

Zendrive

Driver Personas

New Behavioral Clusters and Their
Risk Implications

March 2018



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INTRODUCTION

Using our massive dataset to capture the behavior of millions of drivers across the United States, Zendrive has uncovered trends about Americans' driving behaviors that were previously unattainable.

Zendrive's research and analysis identified 8 driver personas, with 6 predominant personas of interest:

- Phone Addicts
- Frustrated Lead-Footers
- Speed Demons
- Neighborhood Navigators
- Expert Commuters
- Weekend Cruisers

We also looked at the relative risk of each persona, finding a clear separation into High Risk and Low Risk groups. Each persona is defined by a unique characteristic, such as greater than average phone use while driving or time spent on highways. Personas do not overlap: each driver belongs to a unique behavior cluster, the data point to which their attributes are statistically closest via a k-means clustering algorithm. This means that each driver has a unique persona, even if they appear to exhibit the characteristics of two or more.

Zendrive's technology uses machine learning algorithms and the sensors in a smartphone to measure and analyze driver behavior. Zendrive measures the behaviors that are most likely to contribute to crashes: speeding, driver phone use, aggressive acceleration and hard braking.

¹ Refer to the methodology section for details on how each persona was identified.

EXECUTIVE SUMMARY

We found that the majority of drivers, 71%, actually exhibit consistently safe driving habits and, as a result, have low collision frequencies. These personas include Neighborhood Navigators, Expert Commuters and Weekend Cruisers. The remaining 29% exhibit unsafe characteristics such as phone use while driving, excessive speeding, hard brakes, and accelerations. They are **two times more likely** to get into a collision than low risk personas.

The risky personas include: Phone Addicts, Frustrated Lead-Footers, and Speed Demons. Phone Addicts are the largest risky persona, comprising of 12% of American drivers.

This study uncovered the distribution of risk across U.S. drivers. Looking at each driver's phone use, excessive speeding, hard brakes, and accelerations, Zendrive identified three dominant risky driver personas:

PHONE ADDICTS (12%)

People who are **3.2 times more distracted driving than the average driver.**

FRUSTRATED LEAD-FOOTERS (9%)

These are people who make **2.9 times more aggressive acceleration and hard braking events per 100-miles** than the average driver.

SPEED DEMONS (8%)

These are people who speed an average of **5.9 times more** than the average driver.

Identifying drivers who exhibit specific risky behaviors is the first step in understanding risk distribution and constructing a tailored program to price risk and provide coaching to improve safety.

DRIVER PERSONAS, ORGANIZED BY RISK LEVEL²

HIGH RISK

PHONE ADDICTS

Spends 3.2x more on the phone while driving



12%
of drivers are
Phone Addicts

FRUSTRATED LEAD-FOOTERS

Has 2.9x more accelerations and deceleration events per 100 miles



9%
of drivers are
Frustrated
Lead-Footers

SPEED DEMONS

Spends 5.9x more time speeding



8%
of drivers are
Speed Demons

LOW RISK

NEIGHBORHOOD NAVIGATORS

Spends 0.5% of miles driven on a highway



29%
of drivers are
Neighborhood
Navigators

EXPERT COMMUTERS

Spends 1.4x more miles driving on a highway



26%
of drivers are
Expert Commuters

WEEKEND CRUISERS

Spends 1.9x more miles driving on weekends



16%
of drivers are
Weekend Cruisers

Full Driver Persona Study available at www.zendrive.com/datastudy/driver-personas/

*Note: Defining characteristic is a comparison to the sample average.

²Our analysis identified two additional personas but they were excluded due to their small size; Night Riders and Long Haulers. Night Riders can be characterized by the high percent (16%) of their overall time they spend driving at night; which is 13.4 times more than the average driver. Long Haulers can be defined by their average shift which at 3 hours, 21 minutes 5.2-times greater than the average. The Night Riders are a high risk persona while the Long Haulers are a low risk persona, and together they comprise less than 5% of the overall drivers. See the Appendix section for more details on these two behaviors. The total concentrations for each persona referenced on this page exclude the share for the Night Riders and Long Haulers.

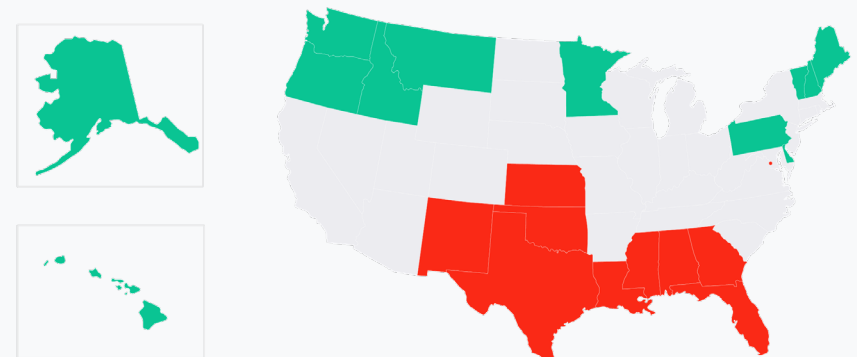
STATES BY DRIVER RISK LEVEL

■ = Top 10 states with the highest concentration of high risk personas

■ = 30 states with a mix of high and low risk personas

■ = Bottom 10 states with the lowest concentration of high risk personas

The ratio of risky personas was calculated as the sum total of the number of drivers belonging to the Phone Addicts, Frustrated Lead-Footers, and Speed Demons personas divided by the sum total of the number of drivers belonging to the Expert Commuters, Weekend Cruisers, and Neighborhood Navigators personas.



MOST PROMINENT HIGH RISK PERSONAS

State	Phone Addicts	Speed Demons	Frustrated Lead-Footers
Alabama	●		
District of Columbia			●
Florida	●	●	
Georgia	●		
Kansas		●	
Louisiana	●		
Mississippi	●		
New Mexico		●	
Oklahoma	●		
Texas	●	●	

MOST PROMINENT LOW RISK PERSONAS

State	Neighborhood Navigators	Expert Commuters	Weekend Cruisers
Alaska	●		
Hawaii	●	●	
Idaho	●		
Maine	●		
Minnesota	●	●	●
Montana	●		
New Hampshire	●	●	
Oregon	●		
Vermont	●		
Washington	●		

RISKY PERSONAS VS. AVERAGE AUTO INSURANCE PRICE BY STATE

Understanding the actual risky behavior of drivers is the first step in pricing risk. Currently most auto insurance models are based on variables that are proxies for drivers' risk levels, such as age and marital status. When insurance companies aren't able to accurately determine risk for individual drivers, they raise base rates for all drivers.

The map below, "States by Relative Auto Insurance Price Level," shows each state's average auto insurance premium in 2017. **Although there is some overlap across risk level and the price when compared to Zendrive's high and low risk driver personas, drivers in some states are overcharged while drivers in other states are undercharged.**

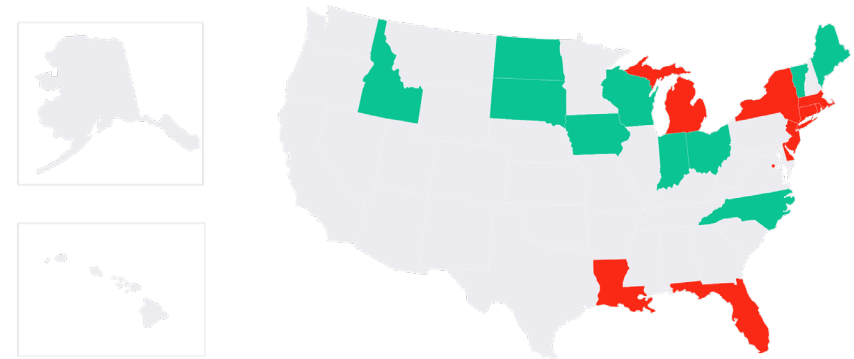
COMPARISON OF DRIVER RISK AND AUTO INSURANCE PRICING

- *Louisiana, Texas, District of Columbia, and Florida* are the riskiest and the most expensive.
- *Idaho, Maine, and Vermont* are the lowest risk states and the least expensive.
- *Delaware* is a low risk state but is among the most expensive, indicating that many drivers in that state are paying too much for their insurance.
- Drivers in *Alaska, Maryland, and Rhode Island* are low risk states but have moderately priced average insurance rates, indicating that drivers may also be overcharged.
- Drivers in *South Dakota, Kansas, Alabama, and New Mexico* are high risk states but have moderately priced average insurance rates, indicating that drivers may also be undercharged.



STATES BY RELATIVE AUTO INSURANCE PRICE LEVEL

- = Top 10 states with the most expensive auto insurance prices
- = 30 states with mid-level auto insurance pricing
- = Bottom 10 states with the least expensive auto insurance prices

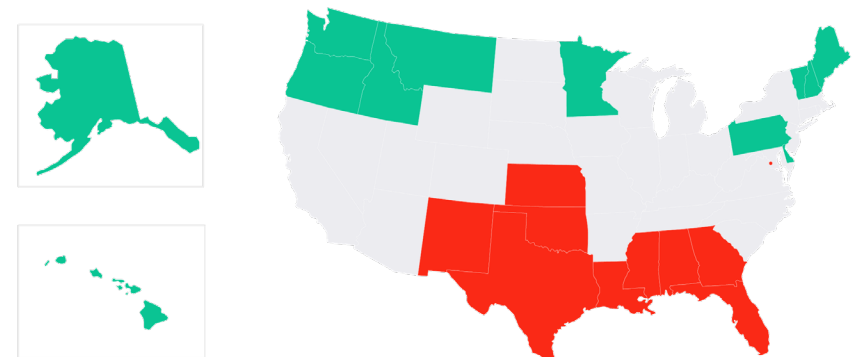


Source: 2015 Average Premiums and Expenditures data from NAIC (National Association of Insurance Commissioners)

STATES BY DRIVER RISK LEVEL

- = Top 10 states with the highest concentration of high risk personas
- = 30 states with a mix of high and low risk personas
- = Bottom 10 states with the lowest concentration of high risk personas

The ratio of risky personas was calculated as the sum total of the number of drivers belonging to the Phone Addicts, Frustrated Lead-Footers, and Speed Demons personas divided by the sum total of the number of drivers belonging to the Expert Commuters, Weekend Cruisers, and Neighborhood Navigators personas.



SIX DRIVER PERSONAS







There are six main driving personas in the United States: **Phone Addicts**, **Frustrated Lead-Footers**, **Speed Demons**, **Expert Commuters**, **Weekend Cruisers**, and **Neighborhood Navigators**. Each persona is defined by a unique characteristic such as abnormal time spent driving at night or during the weekend.

Each persona can be characterized by their risk level: high or low. The table below sorts each driver persona by risk classification and group size. This study used the first fourteen days of driving in the period of the dataset to identify driver personas. It determined risk by calculating the frequency of collisions per driver after the first fourteen days for each persona group. **Personas that are high risk are overall more than two times more likely to get into a collisions than personas that are low risk.**

Phone Addicts are the largest risky persona group. These drivers can be identified by their high phone usage while behind the wheel. Frustrated Lead-Footers and Speed Demons also have relatively high rates of collisions.

Seventy-one (71) percent of drivers are classified as low risk personas. The Neighborhood Navigators and Expert Commuters are the largest groups, together accounting for more than 50% of all drivers.

DRIVER PERSONAS, BY RISK LEVEL

HIGH RISK			LOW RISK		
					
PHONE ADDICTS	FRUSTRATED LEAD-FOOTERS	SPEED DEMONS	NEIGHBORHOOD NAVIGATORS	EXPERT COMMUTERS	WEEKEND CRUISERS
Phone Addicts tend to spend 3.2-times more time driving while using their phone	Frustrated Lead-Footers have 2.9 times more acceleration and deceleration events per 100 miles	Speed Demons spend 5.9 times more time speeding	Neighborhood Navigators spend half of the miles driven on a highway	Expert Commuters spend 1.4 times more miles driven on a highway	Weekend Cruisers spend 1.9 times more miles driving on the weekends

*Note: Defining characteristic is a comparison to the sample average.

NATIONWIDE DISTRIBUTION OF DRIVER PERSONAS

Each geographic region has its own unique mix of driving personas that are determined by unique local characteristics.

We find factors such as state laws, population density, and even household income correlate with the distribution of specific personas in specific areas.

- State bans on driver handheld phone use has a marginal effect; the average percent of phone addicts is 10.3% for states with a phone ban and 12.1% for states with no phone ban
- Household income has an interesting relationship to the frequency of Phone Addicts: the higher the per capita income in a state, the more Phone Addicts in that state
- Frustrated Lead-Footers can be found in regions with high population densities, and their presence is highly correlated with population size. However, even in states with high levels of Frustrated Lead-Footers, this persona is a small minority, indicating that although environment is a factor, it's within the power of individual drivers to practice safe braking and acceleration
- State speed limits work in reducing the frequency of Speed Demons in particular state: the average percent of Speed Demons in states with speed limits over 75 mph is 22%; for states with speed limits 75 mph and under, the average is 5.3%
- Given their high average speed, Speed Demons drivers are likely to get into the most dangerous collisions: the correlation between the percent of Speed Demons in a particular state and the number of fatal crashes per 100,000 population is 0.68 (based on 2016 data).

See page 16 for a detailed discussion of the geographic variability of high risk personas.

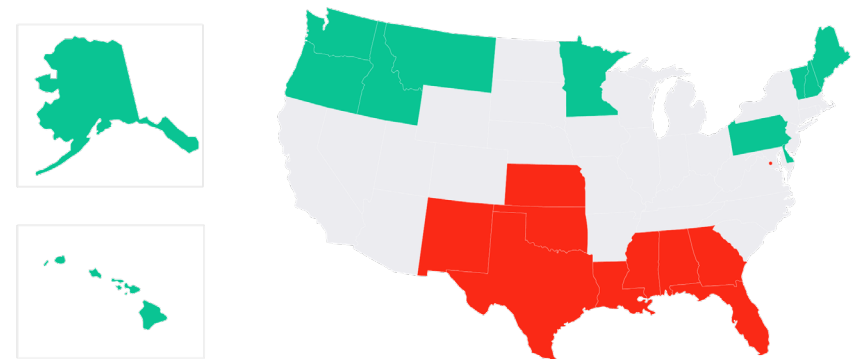
The map on the next page shows each state's risk level and the following tables list the riskiest and safest personas in the ten most dangerous and ten safest states.



STATES BY DRIVER RISK LEVEL

- = Top 10 states with the highest concentration of high risk personas
- = 30 states with a mix of high and low risk personas
- = Bottom 10 states with the lowest concentration of high risk personas

The ratio of risky personas was calculated as the sum total of the number of drivers belonging to the Phone Addicts, Frustrated Lead-Footers, and Speed Demons personas divided by the sum total of the number of drivers belonging to the Expert Commuters, Weekend Cruisers, and Neighborhood Navigators personas.



MOST PROMINENT HIGH RISK PERSONAS

State	Phone Addicts	Speed Demons	
Alabama	●		
District of Columbia			●
Florida	●	●	
Georgia	●		
Kansas		●	
Louisiana	●		
Mississippi	●		
New Mexico		●	
Oklahoma	●		
Texas	●	●	

MOST PROMINENT LOW RISK PERSONAS

State	Neighborhood Navigators	Expert Commuters	Weekend Cruisers
Alaska	●		
Hawaii	●	●	
Idaho	●		
Maine	●		
Minnesota	●	●	●
Montana	●		
New Hampshire	●	●	
Oregon	●		
Vermont	●		
Washington	●		

DETAILS ON DRIVER PERSONAS:

HIGH RISK

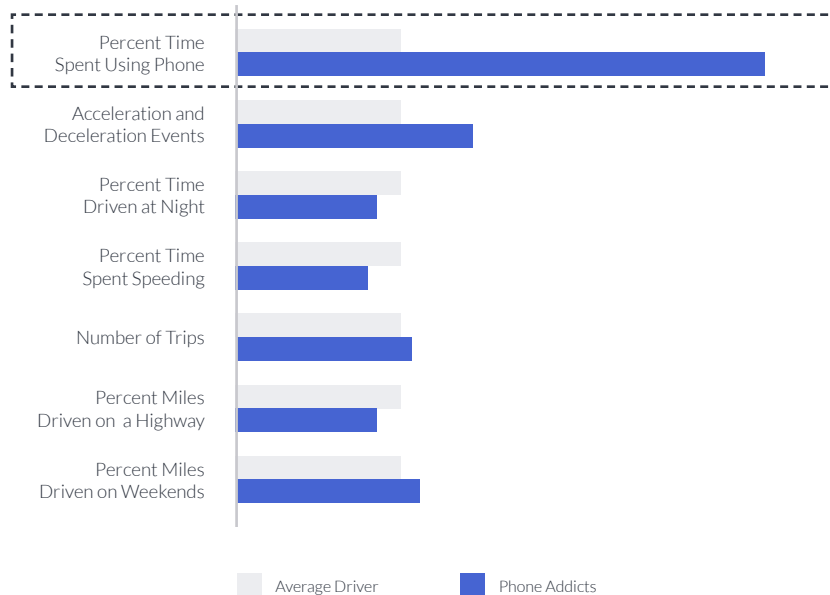
PHONE ADDICTS

Phone Addicts are a high risk group and comprise 12% of the total drivers in the study. On average, these drivers spend 3.2-times more time on their phones than the average driver. They also have many more rapid acceleration and hard braking events than average.

Mississippi (18%), Louisiana (16%), and Rhode Island (16%) have the highest concentration of Phone Addicts.



PHONE ADDICTS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF PHONE ADDICTS



DETAILS ON DRIVER PERSONAS:

HIGH RISK

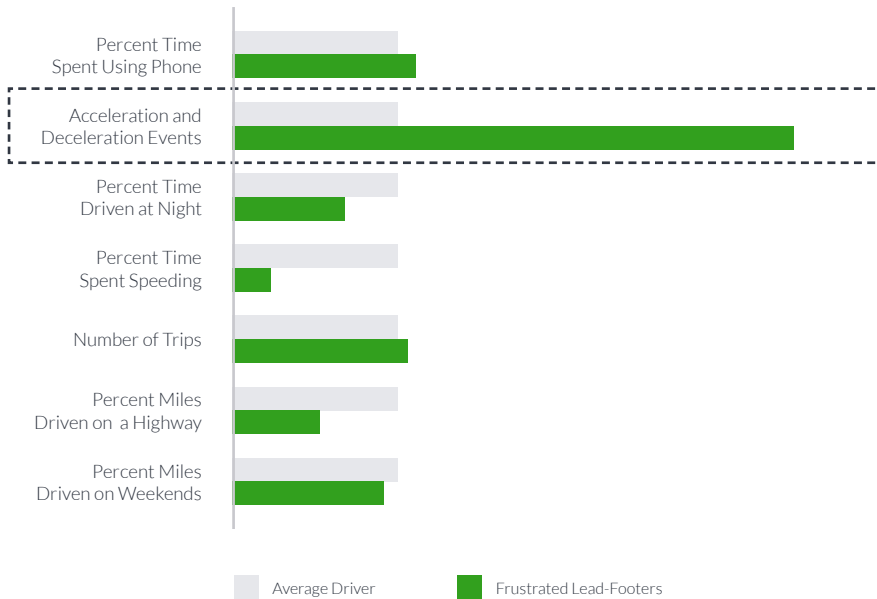
FRUSTRATED LEAD-FOOTERS

Frustrated Lead-Footers are a high risk group and comprise 9% of the drivers in the study. On average, these drivers have 2.9-times more aggressive acceleration and hard braking events per 100-miles than the average driver.

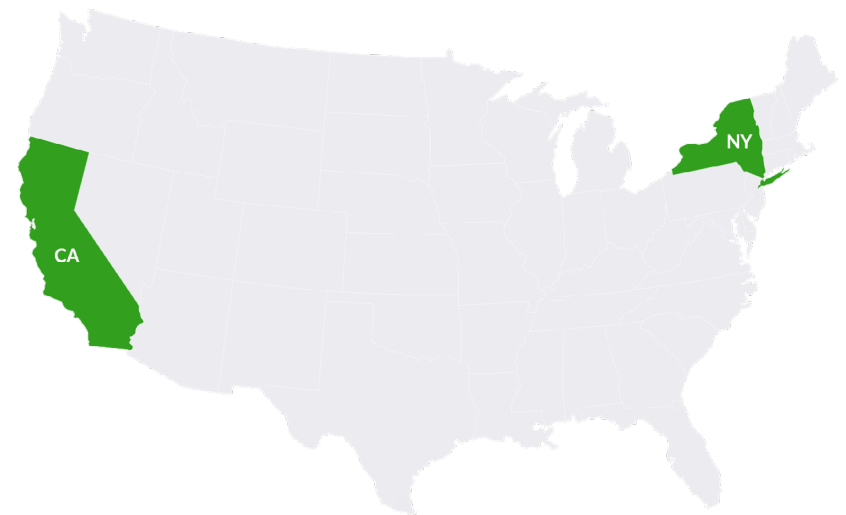
California (17%) and New York (15%) have the highest concentrations of Frustrated Lead-Footers.



FRUSTRATED LEAD-FOOTERS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF FRUSTRATED LEAD-FOOTERS



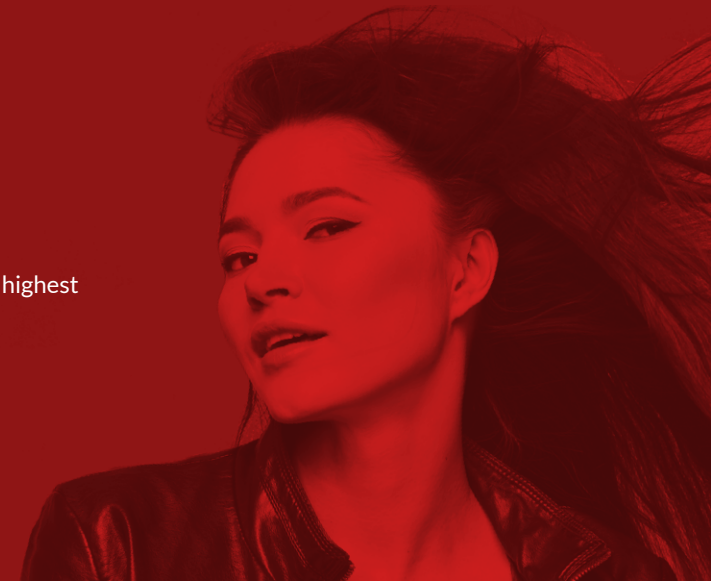
DETAILS ON DRIVER PERSONAS:

HIGH RISK

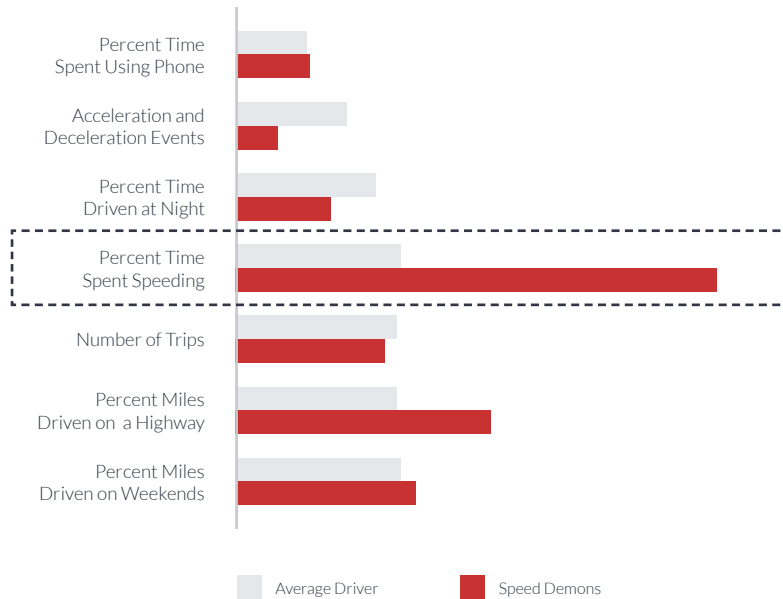
SPEED DEMONS

Speed Demons are a high risk group and comprise 8% of the total number of drivers in this study. These people speed over 75 mph 5.9-times more than the average driver. They also tend to make longer trips than the average of 55-minutes.

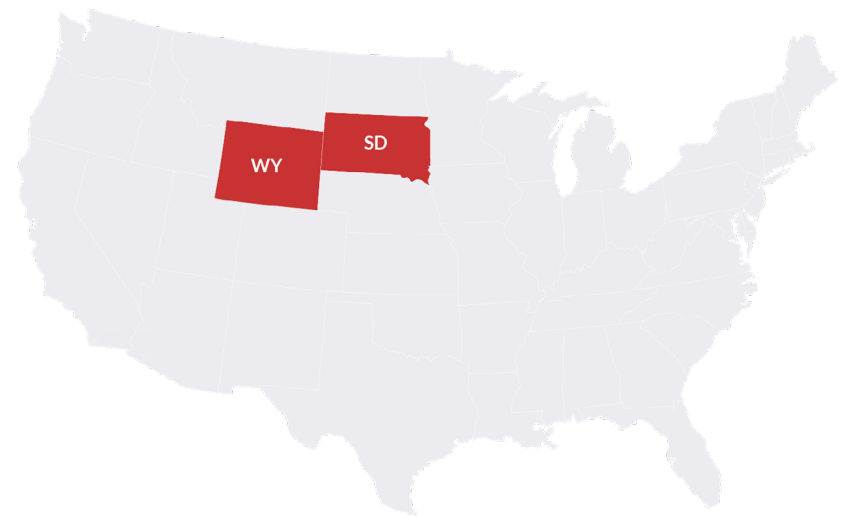
South Dakota (21%) and Wyoming (20%) have the highest concentration of Speed Demons.



SPEED DEMONS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF SPEED DEMONS



DETAILS ON DRIVER PERSONAS:

LOW RISK

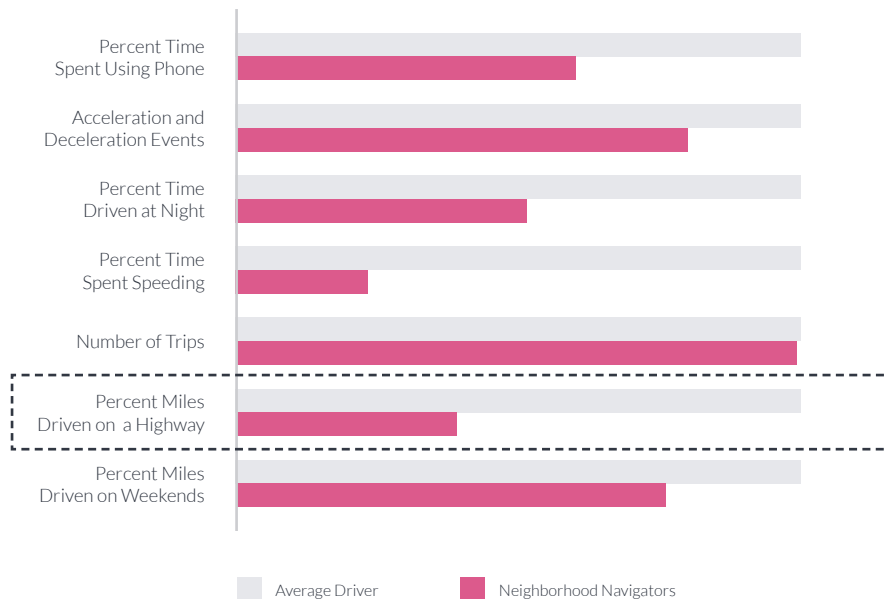
NEIGHBORHOOD NAVIGATORS

Neighborhood Navigators are a low risk group. They comprise 29% of the total study population. These drivers spend half as many miles driving on the highway as the average driver. They tend to have few unique parking locations and safe overall driving habits.

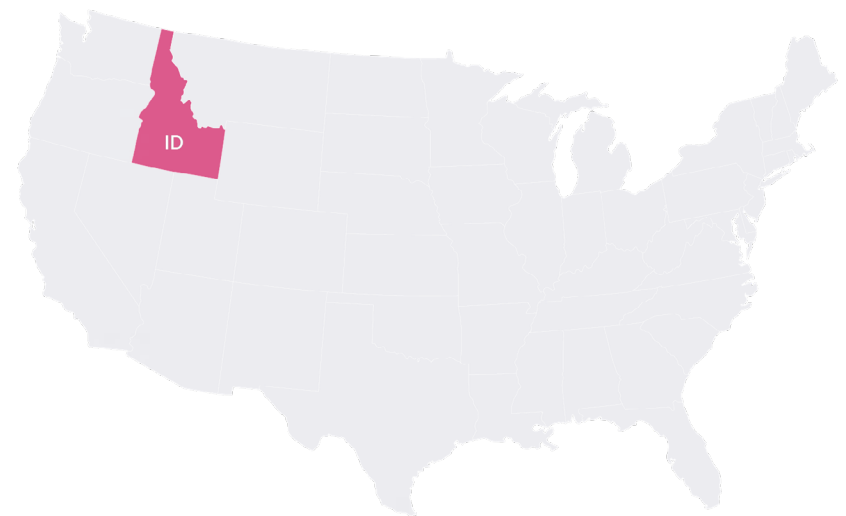
Idaho (51%) has the largest concentration of this driver persona.



NEIGHBORHOOD NAVIGATORS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF NEIGHBORHOOD NAVIGATORS



DETAILS ON DRIVER PERSONAS:

LOW RISK

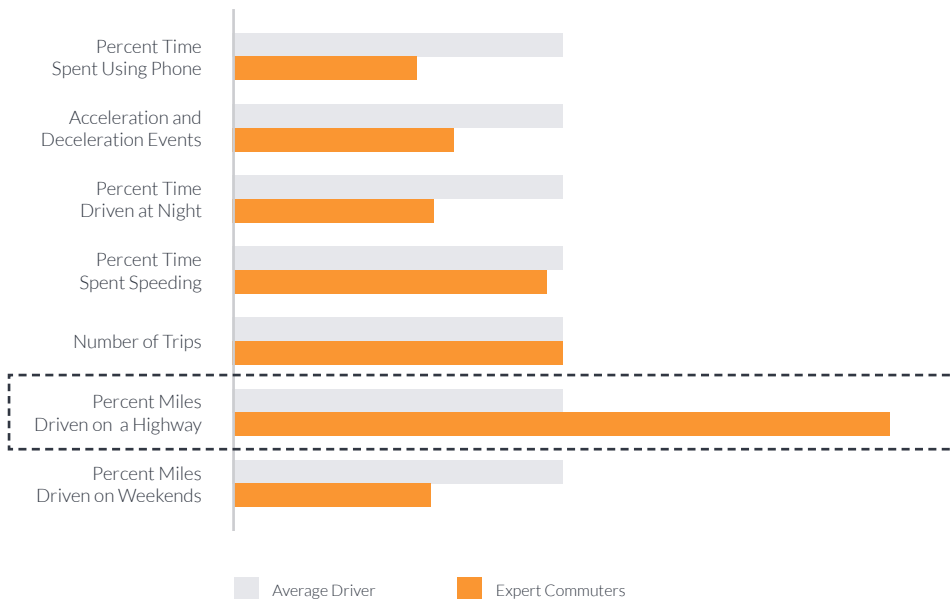
EXPERT COMMUTERS

Expert Commuters are a low risk group and comprise 26% of total drivers in the study. They drive 1.4-times more miles on the highway, spend more time on the road than the average driver, and have relatively safe driving patterns.

Delaware (39%) and Maryland (36%) have the highest concentration of the Expert Commuter driver persona.



EXPERT COMMUTERS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF EXPERT COMMUTERS



DETAILS ON DRIVER PERSONAS:

LOW RISK

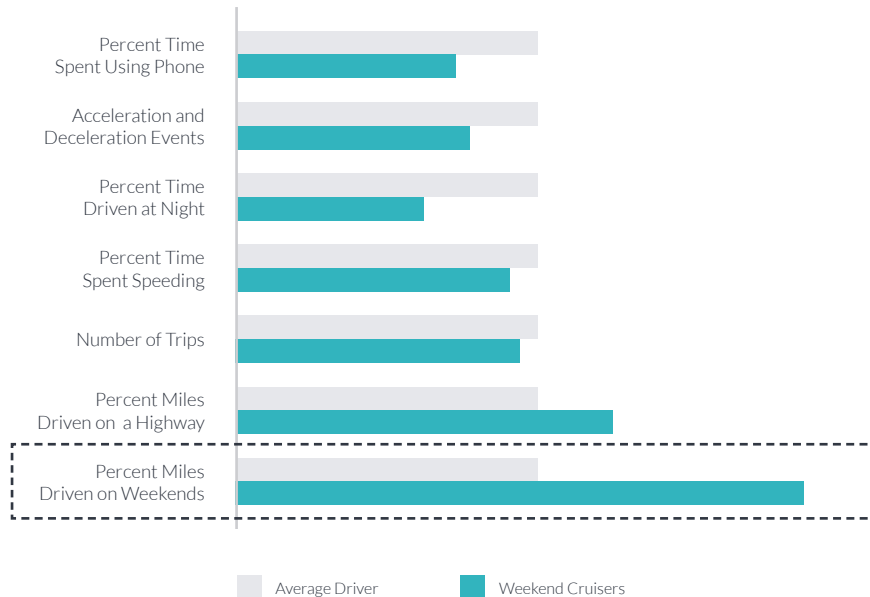
WEEKEND CRUISERS

Weekend Cruisers are a low risk group and comprise 16% of the total study population. They drive 1.9-times more miles on the weekend than the average driver.

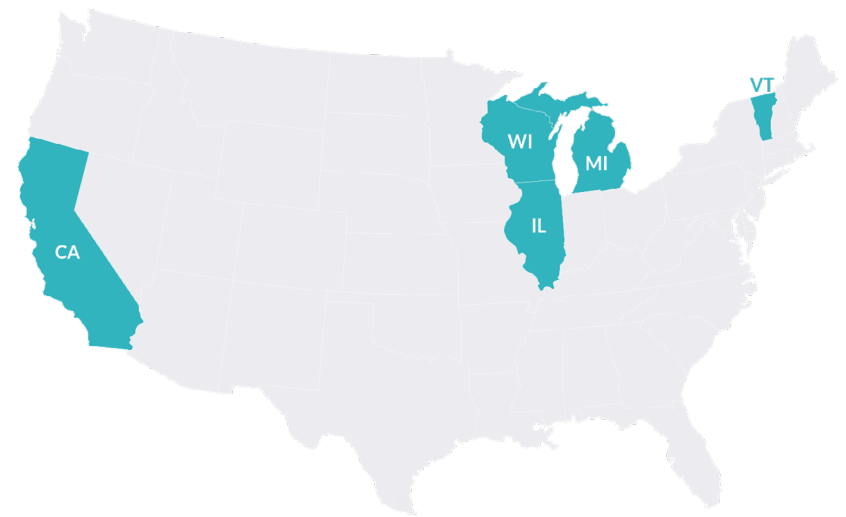
Wisconsin (19%), Illinois (18%), Michigan (18%), California (18%), and Vermont (18%) have the highest concentration of the Weekend Cruiser persona.



WEEKEND CRUISERS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF WEEKEND CRUISERS



GEOGRAPHIC VARIABILITY: ANALYSIS OF HIGH RISK PERSONAS

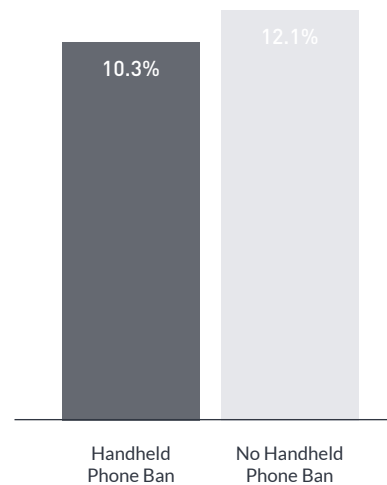
Each geographic region has its own unique mix of driving personas determined by a number of unique characteristics. We find factors such as state laws, population and even per capita income correlate with the distribution of particular personas in particular areas.

PHONE ADDICTS

Phone Addicts account for 12% of all drivers. Phone Addicts are people who, on average, spend 16% of their time behind the wheel on the phone.

State bans on drivers' use of handheld phones has a slightly positive impact on the percent of phone addicts. Zendrive found that the average percent of phone addicts is 10.3% for states with a phone ban and 12.1% for states with no phone ban. Income is also positively correlated with the percent of phone addicts, with a 24% correlation between percent of phone addicts in a particular state and Per Capita Income (see chart *"Positive Relationship between Per Capita Income in State and Phone Addicts"*).

IMPACT OF STATE-LEVEL DRIVER PHONE USE LAWS ON PHONE ADDICTS



Note: Each bar shows the weighted average phone addicts per state, weighted by the number of drivers in each state.

POSITIVE RELATIONSHIP BETWEEN STATE-LEVEL PER CAPITA INCOME AND PHONE ADDICTS

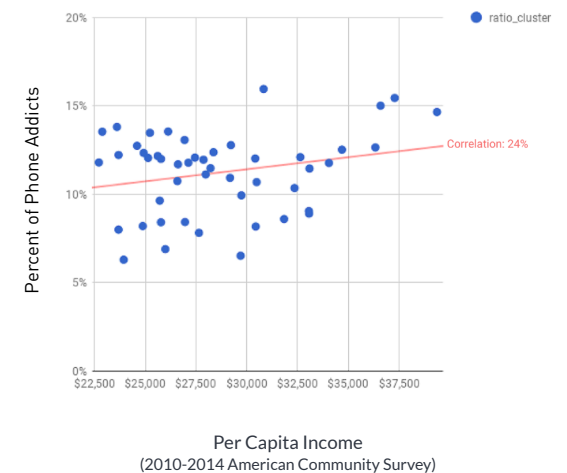


Chart excludes the following outliers:
Mississippi, Louisiana, and District of Columbia

FRUSTRATED LEAD-FOOTERS

Frustrated lead footers account for 9% of all drivers. Frustrated Lead-Footers have 2.9-times more aggressive acceleration and hard braking events per 100-miles.

They can be found in regions with high population densities, and their behavior is highly correlated with population size. The correlation between the percent of Frustrated Lead-Footers in a particular state and the population in that state is 0.72 (see chart “Positive Relationship between State Population and Frustrated Lead-Footers”). However, even in regions with high levels of Frustrated Lead-Footers, this persona is still a small minority, indicating that although environment is a contributing factor, it’s within individuals’ control to practice safe braking and acceleration.

POSITIVE RELATIONSHIP BETWEEN STATE-POPULATION AND FRUSTRATED LEAD-FOOTERS

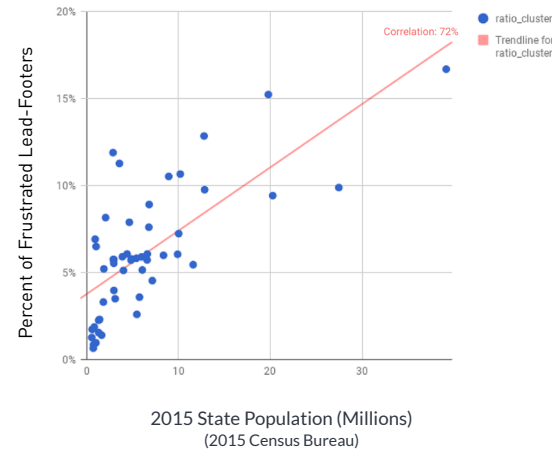


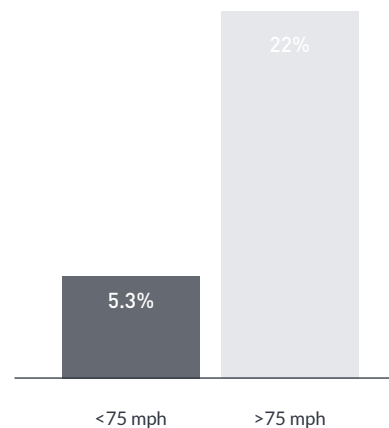
Chart excludes the following outliers:
District of Columbia

SPEED DEMONS

Speed Demons account for 8% of the total drivers in this study. Speed Demons are people who speed over 75 mph 5.9-times more.

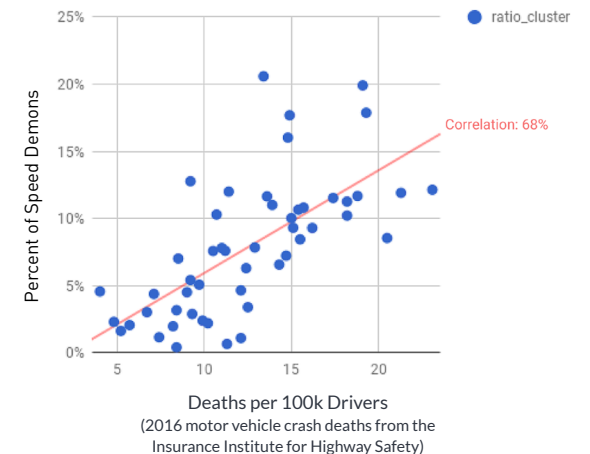
Given their high average speed, these drivers are likely to get into the most dangerous collisions. The correlation between percent of Speed Demons in a particular state and the number of fatal collisions per 100,000 population in 2016 is 0.68 (see chart “Percent of Speed Demons in State vs. 2016 Crash Deaths”). Speed Demons can be found in states with high speed limit laws. The weighted average percent of Speed Demons in states with speed limits over 75 mph is 22%. For states with speed limits 75 mph and under, the weighted average is only 5.3%.

IMPACT OF STATE SPEED LIMITS ON SPEED DEMONS



*Weighted average by number of drivers in each state

POSITIVE RELATIONSHIP BETWEEN CRASH DEATHS AND SPEED DEMONS



CONCLUSION

This study shows that each driver in United States can be characterized by a unique persona. The size and granularity of Zendrive's dataset allowed for this type of modeling. In the last year, Zendrive has measured and analyzed 75-billion miles of anonymized driving and driver behavior data. This study looked at a 2.5-month sample dataset of 2.3-million drivers who drove 5.6-billion miles.

Driver personas have powerful implications for improving insurance risk models. Rather than relying on proxy variables such as age, marital status and geography, Zendrive data captures actual driving behavior to understand each individual driver's actual risk. Given their high collision frequency, Phone Addicts, Frustrated Lead-Footers, and Speed Demons should be subject to the highest insurance rates.

It's important to recognize that most people are actually safe drivers. Seventy one (71) percent belong to one of the low risk categories: Expert Commuters, Weekend Cruiser, and Neighborhood Navigators. Despite their safe driving and low risk, these drivers' insurance rates are unfairly rising each year. They subsidize the increasingly risky behaviors of others on the road. A responsible insurance rating algorithm captures these important distinctions between drivers and prices risk accurately.

Previous Zendrive studies show that driver behavior can be improved, leading to sustained safe driving and a reduction in [collision risk](#) by as much as 49%. While environmental factors such as time of day and highway miles may not be as easy to control, driver behaviors such as phone use and speeding can, and should, be altered. Identification of each driver's key problem area is the first step in constructing a tailored driver coaching program.

Improving the way risk is measured and modeled and the way auto insurance is priced will bring market forces to bare in changing people's behavior behind the wheel, saving lives and money.



DATA AND METHODOLOGY

DATASET

For this study, Zendrive analyzed anonymized and aggregated data from 2.3-million drivers between December 2016 and February 2017. Over the three months, they drove 5.6-billion miles. Personas were identified based on the first two weeks of driving behavior for each driver. Each persona's relative risk was then calculated by dividing the total number of collisions during the following 2.5-months of driving by the number of drivers in that persona group.

METHODOLOGY

IDENTIFICATION OF PERSONAS

Personas were identified in this dataset using K-means clustering approach. K-means clustering is a machine learning methodology that partitions observations into "k" number of clusters in which each driver belongs to a unique cluster with the nearest mean, serving as a prototype of the cluster. For this analysis, observations were based on attributes of the 2.3-million drivers in the study.

Each driver's driving activity for the first 14 days was used to construct their persona. The following driver attributes were selected to determine each cluster:

1. Trip Duration
2. Percent of Miles Driven on Weekends
3. Hard Brake and Aggressive Acceleration Events per 100 Miles of Driving
4. Percent of House Driven at Night
5. Percent of Miles Driven on Highways
6. Percent of Time Speeding
7. Percent of Time Using the Phone

A set of linearly uncorrelated variables were then constructed by passing these variables through a Principal Component Analysis (PCA) transformation. Zendrive researchers ran the k-means clustering process and grouped each driver into a unique cluster based on their driving attributes. Each driver in our dataset is matched with only one unique persona.

An Elbow Method was selected to determine the optimal number of clusters. This examined the percentage of variance and explained it as a function of the number of clusters.



DATA AND METHODOLOGY (CON'T)

Summary statistics were then calculated for the drivers in each persona. Driver personas were defined based on these statistics.

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RISK CLASSIFICATION

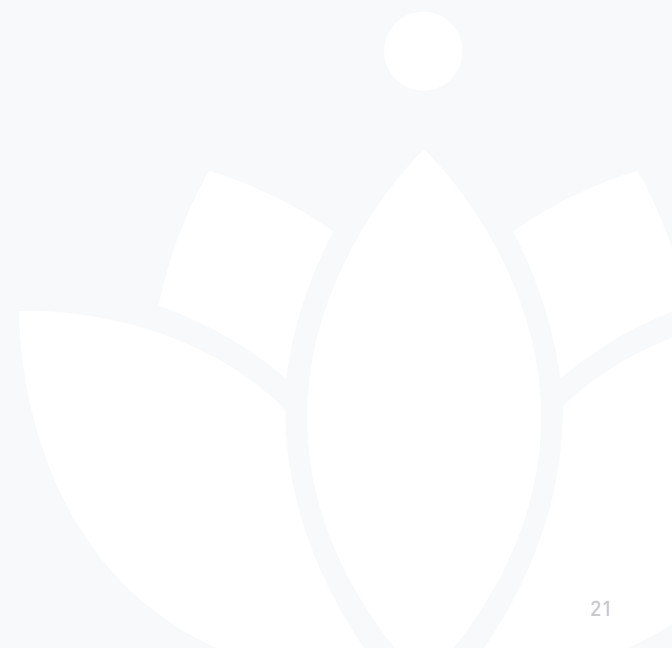
To calculate each persona's risk level, Zendrive compared the total number of collisions to the total number of drivers in the period following their initial two weeks of driving. 2.5-months of driving activity were included in this response period.

OPPORTUNITIES FOR FUTURE RESEARCH

The K-means clustering algorithm are helpful in identifying groups that are not explicitly labeled in the data. Once an algorithm is constructed, any new drivers can be easily assigned to a persona based on their driving data and any switches in driver personas based on driving behavior changes can be tracked. While this analysis is based on a dataset aggregated to the driver day, Zendrive data is deep to the sensor and latitude-longitude level covering over 75 billion miles. Zendrive is also continuously working on constructing new variables the continue to refine our ability to predict risk.



APPENDIX



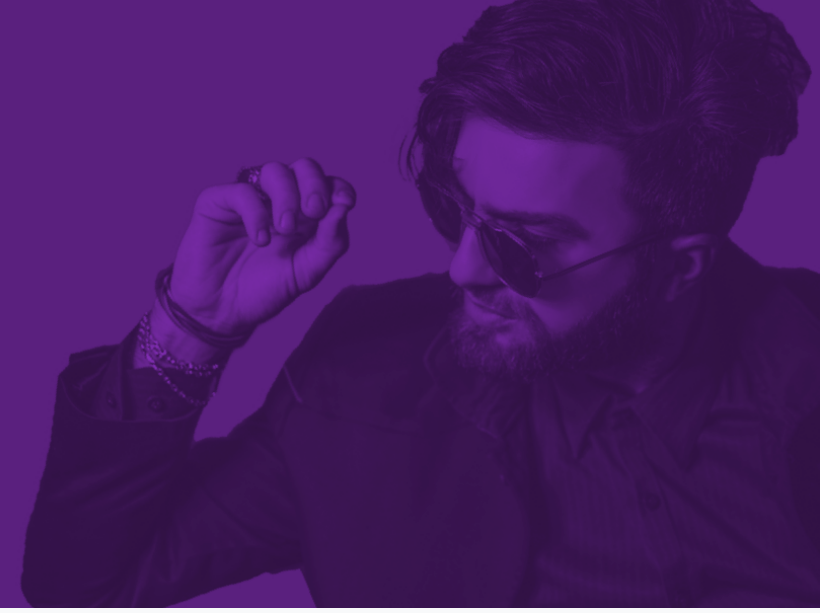
DETAILS ON DRIVER PERSONAS:

HIGH RISK

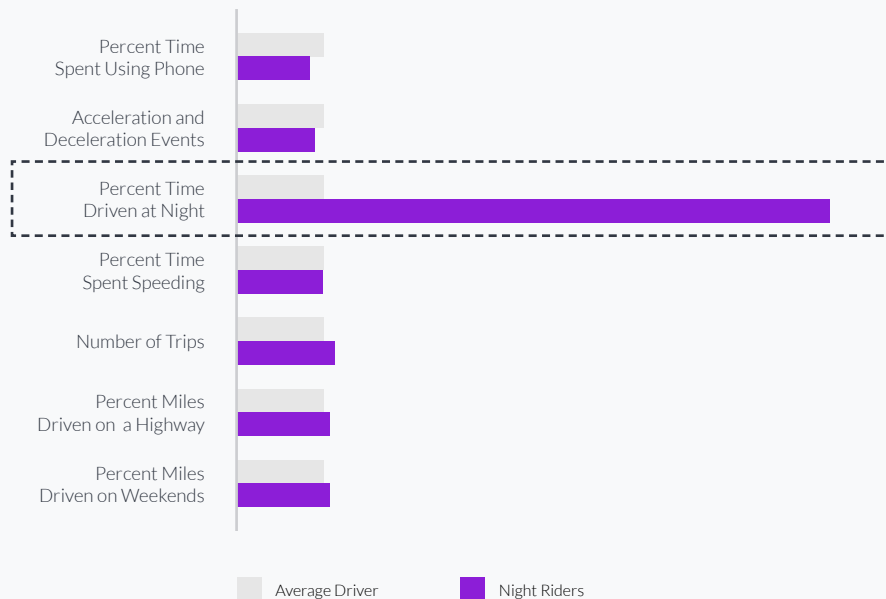
NIGHT RIDERS

Night Riders are a high risk group, but they were not a focus of this study since they only comprise 3%³ of the total driver population in this study.

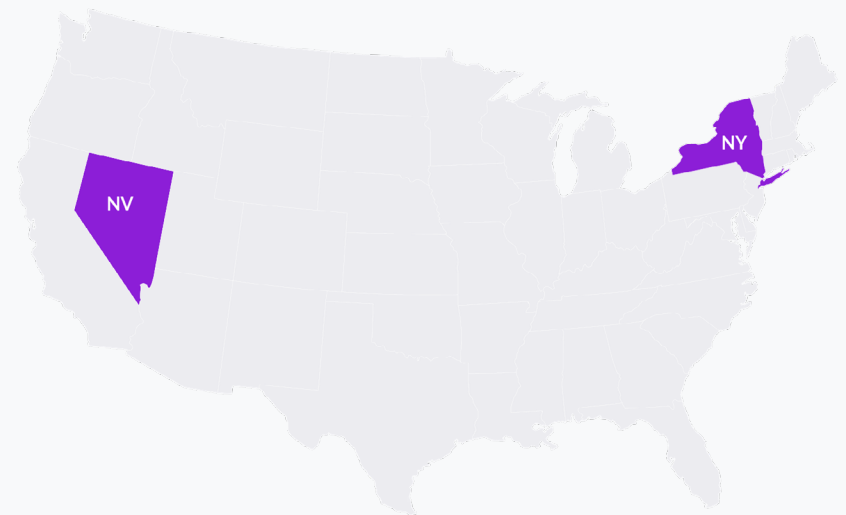
Nevada (6%) and New York (4%) have the highest concentration of Night Riders.



NIGHT RIDERS' AVERAGE BEHAVIOR



STATES WITH HIGHEST CONCENTRATION OF NIGHT RIDERS



³ Previous calculations excluded Night Riders and Long Haulers while the overall total is referring to.

DETAILS ON DRIVER PERSONAS:

LOW RISK

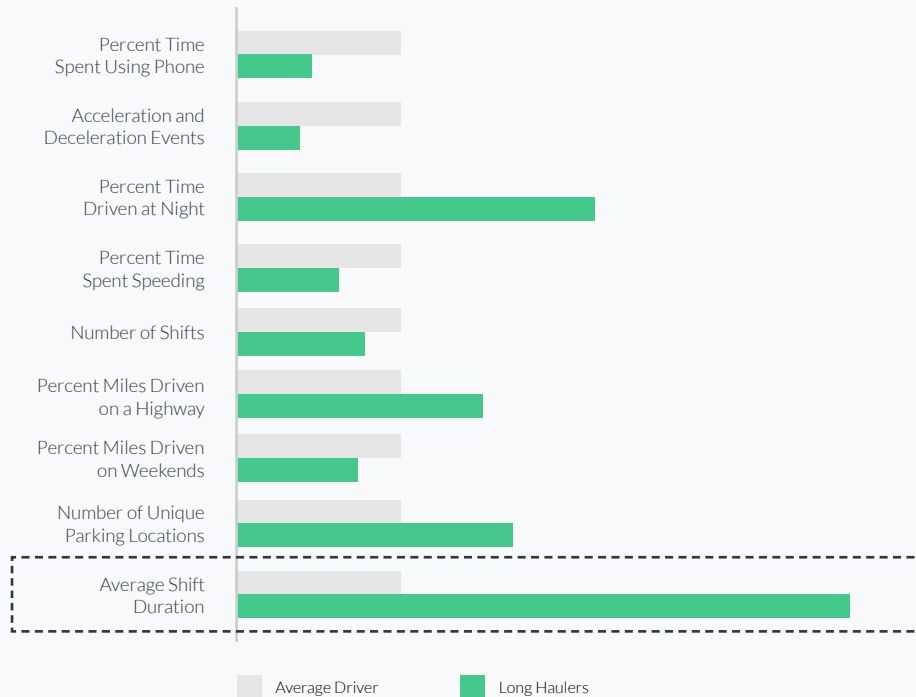
LONG HAULERS

Long Haulers are a low risk group, but they were not a focus of this study since they only comprise 1.4%⁴ of the total study population.

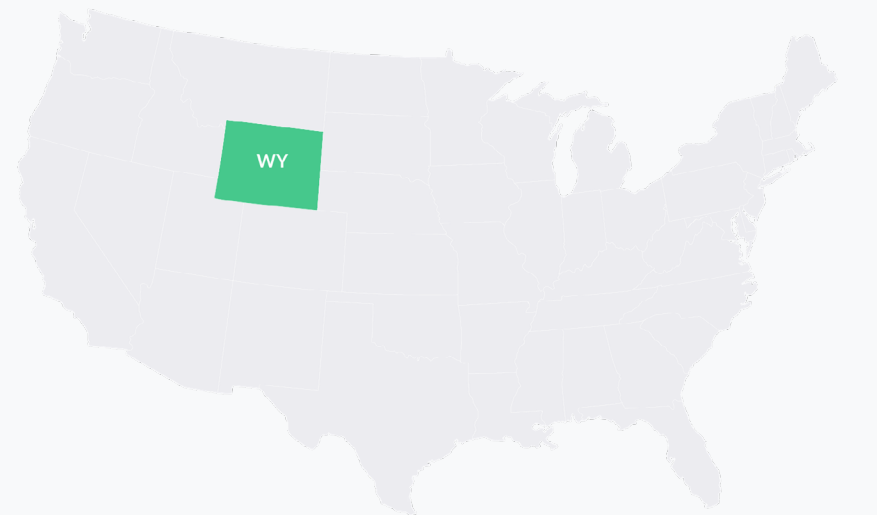
Long Haulers are distributed relatively evenly across the United States.



LONG HAULERS' AVERAGE BEHAVIOR



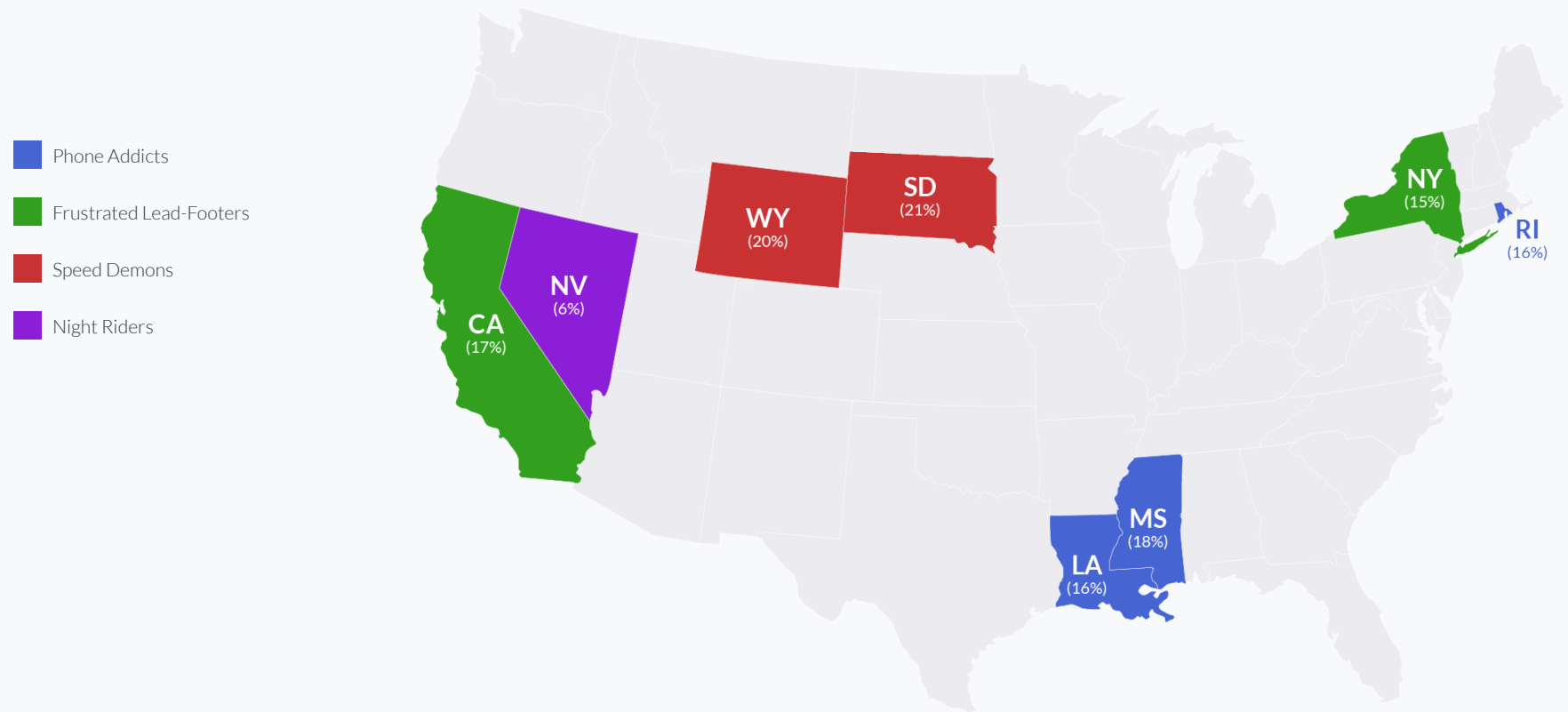
STATES WITH HIGHEST CONCENTRATION OF LONG HAULER



⁴ Previous calculations excluded Night Riders and Long Haulers while the overall total is referring to.

APPENDIX

PERSONAS BY STATE: HIGH RISK



APPENDIX

PERSONAS BY STATE: LOW RISK

