, but it appears that the front seat passenger may be using the phone (e.g., a phone is in the cup holder and just before the onset of the call the front seat passenger reaches over and picks up the phone). There were also scenarios in which no interaction with a cell phone could be detected for a given event, even though viewing other driving trips for that participant clearly indicated that the cell phone records were properly matched. Researchers who use the cell phone data in the future must keep in mind that there are a number of possible scenarios that would account for a participant not having any involvement related to a call or text documented in the cell phone records. It is possible that a driver may not have heard his or her cell phone ring or felt it vibrate, or that a driver may have simply chosen to ignore an incoming cell phone call or text. Day-to-day situations where cell phone users loan their phone to family or friends to use for a day or accidentally leave their phone at home where it may be answered and used by others may also occur.

It is also important to note that there may be months in which a given participant had few, if any, calls or texts. We may have participant data for the time period and know the number of texts or calls to be small, or even zero. At the onset of the study, it was deemed important to include data from a wide demographic of cell phone users. Therefore, the fact that there may be no calls made or received in a month may still be important data, and a month of zero calls or texts would still be included in the total months of data.

However, it is also crucial that future users of the data understand that there are some months in which cell phone data may not be available for a given participant. In these cases, one must carefully distinguish between the aforementioned scenario of having data and the data reflecting zero calls, as opposed to the completely different scenario in which the data are simply unavailable and the number of calls or texts is unknown. In an effort to ensure these scenarios are clearly reflected in the database, a data availability table has been created for each participant. This table will be part of the SHRP 2 NDS database and can be used by future researchers to ensure that any future analyses only take into account the time frame when data were actually available, regardless of the number of calls made during that period. A sample of this cell phone data availability table can be found in Appendix B.

The data availability table also provides clear details regarding the types of data available for different time periods. For example, a participant may have provided 2 years of call data but only 3 months of text data. Also, Verizon and AT&T did not provide any information regarding the number of pictures or videos texted to and from participants, so the data table for records provided by the carriers will indicate that the number of pictures and videos sent and received for these participants is unavailable and unknown.

Future Research Implications

The data collected in the SHRP 2 NDS give researchers more than a million hours of naturalistic driving data that can be used to investigate a wide variety of topics, including the role of cell phone use while driving, especially just before and during safety-critical events. However, it must be noted that the cell phone data specifically referenced in this report were collected from the cell phone records of only 620 of the more than 3,100

SHRP 2 NDS participants. Still, these data will enable researchers to quickly locate specific points of interest within the million hours of driving data in which a cell phone event might have occurred for one of these 620 participants. The cell phone data not only provide information about calls that took place while driving but also provide data about cell phone use in general. These data afford the opportunity for future researchers to gain insight into metrics of exposure and how different drivers may choose to restrict their cell phone use while driving.

The cell phone data for a given primary participant are also tied to the driver assessment data provided by that participant; driver assessment data are much more limited for the 34 secondary drivers enrolled in the CPRS. These primary participant assessments were sampled from the following dimensions of functional capacity thought to be important to driving skill and safety: health, physical ability, perception, cognition, and psychomotor ability, as well as attitudes and perspectives on a variety of topics collected via a questionnaire (Antin et al. 2011). This information will allow future researchers to further investigate the roles that such factors play in a driver's willingness to engage with the cell phone while driving and the relative risks associated thereto.

CHAPTER 5

Study Summary and Future Research Implications

The CPRS was the first follow-on study to the SHRP 2 NDS. It was undertaken to make it easier for researchers to identify epochs wherein a participant's use of a cell phone to talk or to send a text message coincided or overlapped with a recorded driving epoch showing that participant concurrently driving a study vehicle. With such real-world observation of people driving while using cell phones, researchers can better understand any associated behaviors (e.g., possibly identifying the scenarios in which drivers choose to engage or to become hypervigilant) and their possible impacts on crash risk.

Obtaining the cell phone records for this study involved reaching out to SHRP 2 NDS participants and interacting with them remotely to ensure they were willing to participate, were willing to fully consent, and were able to provide either their own copies of their cell phone records or to take the necessary steps to allow researchers to obtain their records directly from their wireless carriers. Steps were taken throughout the process to comply with IRB requirements, with FCC regulations, and with the policies and procedures set by the two individual wireless carriers that agreed to provide authorized electronic records.

The cell phone records collected in this effort represent a wide demographic of drivers and more than 6.3 million call and texting events, including 483,000 events that overlap with driving data and can be examined by researchers in the future.

References

Antin, J., S.E. Lee, J. Hankey, and T.A. Dingus. 2011. *SHRP 2 Report S2-S05-RR-1: Design of the In-Vehicle Driving Behavior and Crash Risk Study.* Transportation Research Board of the National Academies, Washington, D.C.

Antin, J.F., K. Stulce, L. Eichelberger, and J. Hankey. 2015. *SHRP 2 Report S2-S31-RW-1: Naturalistic Driving Study: Descriptive Comparison of the Study Sample with National Data.* Transportation Research Board of the National Academies, Washington, D.C.

CTIA, The Wireless Association. 2014. Wireless History Timeline. http://www.ctia.org/your-wireless-life/how-wireless-works/wireless-history-timeline.

Fitch, G.A., S.A. Soccolich, F. Guo, J. McClafferty, Y. Fang, R.L. Olson, M.A. Perez, R.J. Hanowski, J.M. Hankey, and T.A. Dingus. 2013. *The Impact of Hand-held and Hands-free Cell Phone Use on Driving Performance and Safety-Critical Event Risk.* Report DOT HS 811 757. National Highway Traffic Safety Administration, U.S. Department of Transportation.

Klauer, S.G., F. Guo, J. Sudweeks, and T.A. Dingus. 2010. *An Analysis of Driver Inattention Using a Case-Crossover Approach on 100-Car Data: Final Report.* Report DOT HS 811 334. National Highway Traffic Safety Administration, U.S. Department of Transportation.

McCartt, A.T., L.A. Hellinga, and K.A. Braitman. 2006. Cell Phones and Driving: Review of Research. *Traffic Injury Prevention,* Vol. 7, pp. 89–106.

Olson, R.L., R.J. Hanowski, J.S. Hickman, and J. Bocanegra. 2009. *Driver Distraction in Commercial Vehicle Operations.* Report FMCSA-RRR-09-042. Federal Motor Carrier Safety Administration, U.S. Department of Transportation.

Redelmeier, D.A., and R.J. Tibshirani. 1997. Association Between Cellular Telephone Calls and Motor Vehicle Collisions. *The New England Journal of Medicine,* Vol. 336, pp. 453–458.

APPENDIX A

Sample Cell Phone Summary Data Table

	Average per Month (Total Usage)						Average per Month (Overlapping with Driving Data)						Total Number (Overlapping with Driving Data)					
	Calls		Texts		Pictures/ Videos		Calls		Texts		Pictures/ Videos		Calls		Texts		Pictures/ Videos	
ID	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
1234	10	0.25	2	1.3	NA	NA	0.333	0.1666	0	0	NA	NA	4	2	0	0	NA	NA
5678	1096	1002	980	1025	5	2	83	80	22	16.5	0	0	166	160	44	33	0	0
9876	1000	149	NA	NA	NA	NA	2.5	3.19	NA	NA	NA	NA	30	47	NA	NA	NA	NA

APPENDIX B

Sample Cell Phone Data Availability Table

ID	Available Start	Available End	Type	Carrier	Source
1234	1/1/2010	12/31/2010	Text	Verizon	Carrier
1234	1/1/2010	12/31/2010	Call	Verizon	Carrier
5678	6/1/2010	8/1/2010	Call	T-Mobile	Participant
5678	6/1/2010	8/1/2010	Text	T-Mobile	Participant
5678	6/1/2010	8/1/2010	Picture/Video	T-Mobile	Participant
9876	1/1/2011	12/31/2011	Call	Sprint	Participant

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Related SHRP 2 Research

- Naturalistic Driving Study: Development of the Roadway Information Database (S04A)
- Design of the In-Vehicle Driving Behavior and Crash Risk Study (S05)
- Naturalistic Driving Study: Technical Coordination and Quality Control (S06)
- Naturalistic Driving Study: Field Data Collection (S07)
- Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk (S08A)
- Analysis of Naturalistic Driving Study Data: Offset Left-Turn Lanes (S08B)
- Analysis of Naturalistic Driving Study Data: Roadway Departures on Rural Two-Lane Curves (S08D)
- Naturalistic Driving Study: Descriptive Comparison of the Study Sample with National Data (S31)
- Naturalistic Driving Study: Alcohol Sensor Performance (S31)
- Naturalistic Driving Study: Linking the Study Data to the Roadway Information Database (S31)