

Assessing the effect of COVID-19 travel and work restrictions on vehicle trips: A naturalistic driving case study

Miguel Perez¹ and Kenny Custer¹

¹Affiliation not available

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Abstract

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This project aims to identify the impact of the Commonwealth of Virginia government's response to COVID-19 on travel behavior using naturalistic driving data. While the macroscopic effects of these restrictions on travel are easily observable through substantial shifts in aggregate vehicle volumes on roadways, microscopic observation of unique trips and unique drivers may yield additional useful insights. In an ongoing naturalistic driving study in Southwest Virginia that will be the basis for this investigation, approximately 40 personal vehicles were instrumented with data acquisition systems prior to the first recommendations to stay at home to reduce the rate of spread of the virus. Data collection has continued throughout the pandemic, as restrictions have continued to evolve. Analyzing this driving data over the course of the COVID-19 progression timeline (and associated restrictions on travel and work) for trip volume, trip purpose, trip duration, trip distance, destination variability, and other similar characteristics will help inform how the restrictions have impacted microscopic travel behavior. The data will also be used to provide similar insight into how travel is affected as restrictions are eased.

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**Miguel Perez
Kenny Custer**

**Virginia Tech Transportation Institute
Blacksburg, Virginia**

Introduction:

State-implemented safety measures for the Commonwealth of Virginia in response to the COVID-19 virus progressed from a stay-at-home recommendation to mandatory – and more restrictive – orders, and continue to evolve. These measures have led to unprecedented restrictions and closures on schools, businesses, and universities, significantly altering travel and everyday life.

Prior to the enactment of these restrictions and before travel patterns were measurably impacted by the spread of the virus, VTTI instrumented approximately 40 vehicles in Southwest Virginia (i.e., Blacksburg and surrounding areas) with data acquisition systems as part of the ongoing 1000-Car naturalistic driving study. For this research project, 1000-Car data will be examined throughout the COVID-19 response timeline. Trip time, duration, GPS, and video data will allow us to infer trip purpose, and from that derive trip chains. Trip chains have previously been defined as the sequence of trips beginning and ending at one's home, with a primary activity and (potentially) secondary activities in-between (Primerano et al., 2008). Analyzing the evolution of trip chain sequences as restrictions fluctuate will provide insight into how travel behavior has been impacted by government response to the COVID-19 virus.

Research Questions to be Addressed:

As the threat of COVID-19 progressed, so did the safety measures taken by the Commonwealth of Virginia government to reduce the spread of infection. The key research questions that this investigation is intended to answer are:

- What impact did these measures have on travel behavior? Specifically, how have trip volume, purpose, duration, distance, and destination variability been affected?
- What is the elasticity in the “return to normal” for these measures as restrictions are lifted? Will trip behavior reach pre-pandemic levels when all restrictions are lifted?

In addition, because some of the instrumented vehicles are local to the Blacksburg area, there is potential to observe changes in travel behavior patterns specifically as a function of Virginia Tech's implementation of the government orders, particularly as it shifted to essential personnel operations.

Methods:

The following tasks outline the work that will be conducted under this project.

Data Extraction

GPS data (including latitude and longitude), trip metadata (e.g., date and time-of-day), and sections of forward video will be extracted from the ongoing 1000-Car naturalistic driving study. Specifically, data extraction will occur for all 1000-Car trips containing vehicles instrumented in Virginia at or before the restrictions based on the pandemic began to be enacted. This dataset will be used as the basis for all subsequent processing and analysis in the study.

Origin and Destination Classification

This effort will allow describing the nature of the trip without revealing a participant's private information (e.g., home location). The process to be used in classifying trip origin and destination was previously defined and successfully completed for the SHRP 2 NDS dataset. It is expected that this same process will translate seamlessly to the 1000-Car dataset.

To execute the process, the extracted GPS data, specifically the final GPS coordinates, will be input into the Google Places API (<https://developers.google.com/places/web-service/intro>) to obtain a classification for each trip's destination. The API returns the nearest “places” known to Google. Each “place” is associated with location descriptors that can be further stratified into broad categories such as residential,

store, or health. Trip origin will then be determined by assigning the destination of a given trip as the origin of the next recorded trip for that vehicle, provided that the characteristics of the origin for the next trip minimally support making that connection.

Due to the increased presence of curbside pickup for stores and restaurants, we must account for mid-trip destinations. For instance, a participant may leave their home, use curbside grocery pickup, and return home without ever turning off the ignition. These instances will be noted, and processed similarly to a key-off event for the purpose of this study.

Origin and Destination Validation

Validation of the classification output will be completed via video review. To improve the efficiency of video analysis, trip destinations with similar coordinates will be grouped together and assigned a destination ID. In doing so, a single trip can represent an entire group of trips, substantially reducing the number of trips requiring video validation. If a trip's assigned category is found to be inaccurate, that trip's destination, along with all other trips sharing the same destination ID, will be assigned an appropriate category.

Inferring Trip Purpose

Utilizing the anonymized origin and destination data, as well as existing metrics such as trip times, the trips will be chained together and an attempt made to uncover generalized habitual trends in trip purpose. For instance, a trip from a residential address to an ophthalmology office can be reclassified as a trip from a residential origin to a health-related destination (and used to infer that the trip purpose was a doctor's office visit). Each sequence will be given a unique identifier and will be treated as an individual "trip."

Data Analysis

The initial step will be to clearly define the dates at which different restrictions – both those enacted by the state and by Virginia Tech – were enacted. This will provide logical analysis points for the different measures of interest, which will include, at the vehicle level:

- Number of trips
- Trip duration
- Trip distance
- Trip time-of-day
- Trip day-of-week
- Time between trips
- Variability in distance between trip destinations
- Trip speed

The information presented in the final report will primarily consist of findings from this task and interpretation of any observed trends. Basic statistical analyses (e.g., ANOVA and t-tests) will be applied to different measures where relevant, albeit the limited sample size may limit the statistical power to detect significant differences. Therefore, and given the exploratory nature of the work, trends and observed differences of practical significance will likely be discussed in the report. Given the geographical nature of the work, the team will also strive to develop map representations of trip distributions that illustrate, at an aggregate level, the effect of pandemic restrictions on types and characteristics of vehicle travel.

References:

Primerano, F., Taylor, M. A., Pitaksringkarn, L., & Tisato, P. (2008). Defining and understanding trip chaining behaviour. *Transportation*, 35(1), 55-72.