

**Twisted Metal:
An Investigation into Observable Factors
that Lead to Critical Traffic Events**

Cheryl A. Kieliszewski

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Tom Dingus, Ph.D., Chair
Jon Hankey, Ph.D.
Brian Kleiner, Ph.D.
Vicki Neale, Ph.D.
Tonya Smith-Jackson, Ph.D.

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(ABSTRACT)

The purpose of this research was to explore traffic event severity relationships, evaluate the potentiality of a hazardous event, and develop a framework of observable event factors. Data was collected from three regions in Virginia, each assumed to exemplify a unique driving environment due to amount of traffic and infrastructure characteristics. In combination, a broad spectrum of site, traffic, and driver performance variables were accounted for. Observational techniques of surveillance, incident reporting, and inventorying were used to collect site, traffic, and driver data. This effort resulted in 368 observed traffic events that were evenly distributed among the three regions that represented metropolitan, mid-sized city, and town/rural driving environments. The 368 events were evaluated for severity and contributing variables where 1% of the events were non-injury crashes, 10% were serious, near-crashes, 24% were near-crashes, and the remaining 65% were serious errors with a hazard present. Exploratory analyses were performed to understand the general relationship between event severity levels. Binary logistic regression analyses ($\alpha = 0.05$) were performed to further scope predictor variables to identify traffic event characteristics with respect to severity level, maneuver type, and conflict type. The results were that 69 of 162 observed predictor variables were valuable in characterizing traffic events based on severity. It was found that variables could be grouped to create event severity signatures for crashes, serious near-crashes, and near-crashes. Based on these signatures, it was found that there is a trend between severity levels that included a propensity for problems with straight path maneuvers, lateral and longitudinal vehicle control, and information density within the driving environment as contributing to driver error and hence crashes and near-crashes. There were also differences between the severity levels. These differences were evident in the degree of control the driver appeared to have of the vehicle, type of control regulating the driving environment, and type of road users present in the driving environment. Modifications to roadway evaluative techniques would increase awareness of additional variables that impact drivers to make more informed decisions for roadway enhancements.

Acknowledgements

For those who do not know my story, I embarked on the quest for the Ph.D. in fall of 1996. The start of my journey was a little rocky having broken-out in an unidentifiable full-body rash one week before classes started. Classes started and fortunately the rash went away. That was the first of many interesting experiences while completing coursework and research in pursuit of this degree. I would like to thank the people, friends, family, and acquaintances, whose support and encouragement were an integral a part of this journey.

First, and most importantly, I thank my parents Dalbert and Elaine Kieliszewski for believing that I would persevere and complete this work. I also thank Brian, LeAnne, Lynn, Mike, Patrick, and Susan for doing what siblings do best: tease, chide, love, and support. Thank you for continuing to support me even when it looked as though I might not finish.

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To continue my story, I left Virginia Tech and the Virginia Tech Transportation Institute in November of 2000, with dissertation data in hand, to embark on a new career with IBM. I was a bit optimistic and little did I know that my new career would result in an almost five year hiatus in completing this work. With that said, I thank Drs. Paul Maglio and Jeanette Blomberg for allowing me the time this past year to finish this degree. I also thank Dr. Christopher Campbell for being my sounding board and statistical advisor.

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Executive Summary

A common theme arises in trying to understand crashes and near-crashes. That theme, as in other critical incident investigations, is that crashes are considered to be rare events and very difficult to study. And, even with the best research intentions, collisions are difficult to study and define. To counter the rarity and difficulty of examining crash events, transportation researchers have used surrogate events to study crashes and identify crash factors. This research too proposed to gain a better understanding of crashes and, additionally, the relationship between crashes and less severe traffic events to better understand the potential for a hazardous event.

The purpose of this research was to explore event severity relationships, evaluate the potentiality of a hazardous event, and develop a framework of observable event factors. In support of this purpose, three research questions were examined to scope the investigation. The questions asked focused on

1. identification of observable characteristics that most significantly contribute to near-crashes and crashes;
2. examination of a hierarchical distribution of traffic events to afford greater predictability of crashes; and
3. identification of driver performance proxy variables for possible inclusion evaluative methodologies such as the Traffic Conflict Technique.

Data was collected from three regions of Virginia, each assumed to exemplify a unique driving environment due to amount of traffic and infrastructure characteristics. It was also assumed that the regional differences would result in differences between the number of observed events, severity of events, and type of event conflicts within each region. The approach was selected to account for, in combination, a broad spectrum of site, traffic, and driver performance variables. Observational techniques of surveillance, incident reporting, and inventorying were used to collect site, traffic, and motorist data. This effort resulted in 368 observed traffic events that were evenly distributed amongst the three regions that represented metropolitan, mid-sized city, and town/rural driving environments.

The 368 events were evaluated for severity and contributing variables. Of these events, 1% were non-injury crashes, 10% were serious, near-crashes, 24% were near-crashes, and the remaining 65% were serious errors with a hazard present. Event data representing the four severity levels were analyzed using exploratory statistics to describe the severity distribution of events and the general relationship between event severity levels and conflict types. Binary logistic regression analyses ($\alpha = 0.05$) were performed to further scope predictor variables to identify traffic event characteristics of severity level, maneuver type, and conflict type. The results were that 69 of 162 observed predictor variables were valuable in characterizing traffic events based on severity.

The four severity levels were condensed to three (i.e., crashes, serious near-crashes, and near-crashes) with near-crashes and serious errors with hazard presented being collapsed into one group labeled *near-crashes*. These two levels were collapsed because of near exactness between the event characteristics associated with each level. The distribution between non-injury, serious near-crash, and near-crash events corroborate the hypothesis that there is a hierarchical distribution of traffic events based on severity. However, the distribution between non-injury crashes and near-crashes was

not as great in this study as hypothesized by Heinrich or reported in previous transportation research. The ratio found in this study was 1:73.6 when comparing non-injury crash events to near-crash events—which is approximately a 20% higher yield in the number of observed events than what was expected. In validation of this finding, results from the recent 100-car Naturalistic Driving Study also reported a smaller ratio between crashes and near-crash events. The difference in findings is attributed primarily to increased fidelity in data collection and reduction techniques.

Based on the findings of the study, three severity signatures and driver error conditions were created to identify patterns between crashes, serious near-crashes, and near-crashes. There were patterns that determined information density and complexity of the driving environment was having a direct effect on driver performance. This could be demonstrated through

- lateral and longitudinal vehicle control,
- type and generally high occurrence of violations, and
- type of roadway system as determined by general function, controls, and road user characteristics.

Resulting from closer examination of the severity signatures, driver error conditions, and associated variables, driver performance related measures were identified and engineering countermeasures to reduce the likelihood of traffic events were proposed. Suggested updates to traffic engineering evaluation methodologies would be to add driver performance-related factors beyond vehicle speed into roadway sampling practices. Measures to be added should include type and degree of vehicle control with respect to frequency of:

- excessive acceleration and deceleration,
- proceeding without adequate clearance,
- violations of traffic laws and rules, and
- extreme maneuvers.

Countermeasures focused on physical characteristics of the driving environment that could be re-engineered to better support driver information processing activities.

This research provides several levels of benefit to drivers, road designers, and evaluators by shedding light not only on the correlation of event signatures and traffic events, but also in defining several driver performance related measures that should be included in roadway safety evaluations. By including these additional factors in reviewing designs, evaluators can make more intelligent, informed decisions regarding roadway system improvements, thereby benefiting drivers and designers.

Conclusions were that in addition to more traditional roadway safety evaluation measures of vehicle speed and conflict type to represent the driver, factors such as vehicle control, violations, and failures should be included in data collection and analysis efforts. The addition of these factors would result in greater comprehension of the degree of operational and safety problems due to an association with event severity. This, in turn, would result in more informed decision-making with regards to roadway system improvements.

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1 Overview

This research is based upon a hypothesis that there is a relationship between the severity and frequency of hazardous events; and that the likelihood of a catastrophic event can be predicted based upon this relationship (Heinrich, Peterson, and Roos, 1980). The Heinrich et al. research is within the Industrial Accident domain. However, it has been argued that the same hypothesis can be applied to automotive traffic events (Dingus, Hetrick, and Mollenhauer, 1999; Horst 1990; Hydén, 1987).

Research within the Industrial Accident domain has established that there is a relationship between errors that do not result in injury to a system and errors that do result in injury to a system (where *injury to the system* can take the form of equipment damage or failure and/or bodily injury or fatality of an operator). Fault for these errors can reside with the operator, administration, or mechanical device (Heinrich et al., 1980). Metrics used to evaluate the relationship include accident type, frequency of occurrence, severity, operations, and location. Thus, once the relationship between errors is known for a given system, the occurrence of hazardous events can be controlled either through preventative or corrective measures, thereby lessening or eliminating the likelihood of an unsafe circumstance and reducing the frequency of a hazardous event.

As with industrial applications, hazardous event prediction has been established as a priority for roadway transportation safety (Turner-Fairbank Highway Research Center, 2000). However, until recently, roadway transportation research has placed an emphasis on either infrastructure design or driver behavior. Infrastructure-oriented research has focused on the use of traffic engineering techniques to evaluate traffic conflicts at a location and make recommendations towards the redesign of the physical elements such as roadways or traffic control devices. Driver-oriented research has concentrated on the evaluation of the driver based upon measures such as ergonomics, task performance, and information-processing. Results from driver-oriented research are then used to make recommendations towards the redesign of an aspect of the vehicle to better accommodate driver needs.

The goal of both schools has been to increase safety by lessening the likelihood of a traffic event. Both domains have contributed a wealth of information over the years. However, until recently, research in the two areas has basically paralleled each other in investigating the same question: why is a driver involved in a traffic event and what factors precluded the event? Within both schools, traffic conflicts have been found to be a good surrogate to estimate crash types and crash rates for a given physical infrastructure type (Parker and Zeeger, 1989; Older and Spicer, 1976). Where, a *traffic conflict* is a driving situation for which there is imminent danger of a collision or interaction between two or more vehicles, a vehicle and a person, or a vehicle and an object. As per Parker and Zeeger, a conflict situation is composed of at least two elements of (1) at least one vehicle is in danger of the collision, and (2) at least one vehicle driver or person has to perform an evasive action (e.g., braking or swerving) to avoid the collision.

In addition to the term *traffic conflict*, there are a number of terms used in the literature to discuss degrees of traffic events. In general, the terms most commonly used in this research are:

- **Traffic event.** Umbrella term for a driving situation that can be ranked along a continuum from normal driving to catastrophic collision (Horst, 1991).

- ▣ **Traffic conflict (or conflict).** As defined above with synonymous terms often being critical incident, near-crash, near-miss, or interaction.
- ▣ **Crash, Collision, or Accident.** A driving situation involving one or more vehicle(s) where the road users are unable to react in a timely manner to avoid an impact (Svensson, 1998). The three terms are used synonymously in this document regardless of the degree of subsequent damage or fault.

A number of classification schemes have been constructed over time in a quest to categorize and understand relationships between traffic events. One of the earliest studies to create such a classification was performed by Older and Spicer (1976). They divided traffic events into five severity classifications that were then grouped as either “slight” or “serious” conflicts for four or more wheeled vehicles at roadway junctions. Slight conflicts included those that allow ample time for the driver to perform an evasive action, such as controlled braking or a lane change maneuver. Serious conflicts were those where a more urgent maneuver or emergency action has to be performed. Given these categorizations, an approximate ratio of 2000:1 had been found for serious conflicts to injury accidents.

As research continued in the area of traffic conflicts, Hydén (1987) introduced a pyramidal representation of a hypothesized continuum from normal driving to a fatal crash, illustrating the relationship between traffic events (Figure 1). The pyramidal ranking is based upon the severity of the traffic event and reflects the sum of the individual behaviors in the road user population (Svensson, 1998). Although the ranking of traffic events was an advancement in categorizing events, the central criterion for an event was severity and the only metric Hydén used to determine severity was a time-to-accident measure. The research did not consider additional factors such as infrastructure characteristics or observable behaviors prior to or during an interaction.

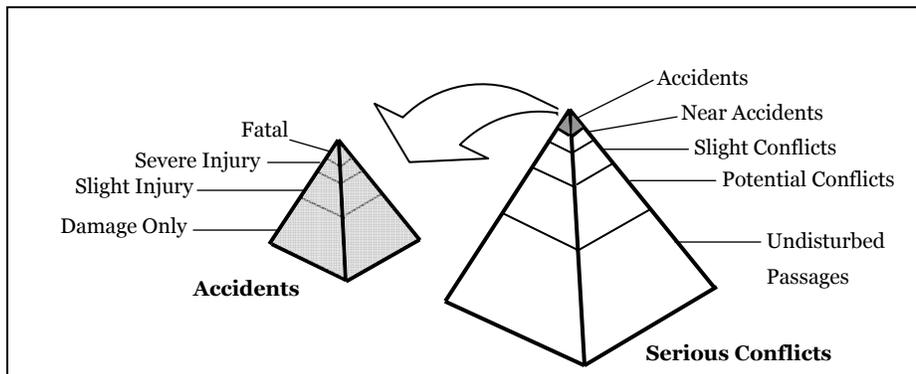


Figure 1. Hydén's (1987) Continuum of traffic events.

To further understand the relationship between traffic events and refine the event continuum, it has been stated that, “...differences in numbers of near-crashes will reflect ordinal differences in accident rates at some level” (Dingus, et al., 1996). With that said, knowing ordinal differences in traffic event rates at some level, based on severity as explored in earlier research, is one aspect of classifying crash and near-crash events. However, as demonstrated in earlier investigations, classifying events by severity isn't enough to gain a true understanding of what circumstances are contributing to events of a particular severity and/or type. Therefore, additional investigations need to be undertaken to

identify factors associated with events and also develop a relationship matrix that links event severity, event or conflict type, and known contributing event factors. This relationship matrix would, in turn, afford better understanding of what circumstances result in events of a given severity level and the relationship between levels.

1.1 Research Goal

In addition to the work performed by Hydén (1987) and Svensson (1998), Dingus (1995) hypothesized that in determining and validating relationships of hazardous traffic events, actions can be taken to either improve the in-vehicle or roadway environment to lessen the likelihood of a crash. Contemporary measures being used by traffic engineers to evaluate the safety of a roadway system tend to be accident or conflict ratios, type of collision, and traffic volume. Unfortunately, these measures have not been linked to an accurate method of crash prediction. One reason these measures may not be fully effective in crash prediction may be that, unlike the domain of Industrial Accidents, representation of the operator, administrator, or mechanical device error are not apparent in these metrics.

It is hypothesized in this research that a more comprehensive traffic event evaluation methodology that combines contemporary traffic engineering measures with additional error elements will provide a better understanding of traffic event occurrence and possible improvements in evaluation techniques. This could then lend itself to increased predictability of where a traffic event may be more likely to occur and what kind of event may occur. The following chapters discuss methods to identify and evaluate traffic conflicts, the methodology used in this research effort, and findings and conclusions with regards to the occurrence of traffic events based on the observance of the traffic environment and navigational scene.

1.2 Purpose

The purpose of this research is to develop a framework of observable event factors through subjective measures that can be used to further investigate event severity relationships and the potential of a hazardous event. Three research questions are examined in this study to explore event severity relationships and to evaluate the potentiality of a hazardous event. Each question and supporting objectives focuses on a particular facet of this research.

- What are the observable characteristics of the traffic environment and navigational scene that most significantly contribute to near-crashes and crashes?
 - Develop a comprehensive framework of traffic events that can be used to evaluate the crash potential of a driving situation.
 - Develop a comprehensive framework of variables that can be used to evaluate the traffic environment and navigational scene.
 - Determine which traffic conflicts most commonly result in near-crash or crash situations and which observable variables contribute significantly to these events.

- Do traffic events have the same hierarchical distribution as industrial accidents, therefore allowing greater predictability of crashes based on the characteristics of the navigation circumstances?
 - Compare found severity ratios with those reported in past conflict studies.

- Determine the frequency of event severity based on event occurrence.
- Determine the probability of occurrence of traffic events for each severity level being investigated.

- Should the Traffic Conflict Technique be revised to incorporate proxy variables that represent driver performance to more fully represent the traffic scene and evolve a surrogate measure for potential crash rate?
 - Identify which observable driver-performance variables significantly affect traffic conflicts.
 - Determine which driver-performance variables should be considered as conflict proxy variables for inclusion in the TCT evaluation methodology.

2 Background

The National Highway Traffic Safety Administration (NHTSA) (2005) reports an estimated 6,181,000 police-reported motor vehicle traffic crashes occurred in 2004. Police-reported motor vehicle traffic crashes are classified by the most severe injury in the crash (i.e., fatal injury, non-fatal injury and/or property damage). Of the almost 6.2 million crashes in 2004, 1% (38,253) resulted in a fatality and 30% (1,862,000) resulted in an injury. The remaining 69% (4,281,000) resulted in only property damage. Fortunately, there has been a general downward trend in crashes since 1988. However deaths, injuries and economic losses from traffic crashes continue to be too high and the economic cost in 2004 was more than \$230 billion.

In addition, findings from a recent 100-car naturalistic driving study were that approximately 82% of actual crashes are never even reported (Dingus, Klauer, Neale, Petersen, Lee, Sudweeks, Perez, Hankey, Ramsey, Gupta, Bucher, Doerzaph, Jermeland, & Knipling, 2005). One can then assume there is an additional unknown economic cost due to these unreported crashes and, possibly, unknown reasons for why there was a crash, in part, due to limited reporting.

There has been an on-going effort that recognizes a need for a more robust, proactive roadway safety analysis methodology to comprehensively understand roadway safety to lessen the likelihood and severity of crashes and near-crashes (McGill, Tonkonojenkov, & Ward, 2005). In general, crash investigations have been based on post hoc database analysis, case study analysis, and interviews to examine factors such as driver demographics, crash locations, and a primary reason for the incident. More exacting studies are also performed exploring crash specifics such as conflict typology, time-to-collision, and crash taxonomies. These investigations all tend to have a common agenda: creating a safer driving environment.

There is a common theme that arises in trying to understand crashes and near-crashes. That theme, as in other critical incident investigations, is that crashes (and to a lesser degree, severe near-crashes) are considered to be rare events and very difficult to study. And, even with the best research intentions, collisions are difficult to identify, define, and study first-hand. To counter the rarity and difficulty of examining crash events, transportation researchers have used surrogate events to study crashes and crash factors. This research too has a purpose to better understand crashes and, additionally, the relationship between crashes and less severe traffic events to better understand the potential for a hazardous event. The following review looks at findings several methodological sources investigating crash event factors, the adoption of the Traffic Conflict Technique as a method to

observe for traffic events, the usage of severity categorization to classify categorize events, and the conceptual framework guiding this research effort.

2.1 The Roadway System

For the purpose of this study, a specified roadway site was considered to be a system that could be observed and evaluated (referred to as *roadway system* or *driving environment* throughout this paper). There are four common boundaries that characterize the roadway system: infrastructure, environment, vehicle, and driver. The infrastructure is defined as the planned and designed elements of the roadway system. These planned and designed elements include the physical characteristics of the road (e.g., surface, alignment, width), barriers, signage, and traffic control devices (TCDs). The environment includes the additional elements, conditions, or constraints that impact the roadway system and possibly drivers. The environment would include amount and type of motorized and non-motorized traffic, vegetation, and weather conditions. The remaining two boundary elements are the vehicle and the driver. Depending on the investigation, the vehicle and driver may be considered to be two units or a single unit. For the purpose of this research, the vehicle and driver are considered to be a single unit where the driver is assumed to be the controller of the vehicle.

A representation of this system would look like the illustration in Figure 2. The model is a modification of one proposed by Brown, Lee, and McGehee (2000). The primary difference, however, is that their model was designed specifically to represent a rear-end collision situation whereas Figure 2 has been generalized to represent any traffic event situation. In Brown, et al.'s representation, the "...inputs into the model are a desired index of cautiousness and lead vehicle behavior" (p. 14). The output of the model is headway (i.e., the speeds and relative positions of the two vehicles). As an input, the driver is outside of the driving environment, considered to be an information processor. Contained within the driving environment are the driver's vehicle and another vehicle.

Also, in Brown, et al.'s model (1) the driver and vehicle are separate entities, (2) they exist in different planes relative to the driving environment, and (3) the actions of other vehicles are assumed to be negligible. Although this may be a proper representation for an attention-based rear-end collision avoidance model, it was considered to be too limiting for the purpose of this research effort. The representation proposed for this research effort was modified where:

1. the driver still is considered to be an information processor,
2. the driver and vehicle are a single unit (V1),
3. V1 is a component within the driving environment,
4. components of site characteristics and traffic characteristics were included because they were thought to be applicable,
5. the input into the system is the driver's desire to maintain an absence from danger (that is, to maintain a condition of "being safe from harm, injury, or loss" (Navin, 1999, p. 49)), and
6. the output is the actual path taken by V1 and the maintenance of an absence from danger.

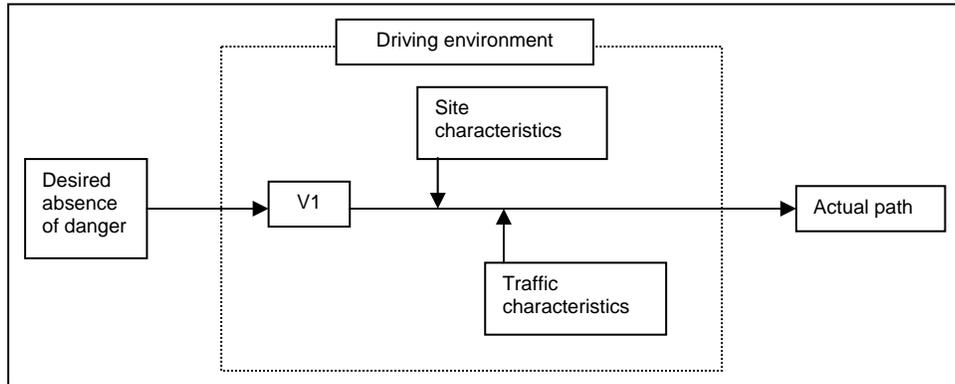


Figure 2. Representation of the roadway system.

Roadway system components can be tangible such as the roadway, TCDs, or vehicle type; or intangible, abstract resources such as perception or information-processing. In addition, the components within the system can be defined as being either static or dynamic in nature. Static components are those considered to remain constant over time. That is, these components, whether or not perceived, are encountered by all drivers entering this system. Examples of static roadway system components include the site geometry, road function, signage, and delineation. Dynamic components are those that are variable in nature and tend to differ over time. Examples of dynamic roadway system components include amount of traffic, driver behavior, and weather conditions. Whether static or dynamic, properties of the components can then be used as variables that may or may not contribute to an event.

For this study, the roadway system was considered to be stable until there was evidence of a problem, in this case, either a crash or near-crash. When a traffic event was observed, reason(s) for the occurrence was deduced through the examination of observable system characteristics that may have contributed to the event. For classification purposes, the event itself was categorized by both a severity rating and a maneuver and conflict type, in addition, a list of system variables was used to catalog the additional observable characteristics (Appendix A).

2.2 Representing Driver Behavior

Tangible roadway system characteristics tend to be readily identifiable; however the same can not necessarily be said about the driver. Information-processing is a common methodology used to evaluate and characterize actions performed by people in different domains such as aviation, medical diagnosis, and industrial inspection. This section explores human error from an information-processing point-of-view in order to examine its application to ascertain driver actions.

Information-processing involves the intrinsic limitation of human abilities to attend to, perceive, remember, decide upon, and act upon a goal (Sheridan, 1981, as cited in Wickens, 1992). Error is an action that renders an undesirable consequence in the achievement of a goal and is influenced by factors such as the nature of the task being performed, environmental circumstances, influence of a mechanism upon performance, and the nature of the individual (Reason, 1990). Wherefore, the error type relates to the origin of the error.

Cognitive stages within which the error can originate are planning, storage, or execution. Planning refers to the development of a goal and its achievement. Storage, for goal execution, is the time duration between formulating a goal and acting upon achieving it. Execution is the actual implementation of the plan. Within the information-processing domain, error definition and classification focuses on the human cognitive aspect that failed in successfully accomplishing a goal (i.e., perception, memory, decision-making; Wiegmann and Shappell, 1997).

A number of models to aid in understanding and defining human error have been developed in the past few decades. Two general models of human error, Rasmussen's (1986, 1994) Generic Error-Modeling System (GEMS) and decomposition of human activity, and Reason's (1990) Classification of Unsafe Acts are considered here as a base for representation and evaluation of driver behaviors. Rasmussen (1986) developed an iterative process for the analysis of error causation and the development of models and classification schemes within the nuclear power domain. The classification scheme is primarily targeted for individuals in supervisory control roles. The skill-, rule-, knowledge-based model has three levels of human performance that reflect the limitation of, and the interference among, processes in human problem-solving. The model is considered to be a hierarchically organized set of cognitive control modes in which a person moves from one mode to the next to achieve a goal (Figure 3).

Reason (1990) provides succinct descriptions for each of Rasmussen's three levels of human performance as:

- Skill-based performance is applicable to highly practiced tasks and is determined by stored patterns of information within a time-space domain. Errors at this level are linked to the variability of force, space, or time coordination.
- Rule-based performance is applicable to solving familiar problems. The solutions are governed by stored rules of the type: IF (state) THEN (diagnosis); or IF (state) THEN (remedial action). Errors at this level are linked with the misclassification of situations that would lead to the application of the wrong rule or the incorrect recall of procedures.
- Knowledge-based performance is applicable to unfamiliar problems or situations for which actions must be planned using conscious analytic processes and stored knowledge, as opposed to the use of stored rules. Errors at this level are linked to human resource limitations and incomplete or incorrect knowledge.

Reason (1990) expounds on concepts presented in GEMS in the Classification of Unsafe Acts schema that details a categorization of unsafe acts. He defines an unsafe act as an error or violation that is committed in the presence of a potential hazard and could cause injury or damage, and can be caused by either an active or latent failure.

- Active failures are actions or inactions of operators that are thought to directly cause an accident, where the consequences of the actions are felt immediately.
- Latent failures stem from errors committed within the larger system and managerial hierarchy of which the operator is an element.

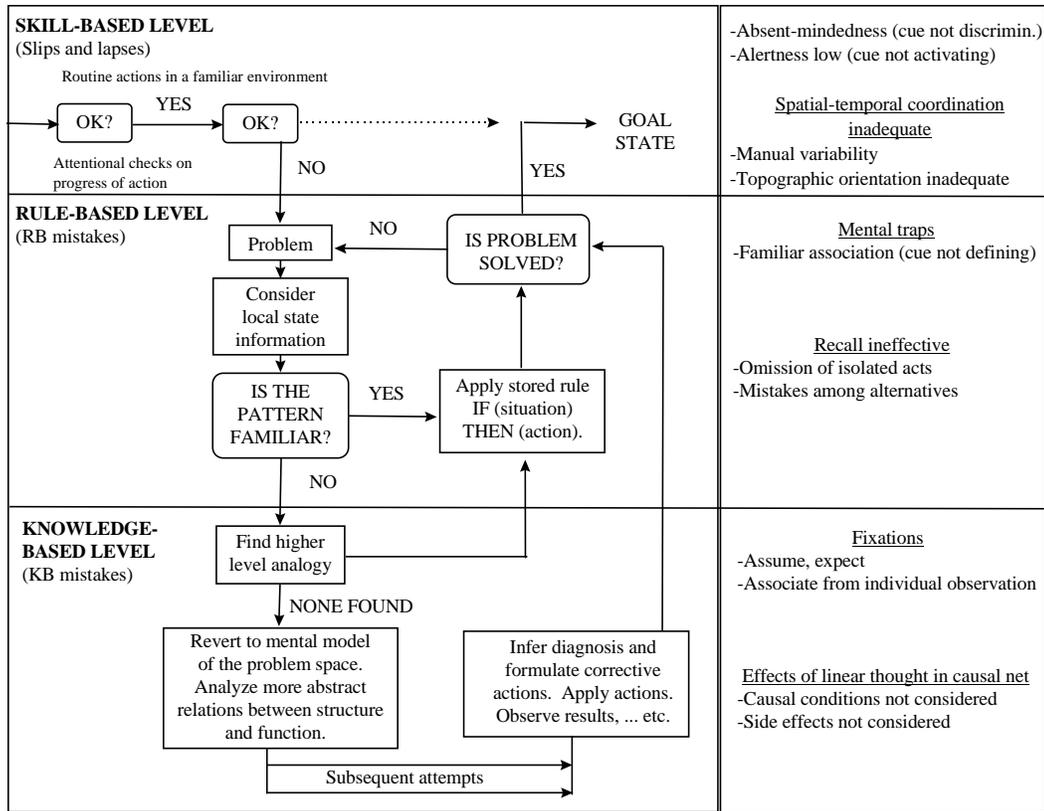


Figure 3. Generic Error Modeling System and typical errors associated with each performance behavior (Rasmussen, 1986).

Unsafe acts are classified according to whether the action was intentional or unintentional (Figure 4). Intentions are the plans, and the expression of these plans, that an individual produces to attain a goal. Unintentional actions are behaviors that are executed, but not as planned, and are divided into two groups: those that succeed regardless of the action, and those that do not succeed. Intentional but mistaken actions arise from poor planning (as opposed to unintentional actions that do not succeed). Unintentional actions are often associated with involuntary actions that occur due to automatism and are not considered in the evaluation of unsafe acts because there is no underlying plan.

Unsafe acts, whether unintended or intended, are further categorized into three basic error types of slips, lapses, and mistakes, along with a category for violations. From there, the basic error types are differentiated by formal characteristics.

- Slips and lapses are associated with unintended actions. In general, these errors result from a failure during the execution and/or storage stage, respectively, of an action sequence, and ultimately result in execution failures (Reason, 1990). Specifically, slips are externalized as actions-not-planned and are due to attentional failures such as absent-mindedness or daydreaming (Reason, 1990; Wiegmann and Shappell, 1997). Lapses are due to memory failure and may not be externalized, in which case they are only apparent to the individual who experiences them.
- Mistakes and violations are associated with intended actions. Mistakes are deficiencies or failures in judgment of an individual, and occur when previously learned rules and procedures are

misapplied or are inappropriate for achieving a goal. They most commonly occur during the planning stage. Violations are not errors, but rather they are attributed to habitual behavior of an individual that is tolerated by the system (routine violations), or isolated and unacceptable departures from authority (exceptional violations).

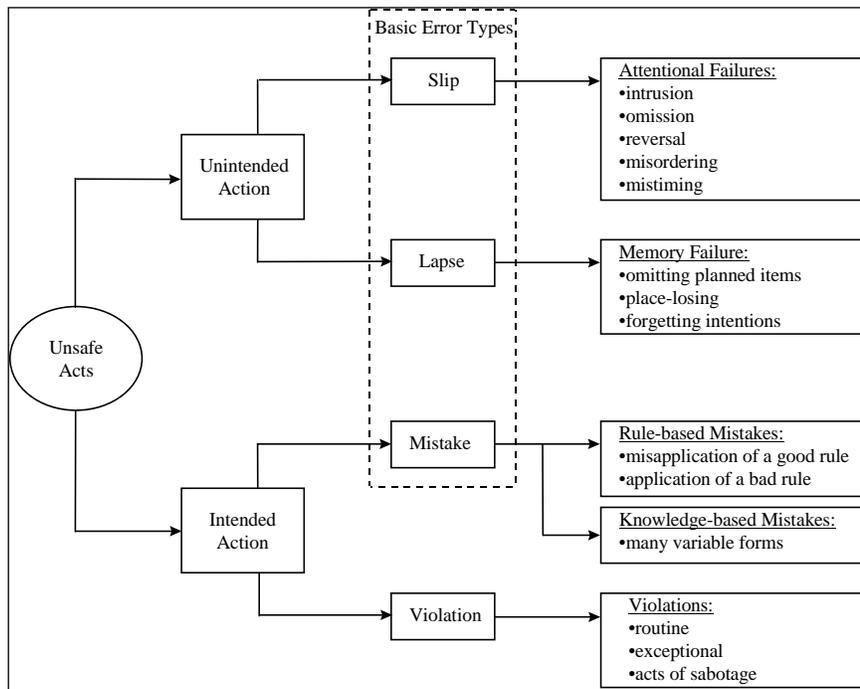


Figure 4. Classification of Unsafe Acts (Reason, 1990).

From the skill-, rule-, knowledge-based model, Rasmussen, Pejtersen, and Goodstein (1994) developed an even more detailed decomposition of human activity to define actions that lead to an error. This model takes into account advances in human error modeling since GEMS was developed, and incorporates other work by researchers such as Rasmussen (1986), Reason (1990), and Norman (1988). A finer distinction between cognitive events that influence human acts has been created from the analyses of human involvement in failures of complex systems (Figure 5).

The updated model factors to evaluate which psychological mechanism caused a decision-making function failure (i.e., situation analysis, goal evaluation, planning, or actual execution) once a component failure of a complex system has occurred. In using this model, the input conditions of the individual can be defined and external events that impacted psychological mechanisms can be identified. This method enables the researcher to evaluate erroneous overt behavior using a multifaceted description of human errors.

Each of the above models contains elements to aid in systematically identify, evaluate, and classify general human error behaviors. In addition, the models and taxonomies also build upon one another, thereby containing common components and definitions of the components. From this point, it is only natural to proceed to apply these general models of human behavior for domain-specific investigation. It is assumed here that the information-processing components of these human error

models can be applied within the surface transportation domain to examine and identify conditions that impact drivers for the evaluation of traffic events and event severity.

In addition to information-processing models, factors found in previous research are reviewed to gain insight into crash influences. The following sections provide a review of findings with respect to roadway investigative methodologies along with crash and near-crash variables found to be important for the understanding of crash and near-crash traffic events.

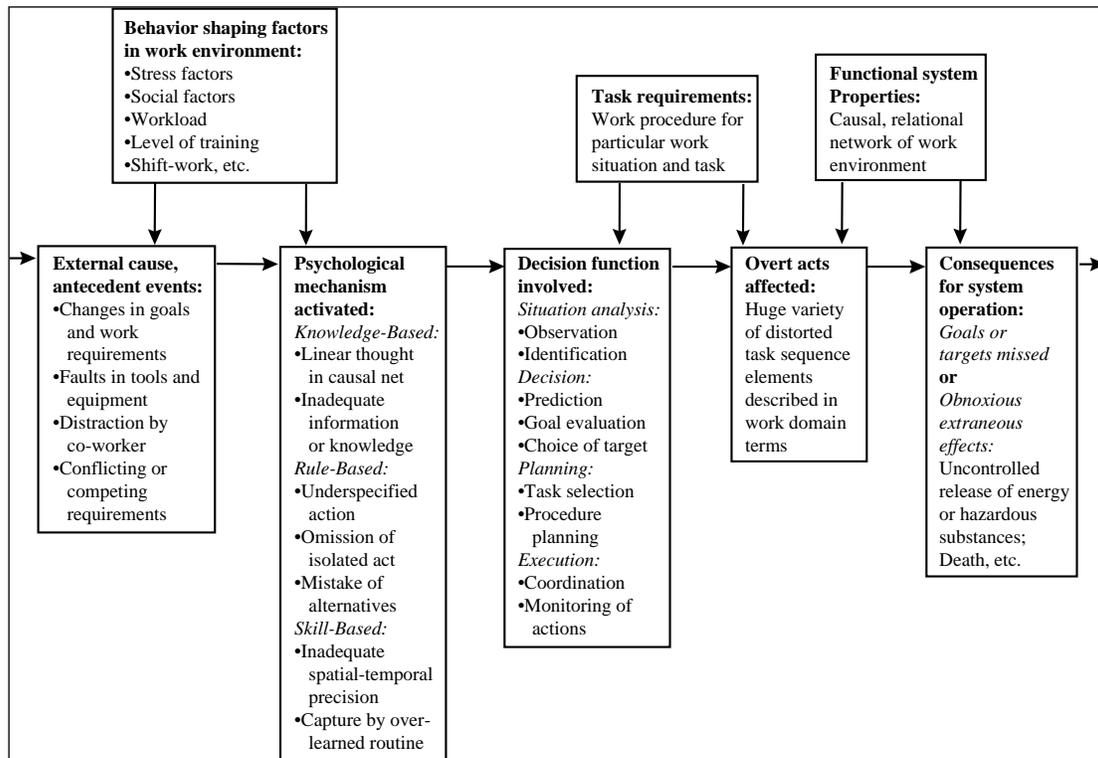


Figure 5. Decomposition of human activity to detail erroneous acts (Rasmussen, et al., 1994).

2.3 Investigating Roadway Safety

As evidenced by the above taxonomic investigations into crashes, human-related factors are found to be the most prevalent cause of a collision. Grime (1987) states that it is not surprising that drivers have been likened as the primary cause of most crashes. He reasons that all traffic accidents involve at least one road user and that it is usually possible to identify an action that could have been performed to avoid the collision. However, he also states that even though a driver action may be identified as the primary cause of a crash, remedial measures may need to address elements of the infrastructure design and engineering improvements. This section provides a perspective on observational methodologies used to investigate and assess roadway safety.

Roadway safety initiatives such as the Forgiving Highway design and the Caring Highway design have been undertaken to better understand and forecast the impact of various road safety strategies and initiatives (Navin, 1999; McGill, et al., 2005). These design evaluation strategies are more comprehensive in examining the relationship between roadway elements with the goal of assessing

risk to the system, which, in turn, can be translated into a degree of safety. However, Navin (1999) recognized that there is a lack of activity-based travel information associated with the driver to evaluate the relationship between safety and mobility.

In retrospect, Perkins and Harris (1967) developed an evaluative tool called the Driver-Conflict Study Technique to measure the frequency and type of accident circumstances at intersections. They felt that accident statistics did not provide enough information to adequately reveal details of complex interactions. The purpose of the technique was to objectively measure the accident potential of a given intersection. They speculated that conflict data could be used to evaluate an intersection, revealing details of complex interactions between driver, vehicles, and roadways. The technique was used to define five basic accident types found at signalized cross intersections.

The Driver-Conflict Study Technique evolved into the Traffic Conflict Technique (TCT). Parker and Zeeger (1989) formalized the technique and listed a number of benefits of conducting a TCT study at intersections that were previously known to have a high rate of crashes. Some of the key advantages of the TCT were thought to be:

- Conflict definitions can be based on crash types.
- Unlike accidents, traffic conflicts occur frequently and can be documented through observation.
- The technique can be used as a post-improvement evaluation tool to assess the effectiveness of a treatment.

The TCT procedure that Parker and Zeeger (1989) specified was to have trained observers watch a given roadway site and document the geometry, control, traffic volume, basic driving maneuvers, and conflicts. They identified and defined six primary conflict types and respective conflict situations for signalized and un-signalized cross intersections as:

1. **Same direction conflicts.** These are four conflict types where two vehicles are traveling in the same direction, yet one of the drivers performs a maneuver that results in an evasive action by the second driver.
2. **Opposing left-turn conflicts.** This is when an oncoming driver makes a left-hand turn in front of a vehicle that is proceeding straight through the intersection.
3. **Cross traffic conflicts.** These are six conflict types where a vehicle on a cross street enters into the path of a second vehicle on the main street.
4. **Right-turn-on-red conflicts.** These are two conflict types that are only defined for signalized intersections. The exhibited maneuver is a vehicle making a right-turn-on-red enters the path of a vehicle that has the right-of-way.
5. **Pedestrian conflicts.** These are two conflict types in which a pedestrian enters the roadway in front of a vehicle, where the vehicle has the right-of-way. In these cases, the pedestrian either is not crossing in a crosswalk or the pedestrian crosses against a red traffic signal or a “do not walk” phase at a signalized intersection.
6. **Secondary conflicts.** These are two conflict types in which a driver is responding to the evasive maneuver of another vehicle, where the other vehicle is in a conflict situation.

Although thought to be effective for the identification of conflicts, criticisms of the TCT include its limitations in identifying improvements that can or should be used to reduce crash potential; and that the analysis relies solely upon the accuracy of the observer’s field notes in performing an immediate

and subjective evaluation of traffic conflicts and their severity (Campbell and King, 1970). Although, the usefulness of observation to identify improvements to reduce crash potential had remained questionable, the addition of video capture has aided in improving the reliability of event evaluation and classification. Regardless of these criticisms, other TCT-like procedures that employ observation and classification of traffic events have been developed for time-related measures investigations and instrumented vehicle studies.

Time-related measures, such as time-to-collision or time-to-intersection, have also been proposed as a technique to objectively quantify traffic events to make a clear distinction between critical and normal behavior (Host, 1991; Hydén, 1987). Primary conflict metrics used in these procedures include type of conflict, distance in space or time between the road users, and/or amount of deceleration required to avoid a collision. Secondary conflict metrics include type of road user (e.g., car, truck, pedestrian, bicycle), speed of the road user, and type of pre-event or evasive maneuver performed.

Time-related traffic event studies have led, very recently, to the development of the System for Assessment of the Vehicle Motion Environment (SAVME) tool (Ervin, MacAdam, Walker, Bogard, Hagan, Vayda, and Anderson, 2000). As with earlier time-related tools, SAVME is used to capture and examine inter-vehicular relationships. The primary purpose of the effort is to quantify vehicle trajectories for the development and test of driver assistance systems (DAS). Where, the normal driving environment is defined by a Kalman filter and factors such as heading, range, and angle-of-attack to define a conflict and appears to disregard human behavioral factors.

Thus far, Ervin, et al., has created 10 test scenarios based on data collected at an arterial roadway for 18 hours capturing approximately 30,500 vehicles. The advantage of the SAVME technique is that large amounts of traffic data can be collected through video capture at prescribed locations. Once the data is captured it is filtered for crashes and near-crashes based on a set of performance algorithms that define normal driving. However, a disadvantage of this technique is that it does not take into account the behavioral and environmental aspects that may impact the driver.

Both time-related investigative tools and the roadway safety initiatives use quantitative metrics and criteria to determine relationships, risk, and the impact of a factor on safety. However, according to findings from the 100-car Naturalistic Driving Study, quantitative criteria are not enough to fully understand driver behavior and impacts to and from the driving environment (Dingus, Klauer, et al., 2005). The study determined that there is a dependency between quantitative characteristics and qualitative characteristics making purely quantitative near-crash criteria inadequate.

The dependency between quantitative and qualitative characteristics had been identified in the past and the research performed by Dingus, Klauer, et al., (2005) provides validation. When performing a general observational or TCT-like procedure, Almquist and Hydén (1994) state that a behavioral study must accompany any conflict analysis. Where, a driver behavioral study should reveal differences between collision-producing behaviors and non-collision producing behaviors. They hypothesize that by cataloging the collision-producing behaviors one can identify a traditional remedy such as improvements to road design, education, or enforcement.

Almqvist and Hydén (1994) state that monitoring and evaluating a given roadway system can be very challenging and information supplementary to an accident analysis has fallen under an umbrella of *proxy variables*. Distinct proxy variables have not been identified and are defined as commonly observed road user behaviors that in some way should be closely linked to crashes. This lack of observable proxy variables is a hole in driver behavioral research. Examples of proxy variables include interactions between road users, compliance with rules and traffic signals, and use of safety devices.

In an effort to establish initial in-vehicle driving measures of performance for near-crashes and crashes to predict safety effectiveness, Dingus, Hulse, Jahns and Mollenhauer (1996) adapted the subjective TCT methodology to analyze near-miss data collected from an instrumented vehicle study. As can be assumed, the central focus of this study was on investigating driving from within the vehicle with the driver and vehicle control metrics. In performing this study, variables were drawn from the 1993 General Estimate System (GES), TCT literature, and their own TravTek Camera Car Study undertaking. The variables identified a range of driver, day-of-week/time-of-day, ambient condition, vehicle, infrastructure, and event factors.

Frequencies were reported for a number of variables; however the reader was cautioned as to making any inferences because of the small sample of near-misses. Reported frequencies were for variables such as:

- conflict type
- number of lanes
- presence of conversation/communication
- movement of the research vehicle prior to an event
- type of traffic control device
- attempt at a corrective action
- presence of system auditory information
- attention directed toward navigation system

Regardless of the small sample size, the use of the TCT was considered to be an extensible tool to establish a standard methodology for near-crash data collection, demonstrating that the TCT could be applied to observational research with a transportation safety focus outside of the traffic engineering domain.

Mollenhauer (1998) repeated the use of the adapted TCT methodology outlined in Dingus et al. (1996) to perform a safety evaluation of an in-vehicle navigation product. Data collected of drivers using a navigation system, baseline driving data, results of the safety evaluation and data collected by Dingus et al. were used in a comparative hazard analysis. Driver error data from the in-vehicle studies were used as a safety surrogate for crashes. Each driver error was assigned an:

- error type (i.e., maneuver being performed prior to or at the time error occurred),
- environmental proximity (i.e., near-miss, hazard present or no hazard present),
- potential severity (i.e., catastrophic, critical, marginal or minor), and
- risk assessment (i.e., unacceptable risk, undesirable risk or acceptable risk).

Findings from the comparative analysis resulted in three groups of expected ratios between environmental proximity classifications. The ratios were 1:2.3 for injury accidents and non-injury accidents, 1:1200 for non-injury accidents and near-misses and 1:10.1 for near-misses and errors with a hazard present. Mollenhauer reported that these ratios were found to be similar to those reported by Older and Spicer (1976) for serious conflicts to injury accidents (2800:1 and 2000:1, respectively).

It was concluded that the ratios support the hypothesized relationship between hazardous traffic events, but that more data are needed to validate the conclusions.

Dingus et al. (1999) have aggregated results from ongoing research to continue addressing the relationship between crashes and near-misses. The results are from investigations into the impact of intelligent transportation systems on driver workload and attentional demands. Findings indicate a relationship between crashes, near-misses and driver error presented in Figure 7.

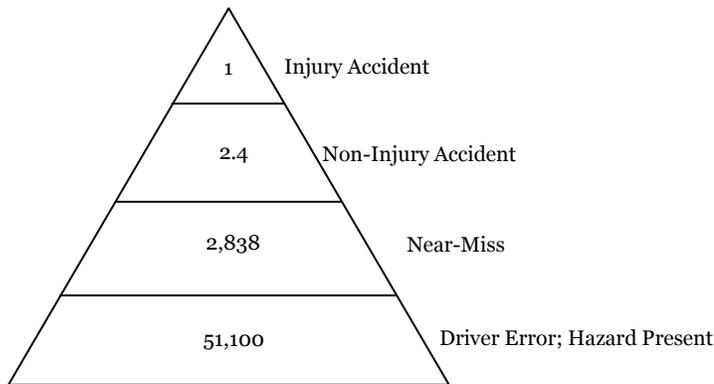


Figure 6. Preliminary findings for a relationship between crashes and near-misses (Dingus et al., 1999).

As with the results reported by Mollenhauer (1998), the ratio of near-misses to injury accidents (2383:1) presented in Dingus et al. (1999) was also considered to be similar to that reported by Older and Spicer (1976). However, this relationship was thought to be more accurate than the Older and Spicer ratio because data was taken from an in-vehicle perspective, instead of an external observational perspective. These findings reinforce and begin to validate the hypothesis that there is a relationship between the severity and frequency of automotive traffic events.

In addition, Svensson (1998) has speculated that not all locations are equal in severity and frequency of traffic event occurrence. He performed a cross-sectional study that evaluated vehicle-pedestrian interactions at three intersections using a time-to-accident measure to define the shape of a severity hierarchy. The shape of a severity hierarchy was formed using the frequency of a conflict type at different severity levels. Svensson hypothesized that by analyzing the shape of different severity hierarchies, traffic safety can be determined for given conditions. Criteria and indicators used for hypothesis testing were:

- type of road user (motor vehicles and pedestrians),
- type of maneuver (vehicles driving straight ahead and vehicle turning right),
- type of intersection (signalized and non-signalized cross intersections), and
- type of situation (interactions with pedestrians involving a collision course that required an evasive action).

Conflicts were rated by severity and grouped by event type to calculate the number of events at each severity level. Data from the observations included total number of interactions, duration of interaction, number of interactions per hour, vehicle flow per hour and pedestrian flow per hour. He

examined similarities between all severity hierarchy shapes; similarities between the hierarchy shapes at similar types of intersections; and if the type of control, maneuver or road user had an influence on hierarchy severity shape. Findings were that locations with a high number of interactions at low severity levels seem to also produce conditions for occasional events that have a high injury accident potential. At locations with the opposite pattern, narrow convexity at high severity levels, there appears to be an indication that the most severe types of events are very infrequent or may never occur (Svensson, 1998).

A more recent instrumented vehicle study performed by Dingus, Klauer, et al. (2005) has also explored the relationship between crashes and near-crashes. The findings in this study were different from those presented in earlier research. The relationship between crashes and near-misses was reported to be 82 crashes, 761 near-crashes, and 8,295 critical incidents. This was the result of an 18 month data collection effort of naturalistic driving. That is, 241 participants drove an instrumented vehicle (as either their own car having been instrumented or a loaned vehicle) for 12 to 13 months from which video and vehicle state kinematic data was collected.

It was found that near-crashes occurred 15 times more often than crashes. In addition, an event database was created that captures information for pre-event maneuvers, a precipitating factor, an event type, and additional contributing factors. The study had 10 goals that characterize different crash and near-crash aspects based on human factors issues. The advantage of this technique, like the SAVME research, is that it is a large-scale effort that can be used to validate specific driver behaviors and possibly intention. However, given the purpose of this research effort, the limitation is that factors that can be observed by a spectator are difficult to determine due to the in-vehicle perspective of the data capture.

Although the severity and frequency of traffic events appears to occur at varying degrees for different roadway systems, ratios reported indicate that a general hierarchical relationship exists. However, identification of event predictor variables beyond conflict type and their relationship with event severity requires additional investigation. In order to investigate event severity relationships and predictor variables, this current research effort builds upon the TCT procedure as an observational and conflict classification methodology while incorporating factors and variable definitions from taxonomic studies to identify road user behaviors. The combination of conflict and taxonomic variables will afford researchers a better understanding of how to include road user behaviors to evaluate hazardous roadway systems and thus crash potential.

2.4 Taxonomic Crash Investigations

A number of researchers have pursued investigating crash causation from the driver's perspective. That is, they have used investigative techniques such as interviews, focus groups, and/or database searches and case reviews to identify reasons to define and categorize crash factors. The following describes three such studies and their taxonomic contributions of factors and variables that can be used in further investigations.

In an attempt to define individual behavior that resulted in near-crashes and crashes, researchers have evaluated vehicle design, roadway design, surrounding environment, and driver (or human-related) factors in the roadway system. The Indiana University Institute for Research in Public Safety

(1977) conducted a seminal study on accident causal factors known as the Indiana Tri-level Study. The objectives of the study were to (Treat, 1980, p. 2):

- identify factors that initiate or influence the sequence of events resulting in a motor vehicle accident;
- determine the relative frequency of those factors and their causal contributions;
- assess the error/accident relationship as a function of driver age, driving knowledge, vision, driving experience and vehicle familiarity;
- develop new methods for assessing the role of human-related factors in accident causation; and
- assess the potential benefits of various improvements in vehicle systems.

These objectives were met through the collection of data from 13,568 documented accident cases, 2,258 on-site investigations of accidents, and the evaluation of 420 cases by a multi-disciplinary team. An information-processing model was used to develop a taxonomy of accident causal factors based on the data collected. The model was based upon the premise of driver as vehicle controller. It was assumed that "...drivers are continuously engaged in perceiving and comprehending information, making decisions and taking actions to achieve needed control responses" (Treat, 1980, p. 7). Factors were placed in four primary groups: (1) Human Conditions and States, (2) Human Direct Causes, (3) Environmental Factors, and (4) Vehicular Factors. Table 1 illustrates the classification hierarchy of factors found to result in automobile events from this research.

Treat (1980) condensed the findings of the Indiana Tri-level Study, and found that human-related factors were the cause of accidents in 70.7% of the cases reviewed. Whereas environmental and vehicle factors were found to be the definite cause of 12.4% and 4.5% of the accidents, respectively. Findings from the study indicate that recognition and decision errors were by far the most common types of driver errors (41.4% and 28.6% of the accidents, respectively). Other significant human-related factors that influenced accidents were dynamic visual acuity, and little or less familiarity with the roadway. Of the environmental factors, view obstructions and slick roads were reported as the two most prevalent pre-crash factors. Each factor was identified as the cause in 3.8% of the accidents. These findings provide insight into actual reasons motorists are involved in a traffic event. However, upon review of the causes, they are sometimes difficult to obtain without knowledge of the driver's physical, psychological, and/or emotional state at the time of the event.

Table 1. Overview of accident causation factors from the Indiana Tri-Level Study (1976).

HUMAN FACTORS				
Human Conditions and States				
Physical/Physiological	Mental/Emotional		Experience/Exposure	
<ul style="list-style-type: none"> ➤ Alcohol impairment ➤ Other drug impairment ➤ Reduced vision 	<ul style="list-style-type: none"> ➤ Emotionally upset ➤ Pressure or strain ➤ In-hurry 		<ul style="list-style-type: none"> ➤ Driver inexperience ➤ Vehicle unfamiliarity ➤ Road over-familiarity ➤ Road/area unfamiliarity 	
Human Direct Causes				
Recognition Errors	Decision Errors	Performance Errors	Critical Non-performance	Non-accident
<ul style="list-style-type: none"> ➤ Failure to observe ➤ Inattention ➤ Internal distraction ➤ External distraction ➤ Improper lookout ➤ Delay in recognition for other or 	<ul style="list-style-type: none"> ➤ Misjudgment ➤ False assumption ➤ Improper maneuver ➤ Improper driving technique or practice ➤ Inadequately 	<ul style="list-style-type: none"> ➤ Panic or freezing ➤ Inadequate directional control 	<ul style="list-style-type: none"> ➤ Loss of consciousness 	<ul style="list-style-type: none"> ➤ Intentional collision

unknown reasons	defensive driving technique <ul style="list-style-type: none"> ■ Excessive speed ■ Tailgating ■ Excessive acceleration ■ Pedestrian ran into traffic 			
ENVIRONMENTAL FACTORS				
Highway-Related		Ambience-Related		
<ul style="list-style-type: none"> ■ Control hindrance ■ Inadequate signs and signals ■ View obstructions ■ Design problems ■ Maintenance problems 		<ul style="list-style-type: none"> ■ Slick roads ■ Special/transient hazards ■ Ambient vision limitations ■ Rapid weather change 		
VEHICULAR FACTORS				
<ul style="list-style-type: none"> ■ Tires and wheels ■ Brake system ■ Steering system 		<ul style="list-style-type: none"> ■ Suspension problems ■ Power train and exhaust ■ Communication system 		<ul style="list-style-type: none"> ■ Driver seating and controls ■ Body, doors, and all other vehicular factors

Although this was a seminal study, Treat has not been the only researcher to perform a large-scale investigation into factors that result in near-crash and crash traffic events. Malaterre (1990) also performed an *a posteriori* accident data analysis based upon an information-processing model. The assumption was made that it would be possible to associate at least one state of the perception, processing, decision, action sequence to every accident. A sequence of errors was used to generate accident mechanism categories and establish typologies. Data were collected at the scene of 72 accidents that involved 115 road users. Data were coded regarding the scene of the accident; driving maneuver; and characteristics of the infrastructure, driver, and vehicle.

Variables that were defined and evaluated included driving tasks that were not carried-out (i.e., failure tasks and critical tasks), categories of activity disturbances that could affect driver control, antecedents to accidents, and function failures. Results from the study identified 15 accident typology categories. Each accident typology describes an accident mechanism along with other variables relevant to the generalized situation. The accident mechanisms were defined as (Malaterre, 1990, pp. 1415-1419):

- Category 1. Reactive road users with no perception of risk.
- Category 2. Road user was not able to perceive another road user sufficiently far ahead in time to avoid an accident.
- Category 3. Passed another vehicle that became visible at the last minute.
- Category 4. Low vigilance and poor speed control.
- Category 5. Road user data acquisition sequence was poor or badly synchronized and the road user did not see an obstacle.
- Category 6. Signage was difficult to read and lead to non-perception of the message.
- Category 7. An unforeseen task was added over and above the original task.
- Category 8. Failure to anticipate because of poor perception, high speed and/or lack of familiarity with roadway.
- Category 9. Limited time span to accomplish multiple tasks.
- Category 10. Poor evaluation of a curve radius or speed resulting in unanticipated excess later acceleration.
- Category 11. Unexpected task of having to avoid another road user.
- Category 12. Decision was made with insufficient information.

- Category 13. Falsely anticipated other road user actions.
- Category 14. Road user bases his/her action upon the decision of another road user; blindly follows the other road user.
- Category 15. Lack of control or insufficient control that was not corrected for.

Malaterre’s categorized accident mechanism results were not as granularly defined as Treat’s causation factors. However, the categories can be used to describe what is observed in the traffic environment versus having to conduct interviews with individual drivers each time an event takes place. A third effort undertaken to identify human-related and other system factors that contribute to driver error was performed by Hankey, Wierwille, Cannell, Kieliszewski, Medina, Dingus, and Cooper (1999). Three approaches were used to identify factors and generate error taxonomies. The three approaches included (1) a national and state accident database study, (2) an investigating officer focus group study, and (3) a critical incident driver interview study. Investigators were particularly interested in the relationship between infrastructure elements and design and their impact upon the driver.

It was found that crashes could be classified by a principle crash type, principle error type and principle factors that contribute to driver task performance. Five principle crash types were defined based on a driving maneuver. Although not considered to be driving maneuvers, two other crash types were also defined due to their prevalence in the findings. Common reasons for each of the crash types were also identified and all are listed in Table 2.

Table 2. Common factors contributing to crash types (Hankey, Wierwille, et al., 1999).

<p>LEFT TURN Driver-related Factors:</p> <ul style="list-style-type: none"> ➤ Right-of-way misunderstanding or violation ➤ Mis-estimation of speed ➤ Failure to detect or see another vehicle <p>Vehicle- or Environment-related Factors:</p> <ul style="list-style-type: none"> ➤ Lack of visibility 	<p>COLLISION WITH AN OBJECT, PEDESTRIAN, OR ANIMAL Driver-related Factors:</p> <ul style="list-style-type: none"> ➤ None reported <p>Vehicle- or Environment-related Factors:</p> <ul style="list-style-type: none"> ➤ Objects falling or thrown from other vehicles ➤ Vehicle components on the roadway ➤ Wildlife entered roadway ➤ Pedestrian entered roadway
<p>RIGHT TURN Driver-related Factors:</p> <ul style="list-style-type: none"> ➤ Misjudging a turn ➤ Improper right-turn-on-red ➤ Turning from the wrong lane <p>Vehicle- or Environment-related Factors:</p> <ul style="list-style-type: none"> ➤ None reported 	<p>LANE CHANGE, MERGE, OR PASSING Driver-related Factors:</p> <ul style="list-style-type: none"> ➤ Improper or illegal passing ➤ Failure to detect or see another vehicle ➤ Improper merge technique <p>Vehicle- or Environment-related Factors:</p> <ul style="list-style-type: none"> ➤ Heavy traffic
<p>RUN-OFF-ROAD Driver-related Factors:</p> <ul style="list-style-type: none"> ➤ Excessive speed ➤ Performing an evasive action ➤ Inattention ➤ Drowsiness <p>Vehicle- or Environment-related Factors:</p> <ul style="list-style-type: none"> ➤ Curving roads: ➤ Not adequately signed ➤ Limited adhesion 	<p>WEATHER-RELATED Driver-related Factors:</p> <ul style="list-style-type: none"> ➤ Driver did not adjust behavior to the conditions ➤ Driver was surprised by the conditions <p>Vehicle- or Environment-related Factors:</p> <ul style="list-style-type: none"> ➤ Ice on bridge or black ice on roadway

Six common and recurring driver error types were found. ‘Failure to yield the right-of-way’ was the most prevalent error type and resulted from inadequate knowledge, improper perception or a misunderstanding of the traffic signs or signals. ‘Misjudgment of speed and/or distance’ often occurred because drivers had either underestimated the speed of their vehicles and/or overestimated

their distances from other vehicles. ‘Failure to perceive or perceive correctly’ was attributed to a number of reasons, but it most often resulted from driver inattention or a distraction. Other poor perception causes included fatigue or drowsiness, performing an improper visual scan or visual impairment.

‘Following too closely’ was commonly cited as a result of either willfully tailgating another vehicle, often in heavy traffic to maintain a position or lack of knowledge regarding reaction times and stopping distances. ‘Excessive speeds for conditions’ and ‘improper assumptions’ were the last two error types reported. ‘Excessive speed for conditions’ primarily occurred under special driving conditions such as a change in weather, construction zones or narrow or curving roadways. ‘Improper assumptions’ were found to be incorrect assumptions made by the drivers about other drivers or traffic conditions.

From the results of the three approaches, a hypothetical framework was developed to link principle factors to driver task performance. The framework was created to organize the findings into groups of principle factors. These principle factors were thought to have a direct influence on driver task performance and could result in a crash (Figure 6).

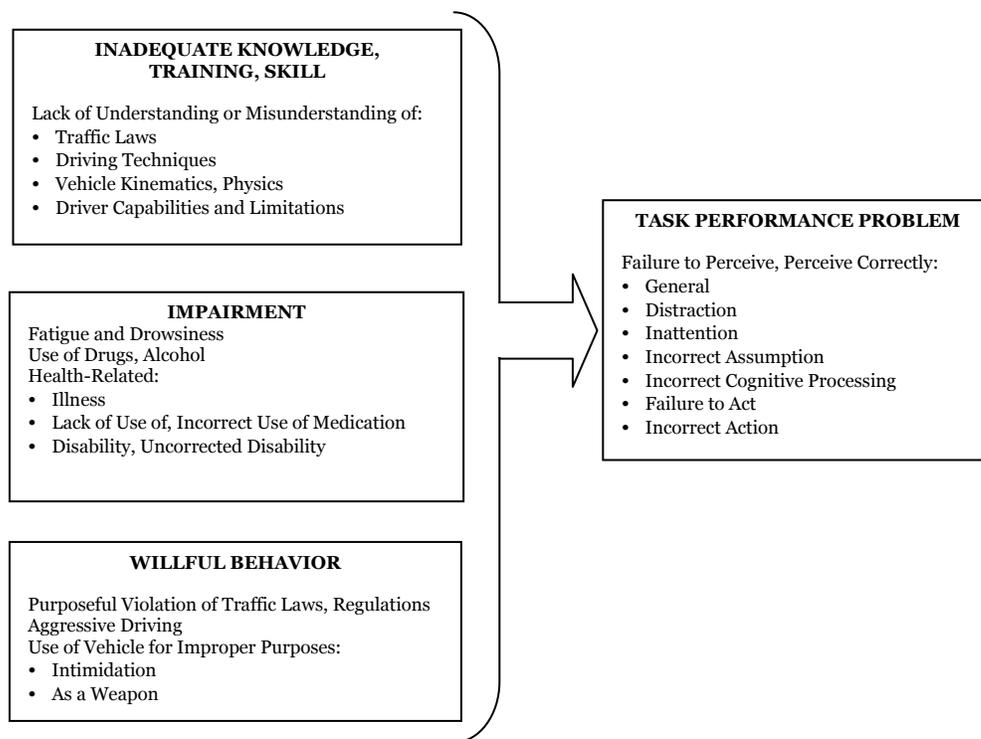


Figure 7. Index of Principle Contributing Factors Affecting Task Performance (Hankey, Wierwille, et al., Figure 63).

Rumar (1985) states that the results can be very general, difficult to relate to other data, difficult to communicate to other disciplines, and often lead to the human being judged as the cause of the event. Nevertheless, the advantages of taxonomic models are three-fold: (1) as a method to inventory factors that lead to an event, (2) substantiate the complexity of a crash, and (3) establish frequencies and

sometimes a correlation between the event and factors. The results from the taxonomic investigations provide context with regards to crash causation and a framework for additional near-crash and crash investigations.

2.5 Research Framework

Mayora and Rubio (2003) state that “a key step to develop accident prediction models is to select a set of independent variables that capture as much of the interaction between roadway characteristics and driver safety performance as possible” (p. 11). The conceptual framework for this project blends the use of the TCT with driver error evaluation research to identify factors, and subsequently surrogate variables, that contribute to traffic events. This section describes the elements used to scope this research effort.

2.5.1 Conflict Types

Recall (as discussed in the *Traffic Control Technique Overview* section) that Parker and Zeeger (1989) identified and defined six primary conflict types mainly for signalized and un-signalized cross intersections. These conflict types were used as a basic starter set of conflict definitions. However, due to the addition of other intersection types, ramps, and streets (i.e., surface streets, highways, and freeways) observed for this research effort the basic set of conflict definitions was revised and expanded.

As with the Parker and Zeeger definitions, the conflict types have two parts: (1) a maneuver classification based on the position or movement of the first vehicle (V1) in the interaction, such as left turn; and (2) the direction from which the next vehicle (V2) was positioned, such as cross traffic from right. (Note that V1 is considered to be the vehicle at-fault in an event conflict.) In addition to providing a classification schema for the observed traffic events, the classifications aided analysts in objectively evaluating events for observed maneuvers regarding vehicle path, position and conflict type (Table 3).

Table 3. Event maneuver classifications based on Vehicle 1 (bold) and corresponding conflict types based on position of Vehicle 2 (bulleted).

TURN MANEUVER AND CONFLICT TYPES
Left turn (Vehicle 1 performed a left turn at an intersection.)
• Conflict with cross traffic from right
• Conflict with cross traffic from left
• Conflict with cross traffic from right, turning left
• Conflict with cross traffic from left, turning left
• Conflict with cross traffic from left, turning right
• Conflict with oncoming through traffic
• Conflict with oncoming traffic turning right
• Conflict with oncoming traffic turning left
• Conflict with adjacent turn traffic
• U-turn, conflict with cross traffic
• U-turn, conflict with oncoming traffic
• Conflict with pedestrian or bicycle
• Conflict with stationary object (e.g., road edge)
Right turn (Vehicle 1 performed a right turn at an intersection.)
• Conflict with cross traffic from right

- Conflict with cross traffic from left
- Conflict with cross traffic turning left
- Conflict with oncoming traffic turning left
- Conflict with adjacent through traffic
- Conflict with adjacent turn traffic
- Right-on-red, conflict with cross traffic from left
- Right-on-red, conflict with oncoming traffic, turning left
- Conflict with pedestrian or bicycle

STRAIGHT MANEUVERS AND CONFLICT TYPES

Lane change (Vehicle 1 moving from one lane to a same-direction adjacent lane.)

- To right, conflict with through traffic in right lane
- To right, conflict with cross traffic turning right-on-red
- To right, conflict with oncoming traffic turning left
- To left, conflict with through traffic in left lane
- To left, conflict with traffic in both lanes
- To left, conflict with cross traffic
- To left, to left-turn-only-lane then back to left through lane
- From right-turn-only-lane, conflict with adjacent through traffic to left
- Conflict with vehicles traveling in outer lanes trying to move into the same opening in inner lane

Same Direction (Vehicle 1 slows and/or changes direction.)

- Conflict with slowed/stopped lead vehicle
- Conflict with lead vehicle having slowed/stopped to turn
- Conflict with adjacent parked vehicles
- Backing, conflict with following vehicle
- Backing, conflict with object other than vehicle

Forward (Vehicle 1 moving either straight through an intersection or on a street.)

- Conflict with oncoming traffic turning right
- Conflict with oncoming traffic turning left
- Conflict with cross traffic from right
- Conflict with cross traffic from left
- Conflict with pedestrian crossing from right
- Conflict with pedestrian crossing from left
- Conflict with stationary object
- Wrong way on one-way, conflict with oncoming through traffic

RAMP MANEUVER AND CONFLICT TYPES

Entering Ramp (Vehicle 1 moving from street to ramp auxiliary lane or directly to ramp proper.)

- Conflict with traffic exiting ramp
- Conflict with lead vehicle having slowed/stopped
- Conflict with through traffic

Ramp Proper (Vehicle 1 slows, stops, or makes a lane change on the ramp.)

- Same direction, conflict with lead vehicle having stopped
- Lane change to left, conflict with traffic in left ramp lane
- Lane change to right, conflict with traffic in right ramp lane

Exiting Ramp (Vehicle 1 moving from a ramp proper or ramp auxiliary lane to street.)

- Same direction, conflict with lead vehicle having stopped
- Lane change to left, conflict with traffic in left ramp lane
- Lane change to right, conflict with traffic in right ramp lane
- Conflict with through traffic

NON-MOTORIST MANEUVER AND CONFLICT TYPES

Pedestrian/Bicycle (When a pedestrian or bicyclist enters the path of vehicle that had the right-of-way.)

- Conflict with traffic on far-side of intersection

- Conflict with traffic on near-side of intersection
- Conflict with adjacent traffic
- Conflict with opposing through traffic

2.5.2 Event Severity

There is a history of determining event severity that evolves from general risk behavior descriptions to scaled hazard descriptions. Parker et al. (1995) performed a study to define different types of abnormal driver behavior and explore error-violation distinctions in abnormal driver behavior. Blockey and Hartley (1995) validated the study. Three general risk behaviors were used in their study to define factors. These behaviors were no risk to other road users, some possibility of risk to others and definite risk to others. The three general risk behaviors were then modified to represent categorical risk to the system and used to determine if the traffic event was a potential conflict, slight conflict, or serious conflict, respectively.

A Traffic Event Rating Scale was developed to assign a severity rating to each event. The rating was used to differentiate and categorize the traffic events for further analysis. An iterative process was used to combine scales and definitions from four sources to create the rating scale. In its final format, the expanded severity rating scale encompassed all types of documented traffic events regardless of their impact upon the driver or other traffic. The final Traffic Event Rating Scale expanded the Conflict Severity Classifications used by Older and Spicer (1976) to include conflict severities defined by Heinrich et al. (1980) and hazard categories defined by Mollenhauer (1998) and Dingus et al. (1999). Table 4 operationally defines each of the severity ratings and lists the corresponding severity category and rating.

Table 4. Traffic Event Severity Rating Scale.

Severity Category	Severity Rating	Definition
Negligible	1	Error, no hazard present. Poor driving behavior that did not cause a conflict or result in an interaction with another vehicle or object. Commonly a single vehicle traffic event that resulted in a minor driving infraction.
Marginal	2	Error, hazard present. Precautionary braking or lane change with no risk or minimal risk of a near-crash. An example would be a vehicle blocking an intersection with very slow moving adjacent traffic or, backing at an intersection with a stopped vehicle to the rear.
	3	Serious error, hazard present. Controlled acceleration, deceleration, lane change and/or a warning behavior such as sound the horn with slight risk of a near-crash. Tailgating in slow traffic for example.
Critical	4	Near-crash. Rapid controlled acceleration, deceleration, lane change or stopping to avoid a crash.
	5	Serious near-crash. Emergency braking or violent swerve to avoid a crash, resulting in a very near-crash situation.
Catastrophic	6	Non-injury crash. Crash resulting in only property damage. No need for an emergency team.
	7	Injury crash. Crash resulting in bodily injury and/or property damage. Emergency medical assistance present.
	8	Fatality. Crash resulting in death and/or severe property damage. Required emergency medical assistance and/or a tow vehicle.

2.5.3 Contributing Factors

In addition to the creation of the Traffic Event Rating Scale, a list of event contributing factors was generated. The list of factors took into account the system elements of infrastructure, environment, and driver (i.e., observed actions) and was generated based upon:

- traffic engineering sources (American Association of State Highway and Transportation Officials, 1994; Lamm, Psarianos, and Mailaender, 1999; Mannering and Kilareski, 1990; and U.S. Department of Transportation, 1988),
- near-crash and crash taxonomies (Hankey, Wierwille, et al., 1999; Indiana University Institute for Research in Public Safety, 1977), and
- researcher input from field experience during data collection for this investigation.

The identified factors were used to generate an extensive list of variables for data extraction and analysis which resulted in a Data Extraction Manual (Appendix A) and input definitions for a data extraction program (described below).

3 Methods

3.1 Site Selection

Sites used for data collection were selected from three regions referred to as metropolitan/urban (the greater Washington, DC area); medium-sized city (the greater Roanoke, Virginia area); and, town/rural (Blacksburg/Christiansburg and Southwest Virginia). The primary objective in observing sites within three different regions was to capture traffic events at locations with varying complexity and traffic flow. It was initially assumed that factors such as the physical complexity of a site, amount of traffic, and primary site geometry would result in different traffic events. This would, in turn, result in a wide variety of event types for analysis affording a greater understanding of event severity and associated factors. Site selection was executed in three primary phases to identify potential sites, evaluate the potential sites, and determine which sites were to be used for data collection. Each of these phases is described in detail in the following sections.

3.1.1 Initial Identification

Sources used for the identification of potential sites were the officer focus group and driver interview data from Hankey, Wierwille, and et al. (1999) and Virginia Department of Transportation (VDOT) crash prevalence data (Virginia Department of Transportation, 1996a; 1996b).

Officer focus group discussions resulted in the identification of relationships between driver error, roadway geometry, and traffic control devices. These discussions identified types of infrastructure that were found to have an influence upon driver behavior, such as interchanges, curves, hillcrests, and superelevation. Specific locations that were considered to be particularly troublesome and accounted for a large number of crashes were also identified.

A second source of potential sites was transcript material from driver interview sessions. Although specific sites from the driver interviews were not included in the Hankey, Wierwille, and et al. (1999) report, the original transcripts were utilized to identify locations considered to be dangerous or problematic by drivers. These locations were then included for consideration along with the sites

from the officer focus group findings. Sites identified by these two sources were primarily located within municipalities or on rural interstates.

Virginia Department of Transportation crash prevalence data were used as a third and final source to balance the potential locations. The crash prevalence data provided counts of the number of crashes that occurred at intersections and roadways maintained by VDOT. Maintained roadways included all Virginia roadways other than those funded and/or maintained by a municipality or the federal government. A potential site identified from the prevalence data was selected based upon a high number of total crashes at the location within the one-year period of July 1, 1995 to June 30, 1996. As with the other potential sites, those identified from the crash prevalence data were compared with other potential sites identified by the officer focus groups and driver interviews. A total of 151 sites (56 metropolitan, 37 city, and 58 town/rural) were then evaluated for final selection. A sample of the sites from the three data sources is shown by region in Table 5.

Table 5. Sample of sites selected from the officer focus groups, driver interviews, and VDOT crash prevalence data.

Regions within Virginia	Officer Focus Group Sites	Driver Interview Sites	VDOT Crash Prevalence Data Sites
Blacksburg, Christiansburg, and Southwest Virginia (Town/Rural)	<ul style="list-style-type: none"> ➤ Tom's Creek Road and Price's Fork Road, Blacksburg ➤ Main Street and Patrick Henry Road, Blacksburg ➤ I-77 north (exit 32) to I-81 north ➤ US 460 at Route 623, Pembroke 	<ul style="list-style-type: none"> ➤ Turner Street and Main Street, Blacksburg ➤ Progress Street and Main Street, Blacksburg ➤ Ramp from North Main Street to US 460 East Bypass, Blacksburg ➤ US 460 West and merge from Pepper's Ferry Road, Christiansburg 	<ul style="list-style-type: none"> ➤ US 460 0.3 miles from Route 642 ➤ Route 114 0.1 miles from Route 800 ➤ Route 8 0.1 miles from Route 616 ➤ Route 8 and Route 1295
Greater Roanoke, VA Area (Medium-sized city)	<ul style="list-style-type: none"> ➤ Ramp from US 220 South to Route 419 ➤ 23rd Street and Brandon Avenue ➤ Williamson Road, 4400 to 5000 block ➤ 23rd Street and Colonial Avenue 	<ul style="list-style-type: none"> ➤ 581 South between entrance from Franklin road and exit to towers Mall ➤ Colonial Avenue and Route 221 ➤ Franklin Road and Brandon Avenue ➤ Hershberger Road and Williamson Road 	<ul style="list-style-type: none"> ➤ US 220 0.1 miles from Route 568 ➤ Route 24 and Route 1007 ➤ Route 419 and Route 706 ➤ Route 419 and Route 795
Greater Washington, DC Area (Urban/Metropolitan)	<ul style="list-style-type: none"> ➤ From west on Washington Boulevard to east on Route 50 ➤ Columbia Pike and Washington Blvd Ramp ➤ Chain Bridge Road and Glebe Road ➤ George Mason Ramp to Carlin Springs Road 	<ul style="list-style-type: none"> ➤ Ramp from Van Dorn to Duke Street ➤ Interchange of 395 South, 495, and 95 ➤ Rotary intersection of Street, M Street, and Pennsylvania Avenue ➤ Wilson Bridge leaving VA and entering MD 	<ul style="list-style-type: none"> ➤ State Route 7 and County Road 3888 ➤ State Route 236 and County Road 713 ➤ US Highway 1 between Route 892 and Route 949 ➤ Ramp to right off of State Route 7 at Route 650

3.1.2 Initial Evaluation

After the initial site selection, an on-site evaluation was conducted to document any researcher or equipment safety issues and location quality. At this point in the process, researchers often were not familiar with the potential sites. Upon arrival to a potential site, a researcher drew a sketch of the location, noted any safety issues, took one or two photographs, and documented potential equipment/researcher placement for data collection.

Researcher and equipment safety was a priority for data collection. A safe location was one in which the researchers could remain inconspicuous to traffic and there was no exposure to unnecessary risk during equipment set-up or surveillance sessions. If the potential site was considered to be safe for data collection, the researcher then evaluated location quality by identifying potential placement of equipment and researchers on the location sketch. General criteria were established for the initial evaluation as:

- There was no restriction on the number of legs approaching/exiting an intersection.
- There was no restriction on the number of lanes of a roadway.
- Rural interstates were to be eliminated from the list of potential sites in order to scope this research effort.
- Urban or metropolitan interstate roadways such as beltways or bypasses would be considered for evaluation.
- Interchanges, or exit/entrance ramps, accessing non-rural interstate highways would be considered for evaluation.
- Sites that were under construction were to be eliminated from the list of potential sites. Construction zones were considered to be a non-routine and special driving environment.

Photographs were taken as a secondary visual reminder of the controls and surroundings for final evaluation. If the site was considered to be safe, a 10 to 15 minute sample observation session was conducted to identify some of the traffic patterns and driver behaviors. During the sample observation session, the researcher documented any noticeable issues with infrastructure and traffic flow, driver behaviors, and/or any actual traffic events. An example of a noticeable infrastructure or traffic flow issue would be left-turn traffic blocking through traffic at an intersection due to no designated left-turn lane. The researcher also watched for driver behaviors such as sudden braking, swerving, or traffic violations that may elicit traffic events.

Potential sites that met the safety and location quality criteria were categorized based upon the primary geometry (i.e., type of intersection, ramp, or roadway), secondary characteristics (i.e., change(s) in grade, curve(s), or superelevation), and primary control (i.e., signalized, stop-signed, or yield-signed). “A Policy on Geometric Design of Highways and Streets” (American Association of State Highway and Transportation Officials, AASHTO, 1994) was used to aid in categorization of the potential sites. The following primary geometries and secondary characteristics were defined as follows.

Primary Geometries

Intersections:

- Three-leg:
 - T: perpendicular cross where one approach does not continue through the intersection.
 - Y: an intersection where the three approaches are offset and basically form a pointed-star shape.
- Four-leg:
 - Cross: approaches to the intersection are perpendicular.
 - Offset Cross: at least one approach is not perpendicular to the cross road.
 - Multi-let: the intersection is composed of five or more approaches coming together.

Roadways: “...the portion of highway, including shoulders, for vehicular use... and, includes the traveled way which is the portion of roadway for the movement of vehicles, exclusive of shoulders (AASHTO, 1994, p. 327):

- ┆ Two-lane: two travel lanes, one lane in each direction.
- ┆ Multi-lane: two or more travel lanes in each direction.

Ramps:

- ┆ Ramp proper:
 - ┆ The transitional section either between the entering terminal (end of an additional lane that exits from one roadway) and the exit terminal (beginning of an additional lane to enter another roadway).
 - ┆ When there is no additional lane, the transition section between exiting one roadway and entering another.
- ┆ Additional lanes:
 - ┆ Auxiliary lane: an additional portion of roadway that aids in traffic flow. The auxiliary lane is not reserved only for use with ramps, but can be an additional traveled way on a roadway such as the addition of a left-turn lane at the approach of an intersection.
 - ┆ Weaving lane: a roadway adjoining ramp enter and exit terminals to accommodate two-way merging traffic movement.
- ┆ The ramp proper or additional lane may be either
 - ┆ single lane to accommodate only one lane of traffic at point of entrance/exit point; or
 - ┆ multi-lane to accommodate more than one lane of traffic at point of entrance/exit.

Secondary Characteristics

Vertical Alignment: change(s) in grade that characterize(s) how level, rolling, or mountainous the terrain is for a specific route.

Horizontal Alignment: the amount of curvature and/or superelevation on a specific route or within a transitional section of roadway such as on a ramp.

Channelized: a designated roadway or travel lane that is differentiated from other travel ways by pavement markings or a divisional island to separate and regulate traffic movement.

- ┆ Simple channelization: accommodates the turning movement of large vehicles especially where the angle of turn would greatly exceed 90 degrees.
- ┆ High-type channelization: accommodates movement of higher speeds and/or volumes of both through and turning traffic.

3.1.3 Final Selection

The final locations were selected to represent a variety of primary geometries, secondary characteristics, and primary controls to investigate a wide range of driving environments. The selection of the final sites was made from a short list of 12 to 15 sites from each of the three regions (Metropolitan/Urban, Mid-sized City, and Town/Rural). From this short list, locations were rated as more or less favorable with regards to safety and location quality, with the intent that only the top 10 favorable sites for each region would be observed. The remaining sites were used as back-up sites in case circumstances such as unexpected road construction did not allow the researchers to observe the

planned site. The final locations that were used for data collection are listed in Table 6 by the primary geometry, an outstanding secondary characteristic, primary control, and region.

Table 6. Summary table of sites used for surveillance.

Primary Geometry: Intersection			
Type of Intersection	Primary Control	Location	Region
Perpendicular 4-legged	Signal	Route 28 and Route 29, Centreville, VA	Metro
		Route 123 and Braddock Road, Fairfax, VA	Metro
		Orange Avenue and Williamson Road, Roanoke, VA	City
		Elm Avenue and Jefferson Street, Roanoke, VA	City
		Pepper's Ferry Road (Route 114) and Route 460 eastbound, Christiansburg, VA	Town
	Stop sign	Arlington Boulevard (Route 50) and Garfield Street, Arlington, VA	Metro
		Colonial Avenue and 23 rd Street, Roanoke, VA	City
		Spring Road/Tech Center Driver and Southgate Drive, Blacksburg, VA	Town
		Giles Road and Main Street, Blacksburg, VA	Town
Off-set 4-legged	Signal	Glebe Road and 24 th Road, Arlington, VA	Metro
	Stop sign	Owens Street and Harding Avenue, Blacksburg, VA	Town
Multi-legged	Signal	Route 7, Margarity/Lisle, and Ramada, Tysons, VA	Metro
		Minnesota Avenue, Pennsylvania, and 25 th Street, Washington, DC	Metro
		Main Street, Progress Street, and McDonald Street, Blacksburg, VA	Town
		Tom's Creek Road, Route 460, and Givens Lane, Blacksburg, VA	Town
T	Signal	Chain Bridge Road and Glebe Road, Arlington, VA	Metro
	Stop	Hollins Avenue and Mason Mill Road, Roanoke, VA	City
		Route 419 and Route 795, Roanoke, VA	City
		Church Street and Jackson Street, Blacksburg, VA	Town
Y	Signal	Elm Avenue and Ferdinand Street, Roanoke, VA	City
Primary Geometry: Roadway			
Type of Roadway	Primary Control	Location	Region
Two-lane	Warning(s)	Glade Road, Montgomery County, VA	Town
		Route 21, Wythe County, VA	Town
Multi-lane	No Warning(s)	Route 50 eastbound (between Rugby Road and Brimwell Place), Chantilly, VA	Metro
		Route 28 northbound (between Darkwood Drive and Route 29), Centreville, VA	Metro
		Rutgers Avenue, Roanoke, VA	City
		3500 Block of Orange Avenue, Roanoke, VA	City
Primary Geometry: Ramp			
Type of Ramp	Primary Control	Location	Region
One-lane	Yield	Route 28 (southbound) and Route 267 (Dulles Access Road), Washington Dulles International Airport, VA	Metro
		Bypass 581 and Hershberger Road, Roanoke, VA	City
		Carlin Springs Road and George Mason Drive, Arlington, VA	Metro
		South Main Street and Route 460 eastbound, Blacksburg, VA	Town
Multi-lane	Signal	Bypass 581/Route 220 Bypass Exit and Route 419 northbound, Roanoke, VA	City

3.2 Observational Techniques

The essence of this research was to capture traffic events as an unobtrusive third-party observer for analysis to determine what, if any, observable factors may lead to critical incidents. With the support of previous research findings, it was assumed that the TCT in conjunction with general observational techniques could be used to capture traffic events and observable contributing factors. Although the TCT has primarily been used as a tool to evaluate intersections, it is considered to be an extensible technique for the evaluation of other roadway geometries (Parker and Zeeger, 1989).

Three observational techniques of surveillance, incident reporting, and inventorying were used to collect data with regards to event circumstances (e.g., locations geometry, control, surrounding environment, and observable driver behaviors). The three techniques and the equipment used to perform data collection are described in detail in the following sections.

3.2.1 Videotape surveillance

Sites were unobtrusively videotaped during the entire observational session using one color video camera to capture traffic events. The video surveillance package consisted of a sheltered video camera, camera mount, external monitor, portable power supply, connection unit and 50-foot cable (Figures 8 and 9). Each of the video surveillance package components are described below in detail.



Figure 8. Videotaping package. Left: video camera set-up. Upper right: remote viewing components. Lower right: monitor used for remote viewing.

Video Camera. A Sony Handycam® Vision Camcorder (model CCD-TRV66) was used for video capture. The primary camcorder feature for this project was that it was capable of Hi8™ XR extended resolution, which extends the luminance bandwidth to provide improved image clarity in low contrast environments. Other features of this camera that were valuable to this project included:

- SteadyShot® image stabilization for windy days,
- titler that was programmed to time and date stamp the image,
- 20x optical/360x digital zoom that afforded camera placement at a safe and inconspicuous distance away from the observation site,
- audio/video output that allowed for remote viewing of the video image via a separate monitor, and
- self-contained rechargeable InfoLithium® battery.

Wide Angle Lens and Polarizing Filter. A wide angle lens or a polarizing filter were added to the camera if the camera's zoom and optical features needed to be enhanced. Each camera had an additional wide angle lens to capture a larger image. One was a Sony VCL-ES06 37mm one-touch wide conversion lens (0.6x), the other was a Sony VCL-0637H wide conversion lens. The filter was a Tiffen® 37mm circular polarizer used to generate a clearer image by reducing glare and reflections from the sun, roadway, and vehicles.

Camera Mount and Shelter. A surveyor tripod with an antenna mast (SECO model #5300-11) was modified to accommodate mounting the camera and camera shelter. The tripod legs extended to approximately 5 feet 4 inches (1.63 m), and a solid mast was milled to telescope another 4 feet 0 inches (1.23 m) for a total linear height of 9 feet 4 inches (2.86 m). The camera mount allowed researchers to adjust the camera's vantage point to obtain an acceptable view of the site by adjusting the height of the tripod leg(s) (tilt) and turning the mast (pan). The camcorder was mounted within an open aluminum shelter to protect the camera from overheating that may have resulted from being in the sun for extended periods of time.

Monitor. A Sony RGB mobile color monitor system XVM-6100 was used as an additional monitor for camera set-up, remote viewing of the videotaping, and time/date stamp information. The XVM-6100 is a super slim design with a high resolution TFT active matrix monitor that allows for audio/video inputs and RGB signal transmission.

Power Supply and Connections. An AutoCraft™ lawn and garden 12-volt battery (part no. U1-3, group size U-1) was used to power the monitor. A Sony connection unit XA-605 allowed for power hook-up (12V DC in) to the monitor with the power supply for camcorder video input and monitor output. A 50-foot coaxial cable (RG59U MIL-C-170) was used to connect camera output with the connection unit and monitor.

Video cassettes. Hi8 video cassettes were used to provide higher image clarity and definition than that provided by standard 8-mm video cassettes.

The video recording was time and date stamped so that observed events could be found and identified during data reduction. Finally, efforts were devoted to making the instrumentation and the observers as inconspicuous and safe as possible. This was accomplished by setting-up the camera unit (camera, mount, battery) unit within lens-view of the site—typically 20 meters or more away from the actual sight. The portability of the camera unit allowed the observers to monitor the site from afar where the van could be parked inconspicuously in a neighboring parking spot.



Figure 9. Camera unit adjacent to research vehicle.

3.2.2 Experimenter Annotations

During the videotape surveillance sessions, the researchers documented all observed traffic events. The researchers were watching and listening for evidence of any near-crash behaviors such as:

- loud sounds (e.g., horns or screeching tires)
- lateral movement (swerving and lane management)
- improper signal usage
- following closely
- running a red light
- not stopping for a stop sign
- not yielding
- longitudinal movement (e.g., excessive speed, slowing or stopping unexpectedly)

Upon observing an event the researcher would document where the event took place on an incident report form using a standard set of information (i.e., date, location, start time, weather conditions, and road surface conditions). The researcher also made a quick sketch of the event and wrote an event description on the form. Within the sketch and description, the researcher was to identify the vehicle(s) involved in the interaction, road segment and direction the vehicle(s) were traveling, and the primary maneuver that precipitated the event. (For a sample incident report form, see Appendix B).

3.2.3 Site Inventory

The third observational technique employed was to perform a general inventory of the site on the same day that the surveillance sessions were performed. The inventory documented what comprised each site and any general observations specific to the site. To conduct the inventory, a site inventory form (AppendixC) was completed, photographs were taken of the site, and drive-through video was performed.

One of the researchers at the site was required to fill-in the site inventory form, which asked for:

- Date, location, general weather and roadway conditions, observer names, times-of-day surveillance was performed, and time-of-day when the drive-through was performed.
- Detailed sketch of the site indicating the orientation of the site, location of controls or signage, and environmental elements. Along with an inventory of the signage and controls, roadway markings, and environmental factors that might affect a driver.
- Written narrative describing the site written from the perspective of a vehicle driver. The description was to include details such as visibility of signage and controls relative to traffic, condition and visibility of roadway markings, and existence of pedestrian/bicycle traffic.
- List of any special concerns or general observations related to the site, such as noticeable problematic traffic patterns, infrastructure, and/or driver behaviors.

To supplement the site inventory, the researchers were also required to perform an in-vehicle drive-through video and take photographs of the site. The drive-through video was used to assist in understanding and inventorying approach elements to the location from the perspective of a vehicle driver. That is, capture which site elements were within or occluded from the driver's field-of-view. Photographs were taken to capture elements such as signage and traffic control devices that may not have been captured in the drive-through video or missing from the site inventory. Due to the varying degree of complexity among surveillance sites, each location had a unique amount of supplemental information.

To perform the in-vehicle drive-through video, a video camera was located within the vehicle between the driver and passenger seats at the same height as the seat headrests (in the lowest position) to mimic a vehicle driver's sight line. In general, one researcher drove the research vehicle through the site while the second researcher operated the camera that is, panning the camera to capture forward and peripheral views of the site and any approaches. Equipment used to perform the in-vehicle drive-through video was:

Video Camera. A Canon ES7000V Hi8 camcorder with two essential features of (1) a 3.5 inch color LCD view screen to enable the researcher to align the camera with the forward and peripheral views in a safe manner; and (2) Image Stabilizer® to correct for camera shake within a moving vehicle.

Tripod. A standard camera tripod was used to carry and stabilize the video camera in the vehicle.

8mm Tape. As with the surveillance videotaping, Hi8 videocassettes were used for video capture.

3.3 Data Reduction

Once data was collected, it was then extracted from the videotape footage, field notes, and photographs in a lab setting to create a database with narratives and factors regarding infrastructure and control information, environment and traffic information, and individual event information. A series of three primary steps were taken to extract the data from its sources (discussed in the following sub-sections). These steps resulted in the description and drawing of each observed site, categorization of 1,038 traffic events, and extraction of up to 268 observable variables per event for analysis.

3.3.1 Step 1: Event Identification

Site surveillance annotations documented 3,544 traffic events ranging from poor driving behaviors that did not affect traffic to non-injury crashes. Therefore, to identify useful traffic events, experimenter annotations were first filtered and classified as being either an actual event (e.g., crash or near-crash) or only poor driving behavior. Once classified, 1,038 traffic events were examined for inclusion in the database.

To determine which events should be fully examined, each documented event was reviewed in its annotated state to determine whether or not the video footage of that event should be examined. Recall that each event report was to include the location, time, date, traffic and roadway conditions, a primary maneuver, and a description with a sketch. Using this information, each incident report was evaluated for possible inclusion into the final dataset in the following manner:

1. The description and sketch were first evaluated to determine what happened and how many vehicles were involved in the event.
2. The primary maneuver was also taken into consideration to determine if the event was a critical incident.
3. If the maneuver did not appear to affect the driver and/or other traffic, the incident was considered to be a non-event and was not included in the dataset. That is, the driver may have made a technical error, but it was so minor that it was considered to be negligible. An

example of such a non-event would be a driver positioning the vehicle on or beyond the white stop line at an intersection to make a right turn on a red light. Although the driver made a technical error in stopping distance from the intersection, the position of the vehicle did not affect cross traffic, hence this maneuver would be considered poor driving behavior or a non-event.

4. If the maneuver had affected the driver or other traffic, the incident report was retained as a traffic event and included for further examination. Using the above example, had the driver instead performed a rolling stop and cross traffic had to slow or swerve to avoid this vehicle, the annotation would have been included as a traffic event.

3.3.2 Step 2: Event Categorization

After the incident reports were reviewed for non-events, the remaining annotations were used to identify the traffic events on the video recordings. The incident report timestamp was synchronized to the video timestamp. Once the event was located on the videotape, the event was reviewed as often as needed by a data reduction analyst to extract event information for inclusion in the dataset. The data extracted from the video included roadway and traffic conditions, an event description (in the form of a narrative), number of vehicles in the traffic event, observable contributing factors for each vehicle, and assignment of a severity rating to the event.

3.3.3 Step 3: Data Extraction

A data extraction program was designed that allowed multiple analysts to input data into a hierarchical database via a graphical user interface. The data extraction program was developed at Virginia Tech Transportation Institute using Microsoft Access 97 for Windows NT (Microsoft Corporation, 1996). Development of the database structure and user interface was an iterative process, where the initial design was based on known event factors gained through the literature (see *Contributing Factors* section). Additional iterations to the database and user interface design continued into the initial weeks of data reduction to accommodate changes to input requirements.

As stated, the data extraction program was designed to be used by multiple data extraction analysts at any given time. To help ensure inter-analyst reliability, the data extraction analysts were first trained to use the interface to extract data from the inventory forms, video footage, and photographs. Recall that the inventory information provided evidence of the site conditions when the site was being observed. This information was considered to be static and only needed to be entered once into the database. Site factors entered into the database by one analyst were cross-checked by another analyst to ensure thoroughness and enforce reliability.

Analysts were also trained extracting data from the individual events. A Data Extraction Manual (Appendix A) was created to aid in identifying, defining, and interpreting contributing factors. However, due to the large number of reported events, all data extracted from the incident reports and surveillance video was not cross-checked by a second analyst. Instead, samples of event data were reviewed as a team to ensure thoroughness and that contributing factors were being extracted in the same manner.

As stated above, the database was hierarchical in design and had three general levels of (1) site data, (2) event data, and (3) vehicle data. Site data included basic identification (e.g., number, name, and region) and discrete variable categories for:

- ┆ Site geometry
- ┆ Primary control
- ┆ Roadway function
- ┆ Horizontal Alignment elements
- ┆ Vertical Alignment elements
- ┆ Obstructions to sight distance
- ┆ Median
- ┆ Road edge type
- ┆ Condition of roadway markings
- ┆ Presence of a sidewalk
- ┆ Barrier (if any)

In addition to the discrete variables, analysts provided a detailed narrative of the location that described the location, street names, and direction of road segments. Additional detail, such as number and purpose of lanes and notable elements or special concerns such as bicycle paths or bus stops, was included.

The subsequent two levels in the database hierarchy were event data and vehicle data. Event data focused on the general event characteristics of location number, timestamp, total number of vehicles in the interaction, severity rating, weather and roadway conditions, visibility, and Level of Service traffic density rating. In addition, the analyst entered a detailed narrative of the event. In general, this narrative included identification of V1 and, if applicable, subsequent vehicles, path of travel for all vehicles, primary maneuver of V1, and reactionary maneuvers by other vehicles.

3.4 Pilot Study

Upon approval from the Virginia Polytechnic Institute and State University Institutional Review Board (Appendix D), pilot testing of data collection techniques and procedures was undertaken. Trial data collection sessions were conducted to pilot observational techniques and estimate the number of events that might be observed during a surveillance period.

Three separate sites identified in a report by Hankey, Kieliszewski, and Wierwille (1999) as potentially good evaluation sites were observed for one hour each during peak traffic periods. The sites were intersections within the town limits of Blacksburg, Virginia:

- ┆ Price's Fork Road and Tom's Creek Road (4-legged signalized intersection) observed from 7:30 a.m. to 8:30 a.m.
- ┆ Price's Fork Road and University City Boulevard (3-legged signalized intersection) observed from 12:00 p.m. to 1:00 p.m.
- ┆ Price's Fork Road and Main Street (3-legged signalized intersection) observed from 4:30 p.m. to 5:30 p.m.

The results of pilot testing indicated that up to two near-crashes could be expected (events with a severity rating of 4 or greater), along with approximately six less severe incidents for every hour of data collection during peak traffic in a small city/town environment. Therefore, it was believed that a minimum of eight to 10 critical incidents per site would be observed and documented. Roadway surveillance was estimated to take between 25 and 30 days. Using these estimates, the goal was to collect approximately 200 critical incidents (events with a severity rating of 3 or greater) for use in data analysis.

In addition to event estimation, observational techniques were piloted. The techniques used in this testing phase were video surveillance, experimenter annotations, and drive-through videotaping. It was concluded that the video surveillance and experimenter annotation techniques were sufficient to capture events and event data. However, the drive-through video was inadequate as a lone site inventory technique, thus the site inventory form and photography were added as inventory techniques.

3.5 Primary Study

3.5.1 Observation Periods

Researchers observed a total of 31 sites. Data were collected during three peak traffic periods (from approximately 6:30 a.m. to 9:30 a.m., 11:00 a.m. to 1:00 p.m., and 3:30 p.m. to 6:30 p.m.) at each site (Table 7). Time at each site varied due to a noticeable decrease in traffic. The research team was able to use the non-peak traffic periods to perform the site inventory. Regardless of differences in absolute start and stop observational periods, time spent in each region remained relatively the same (i.e., metropolitan = 71 hours and 30 minutes, city = 69 hours and 43 minutes, and town/rural = 67 hours and 39 minutes) as did time spent at the three primary geometries (Table 8).

Table 7. Amount of time (in hh:mm:ss) spent at locations during the morning, noon, and afternoon data collection periods for each region.

Metropolitan/Urban				
Location Number and Name	Total Amount of Time for each Observation Period			Total of all Periods
	AM	Noon	PM	
Route 7, Margarity/Lisle, and Ramada, Tysons, VA	3:00:57	2:03:22	3:04:52	8:09:11
Route 28 and Route 29, Centreville, VA*	2:34:40	1:56:19	5:28:18	9:59:17
Route 123 and Braddock Road, Fairfax, VA	2:27:36	1:52:52	2:49:40	7:10:08
Chain Bridge Road and Glebe Road, Arlington, VA	3:50:43	1:48:40	3:03:42	8:43:05
Glebe Road and 24 th Road, Arlington, VA	2:02:54	2:00:20	2:50:25	6:53:39
Arlington Boulevard and Garfield Street, Arlington, VA**	1:56:35	0:00:00	0:00:00	1:56:35
Minnesota Avenue, Pennsylvania Avenue, and 25 th Street, Washington, DC***	0:00:00	1:54:00	2:02:22	3:56:22
Minnesota Avenue and Pennsylvania Avenue, Washington, DC***	0:00:00	2:36:15	2:34:09	5:10:24
Route 28 southbound and Route 267, Washington Dulles International Airport, VA	2:00:30	1:57:18	2:00:27	5:58:15
Carlin Springs Road and George Mason Drive, Arlington, VA**	1:59:15	0:00:00	0:00:00	1:59:15
Route 50 eastbound (between Rugby Road and Brimwell Place), Chantilly, VA	2:29:29	2:00:15	2:55:53	7:25:37
Route 28 northbound (between Darkwood Drive and Route 29), Centreville, VA**	2:21:07	1:47:33	0:00:00	4:08:40
Total observation time at metropolitan/urban sites				71:30:28
Mid-sized City				
Location Number and Name	Total Amount of Time for each Observation Period			Total of all Periods
	AM	Noon	PM	
Hollins Avenue and Mason Mill Road, Roanoke, VA	1:59:56	1:57:01	3:16:12	7:13:09
Elm Avenue and Ferdinand Street, Roanoke, VA	2:01:21	1:58:57	2:20:53	6:21:11
Elm Avenue and Jefferson Street, Roanoke, VA	2:03:21	2:02:41	2:27:42	6:33:44
Orange Avenue and Williamson Road, Roanoke, VA	2:03:12	1:58:04	2:54:08	6:55:24
Colonial Avenue and 23 rd Street, Roanoke, VA	2:02:11	2:00:16	2:59:47	7:02:14
Route 419 and Route 795, Roanoke, VA	1:51:16	2:00:56	2:59:42	6:51:54

581/220 Bypass Exit and Route 419 northbound, Roanoke, VA	2:03:14	2:03:22	2:58:42	7:05:18
581 Bypass and Hershberger Road, Roanoke, VA	3:56:15	1:27:27	2:58:12	8:21:54
Rutgers Avenue, Roanoke, VA	1:53:02	1:55:37	2:53:11	6:41:50
3500 Block of Orange Avenue, Roanoke, VA	2:00:51	2:01:23	2:34:43	6:36:57
Total observation time at mid-sized city sites				69:43:35

Town/Rural				
Location Number and Name	Total Amount of Time for each Observation Period			Total of all Periods
	AM	Noon	PM	
Main Street, Progress Street, and McDonald Street, Blacksburg, VA	2:53:36	1:59:07	2:37:59	7:30:42
Owens Street and Harding Avenue, Blacksburg, VA	2:03:13	2:00:58	2:27:15	6:31:26
Tom's Creek Road, Route 460, and Givens Lane, Blacksburg, VA	1:47:10	2:03:25	2:58:46	6:49:21
Spring Road/Tech Center Driver and Southgate Drive, Blacksburg, VA	1:54:49	2:02:37	2:43:29	6:40:55
Giles Road and Main Street, Blacksburg, VA	1:52:32	2:28:40	2:40:31	7:01:43
Church Street and Jackson Street, Blacksburg, VA	1:53:19	1:58:22	2:52:37	6:44:18
Pepper's Ferry Road and Route 460 eastbound, Christiansburg, VA	1:59:21	1:58:45	3:08:15	7:06:21
South Main Street and Route 460 eastbound, Blacksburg, VA	1:46:19	1:58:43	2:52:28	6:37:30
Route 21, Wythe County, VA	1:23:56	2:03:14	2:31:09	5:58:19
Glade Road, Montgomery County, VA	1:53:11	1:55:52	2:50:09	6:39:12
Total observation time at town/rural sites				67:39:47

- * Locations in which extra data were collected with one camera because of size of location.
- ** Locations in which less data were collected because of low level of traffic events resulting from light traffic flow.
- *** Two cameras at this location because of its size.

Table 8. Total observation time (in hh:mm:ss) at each primary geometry within each region.

Primary Geometry	Metropolitan	City	Town	Total Observation Time for each Primary Geometry
Intersection	51:58:41	40:57:36	41:18:25	134:14:42
Ramp/Auxiliary Lane	7:57:30	15:27:12	13:43:51	37:08:33
General Roadway	11:34:17	13:18:47	12:37:31	37:30:35

3.5.2 Procedure

Teams of two researchers were deployed to the various observational sites for data collection. Each team was responsible for equipment set-up and data collection at their respective site. Two-person research teams were used for the following reasons:

- ▣ **Researcher and Equipment Safety.** Both researchers were expected to remain at the site during the entirety of the data collection periods to increase researcher and equipment safety. Two-way communications were also established (via cellular telephones). If there was more than one team deployed in the field, communications were established between those teams for safety and to monitor progress at each site. If only one team was collecting data, communications were established with personnel at the Virginia Tech Transportation Institute.
- ▣ **Researcher Fatigue.** When possible, a rotational schedule was used during observational periods to relieve observer fatigue that may result in desensitization to repetitive traffic events. When a rotational schedule was used, each researcher was responsible of observing

traffic events for a period of 20 to 30 minutes. A 20 to 25 minute observation session is recommended practice to allow for the observer a break to take notes and, if needed, change viewing location (Parker and Zeeger, 1989). However, if traffic became such that one researcher was unable to observe and capture the full scene, both researchers would collect data and implementing the rotational schedule was delayed.

- **Events Occurring in Rapid Succession.** At times, traffic flow was heavy enough that events would happen almost simultaneously, thereby overwhelming a single researcher. Under these circumstances, both researchers were required to monitor the site, alternately documenting events. Older and Spicer (1976) support this practice stating that two observers are necessary for complete assessment of the observed site. This procedure helped to insure that there was always at least one person monitoring the traffic during peak periods.

Data collection was conducted in the same manner regardless of the region or location geometry. As stated earlier, teams of two researchers were deployed to a site for data collection. The team was responsible for the proper set-up and take-down of equipment, manning of the equipment during the surveillance periods (e.g., being aware of the surroundings for safety issues and ensuring events were being captured on videotape), and performing all observational tasks (as discussed in the *Observational Techniques* chapter.)

In general, the research team reached the site 30 minutes prior to the start of data collection to set-up the equipment and position themselves in a location where they could observe the traffic scene and would be safe. This meant that sometimes the team remained in the research vehicle and, at other times the research vehicle was parked elsewhere and the researchers observed the traffic scene from an inconspicuous location. The videotape surveillance equipment was designed in such a manner that allowed for situational flexibility.

4 Results

There were two phases to data analysis, the first being exploratory with the purpose of reducing the overall number of predictor variables and the second focusing on the identification of specific predictor variables to diagnose traffic events. A total of 1,038 events were categorized using the aforementioned data extraction procedures. Of the categorized traffic events, 368 were determined to be at or above a severity level 3 and therefore applicable to this investigation. The remaining events were identified as being a severity level 1 or 2 and were not examined in this research effort. There was no missing data for any of the events. For all comparisons $\alpha = 0.05$ was used as the criterion for establishing statistical significance. All statistical analyses were performed with SPSS Version 10.0 for Windows.

In addition, due to the uncontrolled nature of observational data collection, time variances at the observation sites, number of applicable traffic events compared to the number of possible predictor variables, and predictor variables being either categorical or dichotomous, parametric analyses were considered inappropriate. Thus, all variables were converted into binary dummy variables, while retaining event membership, for use in nonparametric and regression analyses. The conversion of the predictor variables into binary dummy variables resulted in 268 possible nominally scale predictor

variables. Of the 268 variables, 162 were found to have occurred in at least one event. That is, there was at least one data point for 162 of the 268 predictor variables—of which, 27% were considered to be site variables, 30% event variables, and 43% driver performance variables.

4.1 Distribution of Traffic Events

As stated above, the data set contained 368 observed traffic events. Based on these findings, the near-miss events to crash events ratio was found to be 73.6:1. The number of events per severity level was as follows:

- Two hundred forty events (65%) were rated as serious error, near-crash events (severity level 3). These events were the least severe and had a hazard present which may have been another vehicle, a pedestrian or bicyclist, or other type of obstacle and a controlled driver behavior was observed that resulted in a slight risk of a near-crash. That is, although the event involved an evasive maneuver on the part of the driver, it appeared as if there was ample time to correct the vehicle trajectory in order to avoid a collision. The observed driver behavior may have been controlled acceleration, deceleration, and/or a lane change that may or may not have been accompanied with a warning action such as sounding of a vehicle's horn.
- Eighty-eight events (24%) were rated as near-crash events (severity level 4). These events were considered to be near-crash situations where there was a hazard present which may have been another vehicle, a pedestrian or bicyclist, or other type of obstacle in the path of the event vehicle along with a rapid, yet controlled driver behavior that resulted in avoiding a crash. Observed driver behavior(s) may have included rapid acceleration, deceleration, lane change, and/or stopping of the event vehicle that may or may not have been accompanied with a warning action such as sounding of a vehicle's horn.
- Thirty-five events (10%) were rated as serious, near-crash events (severity level 5). These events were considered to be serious near-crash incidents where, like a severity 4 event, there was a definite hazard present in the path of the event vehicle. However, unlike a severity 4 event, the observed driver behavior(s) would have looked much less controlled and resulted in a very near-crash situation. Observed driver behavior(s) may have included emergency braking or accelerating and/or a violent swerve.
- Five events (1%) were rated as non-injury crash events (severity level 6). These events were actual collisions with an obstacle such as another vehicle or a roadway element (e.g., curb or signage) that resulted in some degree of property damage, but did not result in any observable bodily injury or fatality.
- No severity 7 or 8 events were reported as observed in this set of events. These events would have been, respectively, crashes that resulted in either bodily injury (with or without property damage) or a fatality, to any person involved in the incident.

4.2 Severity Levels and Conflict Types

When categorized based on maneuver and conflict type, the most severe events (those rated as a 5 or 6) were associated with forward moving or relatively straight path maneuvers. As illustrated in Table 9, all five of the severity 6 non-injury crash events were associated with straight path maneuvers. Of the crash events, three (60%) were same direction maneuvers, one (20%) was a lane change maneuver, and one (20%) was a forward maneuver.

The majority of the severity level 5 serious, near-crash events were evenly distributed between straight path conflicts and turn conflicts [16 (46%) and 14 (40%), respectively]; with the remaining severity 5 events belonging to ramp maneuvers (four (11%) events) and pedestrian/bicyclist maneuvers (one event).

Unlike severity 5 and severity 6 events, 40 (45%) of the severity 4 near-crash events were associated with turn maneuvers. However, 29 (33%) were straight path maneuvers with the remaining being 15 (19%) ramp maneuvers and two (2%) pedestrian/bicyclist maneuvers. Severity 3 serious error, near-crash events were distributed similarly to severity 5 and severity 4 events. Where, 124 (52%) were straight path maneuvers, 83 (35%) were turn maneuvers, 29 (11%) were ramp maneuvers, and four (2%) were pedestrian/bicyclist maneuvers.

Table 9. Number of events for each severity level based on observed maneuver type and conflict type, where maneuver type is an aggregate count of the like conflict types.

	Severity 3	Severity 4	Severity 5	Severity 6
Left Turn Maneuver (Vehicle 1 performed a left turn at an intersection)	56	27	8	0
Conflict 10. Conflict with cross traffic from right	9	5	1	0
Conflict 11. Conflict with cross traffic from left	10	2	2	0
Conflict 12. Conflict with cross traffic from right, turning left	7	5	2	0
Conflict 13. Conflict with cross traffic from left, turning left	2	2	0	0
Conflict 14. Conflict with cross traffic from left, turning right	2	0	0	0
Conflict 15. Conflict with oncoming through traffic	14	8	1	0
Conflict 16. Conflict with oncoming traffic turning right	1	2	0	0
Conflict 17. Conflict with oncoming traffic turning left	1	1	1	0
Conflict 18. Conflict with adjacent turn traffic	4	1	0	0
Conflict 19. U-turn, conflict with cross traffic	2	1	0	0
Conflict 100. U-turn, conflict with oncoming traffic	2	0	0	0
Conflict 101. Conflict with pedestrian or bicycle	2	0	0	0
Conflict 102. Conflict with stationary object	0	0	1	0
Right Turn Maneuver (Vehicle 1 performed a right turn at an intersection)	27	13	6	0
Conflict 20. Conflict with cross traffic from right	2	2	1	0
Conflict 21. Conflict with cross traffic from left	12	3	1	0
Conflict 23. Conflict with oncoming traffic turning left	1	2	1	0
Conflict 24. Conflict with adjacent through traffic	6	1	1	0
Conflict 25. Conflict with adjacent turn traffic	0	1	1	0
Conflict 26. Right-on-red, conflict with cross traffic from left	2	3	1	0
Conflict 27. Right-on-red, conflict with oncoming traffic turning left	4	0	0	0
Conflict 28. Conflict with pedestrian or bicyclist	0	1	0	0
Lane Change Maneuver (Vehicle 1 moving from one lane to a same-direction adjacent lane)	22	10	8	1
Conflict 30. To right, conflict with through traffic in right lane	9	3	3	0
Conflict 31. To right, conflict with cross traffic turning right-on-red	0	1	0	0
Conflict 33. To left, conflict with through traffic in left lane	10	4	4	1
Conflict 34. To left, conflict with traffic in both lanes	1	1	0	0
Conflict 35. To left, conflict with cross traffic	1	1	0	0

		Severity 3	Severity 4	Severity 5	Severity 6
Conflict 38.	Conflict with vehicles traveling in outer lanes trying to move into the same opening in an inner lane (e.g., Vehicle 1 traveling in lane 1 and Vehicle 2 traveling in lane 3 simultaneously make a lane change into lane 2 which leads to a conflict)	1	0	1	0
Same Direction Maneuver (Vehicle 1 slows and/or changes direction)		69	16	7	3
Conflict 40.	Conflict with slowed or stopped lead vehicle	58	10	6	1
Conflict 41.	Conflict with lead vehicle having slowed or stopped to turn	10	5	1	0
Conflict 42.	Conflict with adjacent parked vehicles	0	1	0	0
Conflict 43.	Backing, conflict with following vehicle	1	0	0	1
Conflict 44.	Backing, conflict with object other than a vehicle	0	0	0	1
Forward Maneuver (Vehicle 1 moving either straight through an intersection or on a roadway)		33	3	1	1
Conflict 50.	Conflict with oncoming traffic turning right	0	1	0	0
Conflict 51.	Conflict with oncoming traffic turning left	16	0	0	0
Conflict 52.	Conflict with cross traffic from right	7	0	0	0
Conflict 53.	Conflict with cross traffic from left	6	0	0	0
Conflict 54.	Conflict with pedestrian crossing from right	0	0	1	0
Conflict 56.	Conflict with stationary object	1	0	0	1
Conflict 57.	Wrong way on one-way, conflict with oncoming through traffic	3	2	0	0
Enter Ramp Maneuver (Vehicle 1 moving from street to ramp auxiliary lane or directly to ramp proper)		5	4	1	0
Conflict 60.	Conflict with traffic exiting ramp	1	0	0	0
Conflict 61.	Conflict with lead vehicle having slowed or stopped	1	2	0	0
Conflict 62.	Conflict with through traffic	3	2	1	0
Ramp Proper Maneuver (Vehicle 1 slows, stops, or makes a lane change on the ramp)		0	1	0	0
Conflict 71.	Lane change to left on the ramp, conflict with traffic in left ramp lane	0	1	0	0
Exit Ramp Maneuver (Vehicle 1 moving from the ramp proper or a ramp auxiliary lane to roadway)		24	12	3	0
Conflict 80.	Same direction, conflict with lead vehicle having stopped	9	4	1	0
Conflict 83.	Conflict with through traffic	15	8	2	0
Pedestrian/Bicycle Maneuver (a pedestrian or bicyclist enters the path of a vehicle, where the vehicle had the right-of-way)		4	2	1	0
Conflict 90.	Conflict with traffic on far-side of intersection	1	0	0	0
Conflict 91.	Conflict with traffic on near-side of intersection	2	2	1	0
Conflict 93.	Conflict with opposing through traffic	1	0	0	0

Based on results of a Contingency Correlation Analysis, there were 11 significant correlations found between severity levels, maneuver types, and conflict types (Table 10). Two general maneuver types and nine conflict types were found to be significantly correlated with at least one of the four severity levels. Of these correlated maneuver and conflict types, both of the maneuver types (100%) and seven of the conflict types (78%) were non-turning conflicts. However, none of the maneuver or conflict types are significantly correlated with every severity level.

Table 10. Maneuver and conflict types that are significantly correlated to a severity level.*

	Severity 3	Severity 4	Severity 5	Severity 6
Lane Change Maneuver. Vehicle 1 moving from one lane to a same-direction adjacent lane	0.086 0.099	0.004 0.939	0.120 0.021	0.033 0.526
Forward Maneuver. Vehicle 1 moving either straight through an intersection or on a roadway	0.152 0.003	0.126 0.015	0.079 0.127	0.037 0.474
Conflict 102. Left turn, conflict with stationary object	0.071 0.170	0.029 0.575	0.159 0.002	0.006 0.906
Conflict 25. Right turn, conflict with adjacent turn traffic	0.101 0.052	0.045 0.386	0.101 0.050	0.009 0.868
Conflict 38. Lane change, conflict with vehicles traveling in outer lanes trying to move into the same opening in an inner lane	0.024 0.650	0.041 0.427	0.101 0.050	0.009 0.868
Conflict 40. Same direction, conflict with slowed or stopped lead vehicle	0.128 0.014	0.125 0.016	0.026 0.617	0.001 0.983
Conflict 43. Same direction, backing, conflict with following vehicle	0.024 0.650	0.041 0.427	0.024 0.646	0.297 0.000
Conflict 44. Same direction, backing, conflict with object other than a vehicle	0.071 0.170	0.029 0.575	0.017 0.745	0.406 0.000
Conflict 51. Forward, conflict with oncoming traffic turning left	0.154 0.003	0.119 0.022	0.069 0.185	0.025 0.631
Conflict 54. Forward, conflict with pedestrian crossing from right	0.071 0.170	0.029 0.575	0.159 0.002	0.006 0.906
Conflict 56. Forward, conflict with stationary object	0.024 0.650	0.041 0.427	0.024 0.646	0.297 0.000

*Significant correlations are highlighted with black text. The remaining correlations are included in Appendix F.

4.3 Observable Characteristics

To determine which predictor variables were of most value as observable characteristics that contribute to crashes and near-crashes, exploratory analyses were performed with regards to association and goodness-of-fit to scope the variable set for subsequent regression analysis. The exploratory analyses conducted were a χ^2 goodness-of-fit test and a contingency coefficient correlation. Once the final predictor variable set was determined using these exploratory methods, binary logistic regressions were conducted to evaluate the predictive nature of the variables with respect to each of the severity levels, maneuver types, and conflict types.

Binary logistic regression analyses were performed to further scope predictor variables to diagnose traffic events based on the criterion variables of severity level, maneuver type, and conflict types. That is, this analysis procedure was used to determine which predictor variables were most likely to have contributed to a traffic event. These variables were then assumed to be of most value to diagnose traffic events and serve as proxy variables. There were two phases in the regression analysis:

- **Phase 1.** All predictor variables found to be significantly correlated to a specified criterion variable were included in the first binary logistic regression analysis. This first analysis was performed using a block enter method to determine statistical significance of the regression model. If the model was not found to be significant, variable selection via subsequent binary logistic regression was terminated. If the model was found to be significant, Phase 2 was performed.
- **Phase 2.** Further analysis to refine the regression equation consisted of conducting a forward stepwise logistic regression based on the likelihood-ratio statistic for each variable. Forward stepwise variable criteria for entry and removal from the regression equation were significance levels of 0.05 and 0.10, respectively. In addition, cases found to exceed two standard deviations were considered to be outliers and removed from the data set for the given criterion variable

being examined. If needed, a series of forward stepwise analyses were performed on a criterion variable until there were no case outliers.

In addition to the binary regression analysis, the discriminability index (d') was calculated based on the number of observed and predicted events for the respective analysis. This was done to estimate the sensitivity of each regression equation. Analyses that resulted in a d' less than 1 were considered suspect with respect to accuracy of event representation.

4.3.1 Correlated Predictor Variables

A χ^2 goodness-of-fit test was conducted to determine if there were any differences in the expected number of occurrences for each of the variable attributes. All but three variables were found to have a statistically significant χ^2 value. The three variables which were not found to be statistically significant were (1) no median being present at the site [χ^2 (1, N= 368) = 2.446, p = .118], (2) the event having taken place within an intersection [χ^2 (1, N= 368) = 0.011, p = .917], and (3) a Level of Service C at the time of the event [χ^2 (1, N= 368) = 2.130, p = .144]. These three variables were therefore considered to have occurred as expected and were removed from the data set for the regression analysis. (χ^2 values for the remaining variables can be found in Appendix E.)

In addition, the contingency correlation analysis resulted in the general removal of three more predictor variables, all of which were considered to be driver performance-related in nature:

1. the driver entered an intersection on a red light,
2. the driver failed to yield the right-of-way to a pedestrian, and
3. the driver appeared to have difficulty navigating the roadway due to the vertical alignment.

These were variables that were not found to be significantly correlated with any one of the four severity levels, seven maneuver types, or 48 conflict types. This resulted in a total of 156 significantly correlated variables. However, only 33 variables were found to be correlated with both a severity level and at least one maneuver level (Table 11). (All severity level, maneuver type, and conflict type correlations can be found in Appendix F.)

Table 11. Variables found to be correlated with at least one severity level and at least one maneuver type.

<p>Site-related variables</p> <ul style="list-style-type: none"> ➤ Road function—Group B ➤ Road function—Group D ➤ Primary control—Yield sign ➤ Obstruction—Advertisement signs <p>Traffic-related variables</p> <ul style="list-style-type: none"> ➤ Hour event occurred ➤ Relation—Roadway ➤ Weather—Sunny ➤ Weather—Partly cloudy ➤ Debris on roadway—Clear/None ➤ Debris on roadway—Sand ➤ Event obstacle—Pedestrian ➤ Limitations to sight distance—Vegetation ➤ Size of event vehicle <p>Driver performance-related variables</p> <ul style="list-style-type: none"> ➤ Pulled into traffic or proceeded without clearance 	<ul style="list-style-type: none"> ➤ Failure to respond to an active emergency vehicle ➤ Inadequate reaction speed ➤ Lateral vehicle control—Lane change ➤ Vehicle turn control—Over compensate ➤ Backing-up ➤ Defensive maneuver ➤ Avoiding—Obstruction in roadway ➤ Avoiding—Another vehicle ➤ Failure to yield right-of-way—General ➤ Observed difficulties navigating—Alignment/Curve ➤ Creeping into intersection ➤ Lateral vehicle control—No deviation ➤ Lateral vehicle control—Lane break to right ➤ Longitudinal vehicle control—Anticipatory braking ➤ Longitudinal vehicle control—Unanticipated controlled braking ➤ Longitudinal vehicle control—Uncontrolled braking ➤ Longitudinal vehicle control—Normal driving ➤ Longitudinal vehicle control—Unknown
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Note: Maneuver types were used instead of conflict types to identify dually correlated variables due to maneuver type being an aggregate of like conflict types and the high correlation between a given maneuver type and the related conflict types.

4.3.2 Characteristics of Event Severity Levels

None of the variables were found to be significantly correlated with every severity level. However, two variables were included in the final regression results for two of the four severity levels. Uncontrolled braking was found to be valuable in near-crash events and serious error, hazard present events; and an improper signal usage (a signal not being used when there was need for turn indication) was found to be applicable to non-injury crash events and serious near-crash events. Results of each severity level logistic regression analysis are provided in the following sections.

4.3.2.1 Non-injury Crash (Severity Level 6)

Results of the initial block enter logistic regression for severity level 6 found the Model χ^2 (χ^2 (14) = 52.918, $p = 0.000$) to be significant. This would suggest that the significantly correlated predictor variables are valuable in observing a severity 6 event. However, the Hosmer and Lemeshow goodness-of-fit test did not calculate. This result is assumed to be due to too few events of this severity type.

With that said, the reader is cautioned in giving too much credence to the severity level 6 results because they are based on only six events. Two iterations of the forward stepwise were performed where two events and 10 predictor variables were removed. Table 12 illustrates the contribution of each of the predictor variables on Severity Level 6. The d' for severity level 6 events was 0.252 and considered to be low. The percent correct (1%) for variables predicting severity 5 events was low and there were very few false alarms (0.5%).

Table 12. Non-injury crash (severity level 6) binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-35.064	236.487	0.022	1	0.882	0.000
Size of event vehicle	22.716	214.661	0.011	1	0.916	7.34E+09
Lateral vehicle control—Ran off road	35.064	236.489	0.022	1	0.882	1.69E+15
Backing	22.870	194.828	0.014	1	0.907	8.56E+09
Longitudinal vehicle control—Uncontrolled braking	22.874	221.527	0.011	1	0.918	8.59E+09

4.3.2.2 Serious, Near-Crash (Severity Level 5)

The Model χ^2 (χ^2 (8) = 97.893, $p = 0.000$) was found to be significant, suggesting the selected predictor variables are valuable in observing a severity 5 event. This result is corroborated by the Hosmer and Lemeshow goodness of fit test which was not found to be significant (χ^2 (3) = 0.000, $p = 1.000$), suggesting a well fit regression equation. In addition, according to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for only 82% of the variation. Four iterations of the forward stepwise were performed where 21 events and nine predictor variables were removed. Table 13 illustrates the contribution of each of the remaining eight predictor variables on Severity Level 5. The d' for severity level 5 events was 0.670 and considered to be moderate even though the percent correct (3%) for variables predicting severity 5 events was low, but there were very few false alarms (0.6%).

Table 13. Serious, near-crash (severity level 5) binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	3.614	2002.373	0.00	1	0.999	37.128
Relation—Roadway	22.798	111.878	0.042	1	0.839	7.96E+09
Debris on roadway—Clear/None	-38.694	2004.215	0.000	1	0.985	0.000
Event obstacle—Pedestrian	50.282	2008.055	0.001	1	0.980	6.88E+21
Limitations to sight distance—Vegetation	24.184	111.887	0.047	1	0.829	3.18E+10
Pulled into traffic or proceeded without clearance	11.589	71.666	0.026	1	0.872	107851.49
Failure to respond to an active emergency vehicle	35.079	167.108	0.044	1	0.834	1.72E+15
Lateral vehicle control—Lane break to right	11.589	71.673	0.026	1	0.872	107851.48
Longitudinal vehicle control—Uncontrolled braking	34.386	167.103	0.042	1	0.837	8.58E+14

4.3.2.3 Near-crash (Severity Level 4)

Five iterations of the forward stepwise were performed on the severity 4 predictor variables. The final iteration resulted in the Model χ^2 (χ^2 (5) = 145.019, p = 0.000) being found significant, suggesting the selected predictor variables are valuable in observing a severity 4 event; and resulted in the Hosmer and Lemeshow goodness-of-fit test to be found not significant (χ^2 (4) = 0.002, p = 1.000), suggesting a well fit regression equation. The model summary Nagelkerke R^2 indicates that the predictor variables accounted for 64.3% of the variation. However, as noted above, 47 events were removed in the process of iterating through the forward stepwise tests. Table 14 illustrates the contribution of each of the predictor variables on Severity Level 4. The d' for severity level 4 was 0.717 and considered to be moderate even though the percent correct (4%) for variables predicting severity 4 events was low, but there were very few false alarms (0.6%).

Table 14. Near-crash (severity level 4) binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-11.161	21.959	0.258	1	0.611	0.000
Obstruction—Advertisements	11.903	21.982	0.293	1	0.588	147758.18
Lateral vehicle control—No deviation	-10.869	21.960	0.245	1	0.621	0.000
Longitudinal vehicle control—Unanticipated controlled braking	10.533	21.960	0.230	1	0.631	37525.890
Longitudinal vehicle control—Unknown	21.338	43.929	0.236	1	0.627	1.85E+09
Signal usage—Signal not used	11.161	21.961	0.258	1	0.611	70361.042

4.3.2.4 Serious Error, Hazard Present Events (Severity Level 3)

The Model χ^2 (χ^2 (7) = 95.402, p = 0.000) was found to be significant, suggesting the selected predictor variables are valuable in observing a severity 3 event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (6) = 3.187, p = 0.785), suggesting a well fit regression equation. However, according to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for only 32.6% of the variation. Four iterations of the forward stepwise test were performed and 11 events removed as outliers. Table 15 illustrates the contribution of each of the predictor variables on Severity Level 3. The d' for severity level 3 events was 1.090 and considered to be moderate with a relatively high number of percent correct (62%) compared to false alarms (22%).

Table 15. Serious error, hazard present (severity level 3) binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	0.520	0.217	5.746	1	0.017	1.681
Road function—Group D	0.959	0.408	5.531	1	0.019	2.609
Event obstacle—Other vehicle(s)	-0.870	0.344	6.391	1	0.011	0.419
Force another vehicle out of lane	-9.479	39.579	0.057	1	0.811	0.000
Lateral vehicle control—No deviation	0.560	0.259	4.676	1	0.031	1.750
Longitudinal vehicle control—Anticipatory braking	8.515	14.416	0.349	1	0.555	4986.568
Longitudinal vehicle control—Uncontrolled braking	-9.497	33.804	0.079	1	0.779	0.000
Signal Usage—Signal Not Used	-0.902	0.300	9.043	1	0.003	0.406

4.3.3 Characteristics of Turn Maneuvers

Turn maneuver analyses include logistic regression results for left turn maneuver, right turn maneuver, and the two turn conflicts that were found to be significantly correlated with at least one of the four severity levels. All of the variables in the final regression results for each of the turn maneuvers and conflicts were found to be unique. That is, there was no overlap or duplication of findings for turns. Regardless, observable variables that appear to have the most influence on events based on turn maneuvers were related to violations such as illegal turns or not stopping. Vehicle control (i.e., lateral, longitudinal, and turning) also appeared to be influential in turn events. Results of each turn logistic regression analysis are provided in the following sections.

4.3.3.1 Left Turn

The Model χ^2 (χ^2 (9) = 241.677, p = 0.000) was found to be significant, suggesting the selected predictor variables are valuable in observing a left turn maneuver event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (7) = 0.001, p = 1.000), suggesting a well fit regression equation. In addition, according to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for only 77.6% of the variation. Five iterations of the forward stepwise were performed where 23 events and 43 predictor variables were removed. Table 16 illustrates the contribution of each of the remaining nine predictor variables for a left turn maneuver event. The d' for left turn maneuvers was 1.060 and considered to be moderate even though the percent correct (11%) for factors predicting a left turn maneuver was low and there were very few false alarms (1%).

Table 16. Left turn maneuver binary logistic regression results

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-50.059	134.059	0.139	1	0.709	0.000
Geometry—All intersections	38.022	107.031	0.126	1	0.722	3.25E+16
Relation—Pre-intersection	-34.832	183.296	0.036	1	0.849	0.000
Lanes—1	11.904	41.197	0.083	1	0.773	147914.14
Level of Service B	-21.859	66.149	0.109	1	0.741	0.000
Following closely	-26.711	98.398	0.074	1	0.786	0.000
Observed difficulties navigating—Intersection angle	12.038	41.216	0.085	1	0.770	169040.15
Violations turning—Illegal left turn	12.731	41.203	0.095	1	0.757	338100.40
Lateral vehicle control—Deviation in lane to left	29.844	86.278	0.120	1	0.729	9.15E+12
Signal usage—Correct signal on in advance	12.038	41.203	0.085	1	0.770	169046.30

4.3.3.1.1 Left Turn Conflict

As illustrated in the *Contingency Coefficient Correlation Analysis* section, only one left turn conflict was found to be significantly correlated with severity level 5: Left turn, conflict with stationary object.

The results of the forward stepwise test were surprising in that only one predictor variable was found to contribute to this event type (Table 17). However, the Model χ^2 ($\chi^2(1) = 8.809, p = 0.003$) was found to be significant and the Nagelkerke R^2 indicates that 64.2 % of the variation is accounted for by the equation. However, the Hosmer and Lemeshow goodness-of-fit test did not calculate. This result is assumed to be due to too few events of this conflict type and the reader is cautioned from placing too much emphasis on this single variable as a lone predictor.

Table 17. Left turn conflict, conflict with stationary object binary logistic regression results.

Variable	B	Std. Error	Wald	Df	Sign.	Exp(B)
Constant	-15.203	105.030	0.021	1	0.885	0.000
Lateral vehicle control—Ran off road	13.817	105.036	0.017	1	0.895	1001090.1

4.3.3.2 Right Turn

The Model χ^2 ($\chi^2(9) = 135.264, p = 0.000$) was found to be significant, suggesting the selected predictor variables are valuable in observing a right turn maneuver event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant ($\chi^2(5) = 0.985, p = 0.964$), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 72.4% of the variation. Four iterations of the forward stepwise were performed where 18 events and 24 predictor variables were removed. Table 18 illustrates the contribution of each of the remaining selected predictor variables on a right turn maneuver event. The d' for right turn maneuvers was 2.676 and considered to be high even though the percent correct (4%) for factors predicting this maneuver type was low.

Table 18. Right turn maneuver binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-33.610	120.113	0.078	1	0.780	0.000
Geometry—4-legged intersection	15.577	60.061	0.067	1	0.795	5823963.8
Road edge—Paved partial shoulder	16.539	60.063	0.076	1	0.783	15235716
Limitation to sight distance—Pedestrian or bicyclist	47.813	1219.652	0.002	1	0.969	5.82E+02
Vehicle turn control—Turned into incorrect lane	16.413	60.062	0.075	1	0.785	13430973
Violation stopping—Rolling stop	16.814	60.062	0.078	1	0.780	20054810
Failure to yield right-of-way—Right turn on red light	16.608	60.062	0.076	1	0.782	16319231
Violations turning—Illegal right turn	25.400	94.988	0.072	1	0.789	1.07E+11
Lateral vehicle control—Unknown	18.032	60.074	0.090	1	0.764	67818584
Longitudinal vehicle control—Accelerating	16.415	60.054	0.075	1	0.785	13462605

4.3.3.2.1 Right Turn Conflict

As illustrated in the *Contingency Coefficient Correlation Analysis* section, only one right turn conflict was found to be significantly correlated with severity level 5: Right turn, conflict with adjacent turn traffic. Results of the initial block enter logistic regression, the Model χ^2 ($\chi^2(15) = 24.849, p = 0.052$) was not found to be significant, suggesting the predictor variables are not unique and may have been observed due to chance alone. This result is assumed to be due to too few events of this conflict type.

4.3.4 Characteristics of Straight Path Maneuvers

Straight path maneuver analyses include logistic regression results for lane change maneuver, same direction maneuver, forward maneuver, and the six straight path conflicts that were found to be significantly correlated with at least one of the four severity levels. There was overlap of four variables

that were found to be valuable for straight path maneuvers. They were one event variable (Relation—Pre-intersection) and three driver performance variables (Pulled into traffic or proceeded without clearance, Following closely, and Longitudinal vehicle control—Normal driving). The remaining variables in the final regression results were found to be unique amongst the straight path maneuvers and conflicts. Results of each turn logistic regression analysis are provided in the following sections.

4.3.4.1 Lane Change

The Model χ^2 (χ^2 (5) = 159.597, p = 0.000) was found to be significant, suggesting the selected predictor variables are valuable in observing a lane change maneuver event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (6) = 0.000, p = 1.000), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 84% of the variation. Six iterations of the forward stepwise was performed where 16 events and 27 predictor variables were removed. Table 19 illustrates the contribution of each of the predictor variables on a lane change maneuver event. The d' for lane change maneuvers was 0.696 and considered to be moderate even though the percent correct (6%) for variables predicting this maneuver type was low.

Table 19. Lane change maneuver binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-32.368	121.647	0.071	1	0.790	0.000
Barrier—None	-21.677	84.483	0.069	1	0.793	0.000
Lanes—2	21.321	84.482	0.067	1	0.796	1.82E+09
Lateral vehicle control—Lane change	32.591	121.649	0.072	1	0.789	1.43E+14
Vehicle turn control—Turned into incorrect lane	-34.430	269.406	0.016	1	0.898	0.000
Longitudinal vehicle control—Normal driving	20.761	82.478	0.063	1	0.801	1.04E+09

4.3.4.1.1 Lane Change Conflict

As illustrated in the *Contingency Coefficient Correlation Analysis* section, only one lane change conflict was found to be significantly correlated with any one of the four severity levels: Lane change, conflict with vehicles traveling in outer lanes trying to move into the same opening in an inner lane. One forward stepwise logical regression was performed where no events and one predictor variable were removed. The Model χ^2 (χ^2 (4) = 22.076, p = 0.000) was found to be significant, suggesting the remaining four predictor variables are valuable in observing this lane change conflict. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (1) = 0.000, p = 1.000), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 89.2% of the variation. Table 20 illustrates the contribution of each of the predictor variables for this lane change conflict event type. The d' for lane change, conflict with vehicles traveling in outer lanes trying to move into the same opening in an inner lane was 1.702 and considered to be high even though the percent correct (0.3%) for variables predicting this conflict type was very low.

Table 20. Lane change, conflict with vehicles traveling in outer lanes trying to move into the same opening in an inner lane binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-38.232	377.986	0.010	1	0.919	0.000
Lanes-3	14.070	181.901	0.006	1	0.938	1290367.3
Missing regulatory sign(s)	12.818	276.956	0.002	1	0.963	368914.61
Gesturing—Sounding horn	12.787	276.956	0.002	1	0.963	357482.72
Longitudinal vehicle control—Normal driving	24.162	276.953	0.008	1	0.930	3.11E+10

4.3.4.2 Same Direction

Five iterations of the forward stepwise was performed where 19 events and 30 predictor variables were removed. The Model χ^2 (χ^2 (7) = 279.763, p = 0.000) was found to be significant, suggesting the selected predictor variables are valuable in observing a same direction maneuver event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (7) = 0.184, p = 1.000), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 83.1% of the variation. Table 21 illustrates the contribution of each of the predictor variables on a same direction maneuver event. The d' for same direction maneuvers was 0.934 and considered to be moderate even though the percent correct (20%) for variables predicting this maneuver type was low.

Table 21. Same direction maneuvers binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	0.246	0.404	0.370	1	0.543	1.279
Relation—Pre-intersection	20.835	42.666	0.238	1	0.625	1.12E+09
Relation—Within intersection	-1.477	0.515	8.207	1	0.004	0.228
Relation—Entering ramp	-19.689	42.626	0.213	1	0.644	0.000
Pulled into traffic or Proceeded without clearance	-18.951	42.600	0.198	1	0.656	0.000
Following closely	19.443	42.601	0.208	1	0.648	2.78+08
Signal usage—Correct signal on in advance	-19.982	42.639	0.220	1	0.639	0.000
Signal usage—Signal not used	-10.317	28.918	0.127	1	0.721	0.000

4.3.4.2.1 Same Direction Conflicts

Three same direction conflicts were found to be significantly correlated with at least one of the four severity levels (correlations can be found in the *Contingency Coefficient Correlation Analysis* section). These conflicts were:

1. Same direction, conflict with slowed or stopped lead vehicle (correlated with levels severity 3 and severity 4);
2. Same direction, backing—conflict with following vehicle (correlated with severity level 6);
3. Same direction, backing—conflict with object other than a vehicle (correlated with severity level 6).

Results for each of these same direction conflicts are presented in the following sub-sections.

4.3.4.2.2 Same Direction, Conflict with Slowed or Stopped Lead Vehicle

Seven iterations of the forward stepwise logical regression procedure were performed where 23 events and 32 predictor variable were removed. The Model χ^2 (χ^2 (12) = 276.759, p = 0.000) was found to be significant, suggesting the remaining 12 predictor variables are valuable in observing this same direction conflict. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test

which was not found to be significant ($\chi^2(1) = 0.000, p = 1.000$), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 92.6% of the variation. Table 22 illustrates the contribution of each of the predictor variables for this same direction conflict event type. The d' for same direction, conflict with slowed or stopped lead vehicle was 1.138 and considered to be moderate even though the percent correct (15%) for the variables predicting this conflict type was low.

Table 22. Same direction conflict binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-61.225	263.476	0.054	1	0.816	0.000
Geometry—Roadway segment	41.221	178.126	0.054	1	0.817	7.98E+17
Road function—Group B	40.998	178.122	0.053	1	0.818	6.38E+17
Relation—Pre-intersection	61.631	263.477	0.055	1	0.815	5.83E+26
Relation—Post-intersection	30.876	138.003	0.050	1	0.823	2.35E+13
Lanes—4	77.428	3309.744	0.001	1	0.981	4.23E+33
Pulled into traffic or proceeded without clearance	-30.563	138.004	0.049	1	0.825	0.000
Failure to respond to primary control	-51.142	245.694	0.043	1	0.835	0.000
No room to respond to active emergency vehicle	80.306	3324.955	0.001	1	0.981	7.52E+34
Following Closely	41.221	178.121	0.054	1	0.817	7.98E+17
Lateral vehicle control—Lane break to right	-22.882	347.907	0.004	1	0.948	0.000
Longitudinal vehicle control—Normal driving	-31.268	166.618	0.035	1	0.851	0.000
Signal usage—Signal not required	20.004	101.456	0.039	1	0.844	4.87E+08

4.3.4.2.3 *Same Direction, Backing—Conflict with Following Vehicle*

One forward stepwise logical regression was performed where no events and seven predictor variables were removed. The Model χ^2 ($\chi^2(2) = 24.849, p = 0.000$) was found to be significant. However, only one predictor variable was kept for inclusion in the final equation based on the forward stepwise regression procedure (Table 23). The d' for same direction, backing—conflict with following vehicle conflict was 1.702 and considered to be moderate even though the percent correct (0.3%) for the variables predicting this conflict type was very low.

Table 23. Same direction, backing—conflict with following vehicle binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-14.203	64.418	0.049	1	0.825	0.000
Backing	12.498	64.422	0.038	1	0.846	267840.14

4.3.4.2.4 *Same Direction, Backing—Conflict with Object other than a Vehicle*

The Model χ^2 ($\chi^2(13) = 13.813, p = 0.387$) was not found to be significant based on results of the initial block enter logistic regression for a same direction conflict where the driver had a conflict with another vehicle when backing up. This result suggests that the predictor variables are not unique and may have been observed due to chance alone. The result is assumed to be due to too few events of this conflict type.

4.3.4.3 *Forward*

The Model χ^2 ($\chi^2(9) = 160.153, p = 0.000$) was found to be significant, suggesting the selected predictor variables are valuable in observing a forward maneuver event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant ($\chi^2(6) = 1.314, p = 0.971$), suggesting a well fit regression equation. According to the model summary, the

Nagelkerke R² indicates that the predictor variables account for 78.3% of the variation. Four iterations of the forward stepwise was performed where six events and 37 predictor variables were removed. Table 24 illustrates the contribution of each of the predictor variables on a forward maneuver event. The d' for forward maneuvers was 2.854 and considered to be high even though the percent correct (5%) for the variables was low.

Table 24. Forward maneuver binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-37.039	110.936	0.111	1	0.738	0.000
Geometry—Offset 4-legged intersection	10.674	42.274	0.064	1	0.801	43231.788
Primary control—Stop sign	18.322	55.467	0.109	1	0.741	90602989
Event obstacle—Pedestrian	51.242	1218.782	0.002	1	0.966	1.79E+22
Missing warning sign(s)	18.073	55.487	0.106	1	0.745	70629116
Missing direction or guide sign(s)	18.172	55.474	0.107	1	0.743	77956413
Entered intersection on red light	28.174	101.550	0.077	1	0.781	1.72E+12
Failure to yield right-of-way—General	17.692	55.475	0.102	1	0.750	48274830
Longitudinal vehicle control—Anticipatory braking	18.052	55.470	0.106	1	0.745	69194899
Signal Usage—Unknown	-27.572	126.793	0.047	1	0.828	0.000

4.3.4.3.1 *Forward Conflicts*

As with Same Direction Conflicts, three forward conflicts were found to be significantly correlated with at least one of the four severity levels (correlations are provided in the *Contingency Coefficient Correlation Analysis* section). These conflicts were:

4. Forward, conflict with oncoming traffic turning left (correlated with levels severity 3 and severity 4);
5. Forward, conflict with pedestrian crossing from right (correlated with severity level 5);
6. Forward, conflict with stationary object (correlated with severity level 6).

Results for each of these same direction conflicts are presented in the following sub-sections.

4.3.4.3.2 *Conflict with Oncoming Traffic Turning Left*

Three forward stepwise logical regressions were performed where seven events and 26 predictor variables were removed. The Model χ^2 (χ^2 (5) = 79.112, p = 0.000) was found to be significant, suggesting the remaining five predictor variables are valuable in observing a forward conflict where there may be oncoming traffic turning left. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (3) = 0.000, p = 1.000), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R² indicates that the predictor variables account for 87.9% of the variation. Table 25 illustrates the contribution of each of the predictor variables for this forward conflict event type. The d' for forward, conflict with oncoming traffic turning left was 2.345 and considered to be high even though the percent correct (2%) for the variables predicting this conflict type was low.

Table 25. Forward, conflict with oncoming traffic turning left binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-54.335	302.017	0.032	1	0.857	0.000
Road function—Group D	20.023	150.349	0.018	1	0.894	4.96E+08
Primary control—Stop sign	20.910	159.561	0.017	1	0.896	1.21E+09
Road edge—Soft full shoulder	13.115	156.465	0.007	1	0.933	496109.73

Enter intersection on red light	54.335	302.021	0.032	1	0.857	3.96E+23
Longitudinal vehicle control–Anticipatory braking	23.235	183.880	0.016	1	0.899	1.23E+10

4.3.4.3.3 Conflict with Pedestrian Crossing from Right

Although the Model χ^2 ($\chi^2 (5) = 13.813, p = 0.017$) results were found to be significant, the variables that were significantly correlated with Forward, conflict with Pedestrian Crossing from Right could not be evaluated further to determine which may be of most value in observing this conflict type using a forward stepwise regression procedure. This result is assumed to be due to too few events of this conflict type.

4.3.4.3.4 Conflict with Stationary Object

The Model χ^2 ($\chi^2 (15) = 24.849, p = 0.052$) results of the initial block enter logistic regression were not found to be significant for a forward conflict with a stationary object. This suggests that the predictor variables are not unique and may have been observed due to chance alone. The result is assumed to be due to too few events of this conflict type.

4.3.5 Characteristics of Ramp Maneuvers

Ramp maneuver analyses include logistic regression results for entering a ramp, ramp proper maneuver, and exiting a ramp. None of the ramp conflicts were found to be significantly correlated with at least one of the four severity levels, therefore no individual ramp-related conflict analyses were performed. The only overlapping variable between the three ramp maneuver types was *Observed difficulties–Navigating ramp*. The remaining variables in the final regression results found to be unique to each maneuver type and tended to be specific to the type of ramp maneuver. That is, variables for entering a ramp tended to illustrate problems specific to entering a ramp such as issues with exiting traffic, lane breaks to the right (all ramp geometries were right-hand exit/enter configuration), and signaling. Whereas, exiting ramp variables focused on problems with entering ramp traffic and roadway design. However, in general, observable variables that appear to have the most influence on ramp events were related to navigational difficulties due to geometry and/or other traffic. Results of each ramp maneuver logistic regression analysis are provided in the following sections.

4.3.5.1 Enter Ramp

The Model χ^2 ($\chi^2 (4) = 69.312, p = 0.000$) was found to be significant, suggesting the selected predictor variables are valuable in observing a driver entering a ramp. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant ($\chi^2 (3) = 0.000, p = 1.000$), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 91% of the variation. Two iterations of the forward stepwise was performed where three events and 21 predictor variables were removed. Table 26 illustrates the contribution of each of the predictor variables on a ramp entering maneuver. The d' for enter ramp maneuvers was 2.345 and considered to be high even though the percent correct (2%) for the variables predicting this maneuver type was low.

Table 26. Enter ramp maneuver binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-45.698	273.482	0.028	1	0.867	0.000

Relation—Exiting ramp	34.080	216.827	0.025	1	0.875	6.32E+14
Observed difficulties—Navigating ramp	10.925	96.230	0.013	1	0.910	55556.967
Lateral vehicle control—Lane break to right	11.876	134.059	0.008	1	0.929	143772.68
Signal usage—Correct signal on in advance	22.204	170.424	0.017	1	0.896	4.40E+09

4.3.5.2 Ramp Proper

The Model χ^2 (χ^2 (15) = 24.849, $p = 0.052$) was not found to be significant based on the results of the initial block enter logistic regression. This suggests that the predictor variables are not unique and may have been observed due to chance alone. Considering there was only one observed event of this maneuver type, this result is assumed to be due to too few events.

4.3.5.3 Exit Ramp

Events categorized as having occurred while exiting a ramp resulted in there being 56 significantly correlated predictor variables. Three iterations of the forward stepwise logistic regression were performed, where 52 of the predictor variables were removed along with 10 outlier events. This resulted in the Model χ^2 (χ^2 (4) = 187.131, $p = 0.000$) as being found significant, and the Hosmer and Lemeshow goodness-of-fit test as not significant (χ^2 (1) = 0.000, $p = 0.987$), suggesting a well fit regression equation. In addition, the Nagelkerke R^2 indicates that the remaining four predictor variables account for 91.4% of the variation. Table 27 illustrates the contribution of each of the four predictor variables on a ramp exiting maneuver. The d' for exit ramp maneuvers was 1.101 and considered to be moderate even though the percent correct (8%) for the variables predicting this maneuver type is low.

Table 27. Exit ramp maneuver logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-23.024	83.023	0.077	1	0.782	0.000
Road edge—Paved full shoulder	11.575	59.058	0.038	1	0.845	106376.64
Relation—Entering ramp	12.954	58.366	0.049	1	0.824	422340.78
Observed difficulties navigating—Ramp	10.939	58.362	0.035	1	0.851	56312.107
Observed difficulties navigating—Alignment/Curve	12.086	59.073	0.042	1	0.838	177294.37

4.3.6 Characteristics of Pedestrian/Bicyclist Maneuvers

Pedestrian/Bicyclist analysis was only performed for the maneuver because none of the pedestrian/bicyclist conflicts were found to be significantly correlated with at least one of the four severity levels. Therefore, individual pedestrian/bicyclist conflict analyses were not performed. Observable variables that appear to have the most influence on pedestrian/bicyclist events were related to not having a pedestrian signal and navigational violations. Results of the logistic regression analysis are provided as follows.

One iteration of the forward stepwise was performed where two events and 19 predictor variables were removed. The Model χ^2 (χ^2 (5) = 44.487, $p = 0.000$) was found to be significant, suggesting the selected predictor variables are valuable in observing a pedestrian or bicyclist maneuver event. This result is corroborated by the Hosmer and Lemeshow goodness-of-fit test which was not found to be significant (χ^2 (1) = 0.000, $p = 1.000$), suggesting a well fit regression equation. According to the model summary, the Nagelkerke R^2 indicates that the predictor variables account for 85.1% of the variation. Table 28 illustrates the contribution of each of the predictor variables on a pedestrian or

bicyclist maneuver event. The d' for pedestrian/bicyclist maneuvers was 2.080 and considered to be high.

Table 28. Pedestrian/Bicyclist maneuvers binary logistic regression results.

Variable	B	Std. Error	Wald	df	Sign.	Exp(B)
Constant	-65.743	514.381	0.016	1	0.898	0.000
No pedestrian signal	61.440	5450.933	0.000	1	0.991	4.82E+26
Avoiding—Another vehicle	33.055	297.126	0.012	1	0.911	2.27E+14
Violation stopping—Ran red light or stop sign	43.321	352.436	0.015	1	0.902	6.52E+18
Violations turning—Wrong way on one-way	54.336	444.034	0.015	1	0.903	3.96E+23
Signal usage—Signal not required	21.505	216.314	0.010	1	0.921	2.19E+09

4.4 Summary

The results of analyses found that 69 (43%) of the 162 occurring predictor variables were of value as observable predictor variables for traffic events (Table 29). Of these 69 variables, 11 (16%) were site-related, 21 (30%) were traffic-related, and 37 (54%) were driver performance-related.

- Twenty predictor variables were found to be of value when only considering event severity level. Of these 20 predictor variables, 2 (10%) were site variables, 6 (30%) were traffic variables, and 12 (60%) were driver performance variables.
- Fifty-seven predictor variables were found to be of value when only considering a maneuver or conflict type. Of these 57 predictor variables, 10 (18%) were site variables, 16 (28%) were traffic variables, and 31 (54%) were driver performance variables.

Table 29. Valuable predictor variables for severity levels, maneuver types, and conflict types based on results of binary logistic regression analyses.

SITE VARIABLES												
	S3	S4	S5	S6	LT	RT	LC	SD	F	R	PB	
1. Geometry—Roadway segment								C				
2. Geometry—4-legged intersection						M			M			
3. Geometry—All intersection types					M							
4. Road function—Group B								C				
5. Road function—Group D	X								C			
6. Primary control—Stop sign									M,C			
7. Road edge—Paved full shoulder										M		
8. Road edge—Soft full shoulder									C			
9. Road edge—Paved partial shoulder						M						
10. Barrier—None												
11. Obstruction—Advertisement signs		X										
TRAFFIC VARIABLES												
	S3	S4	S5	S6	LT	RT	LC	SD	F	R	PB	
12. Relation--Pre-intersection					M			M,C				
13. Relation—Within intersection								M				
14. Relation--Post-intersection								C				
15. Relation—Exiting ramp										M		
16. Relation—Entering ramp								M		M		
17. Relation—Roadway			X									
18. Lanes—1					M							
19. Lanes—2							M					
20. Lanes—3							C					
21. Lanes—4								C				
22. Debris on roadway—Clear/None			X									
23. Level of Service B					M							
24. Event obstacle—Pedestrian			X						M			
25. Event obstacle—Other vehicle(s)	X											
26. Missing regulatory sign(s)							C					
27. Missing warning sign(s)									M			
28. Missing directional or guide sign(s)									M			
29. No pedestrian signal											M	
30. Limitations to sight distance—Pedestrian/Bicyclist						M						

31. Limitations to sight distance—Vegetation				X									
32. Size of event vehicle					X								
DRIVER PERFORMANCE VARIABLES													
	S3	S4	S5	S6	LT	RT	LC	SD	F	R	PB		
33. Pulled into traffic or Proceeded without clearance			X					M,C					
34. Entered intersection on red light									M,C				
35. Failure to respond to primary control								C					
36. Failure to respond to an active emergency vehicle			X										
37. Lateral vehicle control—Lane change							M						
38. Lateral vehicle control—Ran off road				X	C								
39. Backing-up				X				C					
40. Vehicle turn control—Turned into incorrect lane						M	M						
41. No room to respond to an active emergency vehicle								C					
42. Gesturing—Sounding horn							C						
43. Avoiding—Another vehicle												M	
44. Violation stopping—Ran red light or stop sign												M	
45. Violation stopping—Rolling stop						M							
46. Failure to yield right-of-way--General									M				
47. Failure to yield right-of-way—Right turn on red light						M							
48. Following closely					M			M,C					
49. Force another vehicle out of lane	X												
50. Observed difficulties navigating—Intersection angle					M								
51. Observed difficulties navigating—Ramp											M,M		
52. Observed difficulties navigating—Alignment/Curve											M		
53. Violations turning—Illegal left turn					M								
54. Violations turning—Illegal right turn						M							
55. Violations turning—Wrong way on one-way												M	
56. Lateral vehicle control—No deviation	X	X											
57. Lateral vehicle control—Deviation in lane to left					M								
58. Lateral vehicle control—Lane break to right			X					C		M			
59. Lateral vehicle control—Unknown						M							
60. Longitudinal vehicle control—Anticipatory braking	X								M,C				
61. Longitudinal vehicle control—Unanticipated controlled braking		X											
62. Longitudinal vehicle control—Uncontrolled braking	X		X	X									
63. Longitudinal vehicle control—Accelerating						M							
64. Longitudinal vehicle control—Normal driving							M,C	C					
65. Longitudinal vehicle control—Unknown		X											
66. Signal usage—Signal not required								C				M	
67. Signal usage—Correct signal on in advance					M			M		M			
68. Signal usage—Signal not used	X	X						M					
69. Signal usage—Unknown									M				

■ X = severity level variable based on logistic regression results; M = maneuver variable based on logistic regression results; C = conflict variable based on logistic regression results.

■ S3, S4, S5, and S6 = severity level 3, severity level 4, severity level 5, and severity level 6, respectively.

■ LT and RT = left turn and right turn maneuvers and conflicts, respectively. LC, SD, F = lane change, same direction, and forward maneuvers and conflicts, respectively. R and PB = ramp and pedestrian/bicycle maneuvers, respectively.

5 Discussion

Recall that the purpose of this research was to develop a framework of observable event factors to further investigate event severity relationships and the potential of a hazardous event. The primary focus has been determining whether or not there is any kind of direct or indirect relationship between severity levels based on a set of key characteristics. If so, this would, in part, validate findings by

Svensson (1998) that locations with a high number of traffic events of lesser severity (e.g., near-crashes) also produce conditions for occasional events of greater severity (e.g., crashes), in that conditions that produce events would be known.

A Traffic Conflict Technique-like observational methodology was used in this research effort to capture crashes and near-crashes as they occurred on video. Once captured on video, the events could then be analyzed in detail to identify variables that affect crashes and near-crashes. This, in turn, would result in a framework of observable event factors that could be used as proxy variables to inform safety, risk, and roadway improvement evaluation methodologies.

In this research, 368 events that varied in severity from non-injury crashes to near-crashes resulting from serious errors were examined for variable patterns between four event severity levels. The four levels were condensed to three because of near exactness between near-crash and serious, near-crash event characteristics. The distribution between non-injury, serious near-crash, and near-crash events corroborate the hypothesis that there is a hierarchical distribution of traffic events based on severity.

As evidenced in past research (e.g., Heinrich et al., 1980; Mollenhauer, 1998; and Dingus, et al., 1999, 2005), the more severe an event, the less likely it is to occur. However, the distribution between non-injury crashes and near-crashes was not as great in this study as hypothesized by Heinrich or reported in previous transportation research (Table 30). The ratio found in this study was 1:73.6 when comparing non-injury crash events to near-crash events—which is approximately a 20% higher yield in the number of observed events than what was expected. Findings reported in the 100-car Naturalistic Driving Study also demonstrated a higher yield, of approximately 13%, than reported in earlier studies. There are two primary reasons assumed to be responsible for this higher yield, that of improved fidelity of the data and an increased scale of understanding.

- Improved fidelity in data collection techniques and data extraction methods. Where, although all of the studies relied on human judgment to some degree to evaluate traffic events, the advent of newer digital technologies used especially for data capture and analysis resulted in an overall improvement in the accuracy of discovery. In turn, this had a positive impact on the exactness of the final result.
- Increased scale of understanding. This is related to improved fidelity in that smaller devices, faster processing speeds, along with improved and less expensive storage in newer technologies are allowing researchers to collect and analyze more data in a shorter period of time. These advances have a direct impact on the scalability of data collection efforts in general. Although large-scale data collection efforts are not the right answer for all types of research investigations, it is advantageous when the goal is to gain a better understanding of the driving environment with a focus on traffic events. In this case, more data tends to be better, especially for validating previous research efforts and refining safety metrics, resulting in an increased scale of understanding of variables that contribute to hazardous events.

Table 30. Trend in non-injury crash to near-crash incident ratios.

Non-injury Crash to Near-crash Ratios	Research
1:73.6	Kieliszewski, 2005
1:110	Dingus, Klauer, et al., 2005
1:1183	Dingus, Hetrick and Mollenhauer, 1999
1:1200	Mollenhauer, 1998
1:2000*	Older and Spice, 1976

Recall that this was an observational study. Therefore, factors discovered through other inquiry methods such as interviews, focus groups, or in-vehicle observations cannot be addressed because they were out of scope with respect to this research effort. With that said, the focus of the discussion will be on observed variables with assertions towards driver error based on human error information-processing models and evidence from other research. From the 368 examined events there were 162 significantly associated variables, where

- 27% were site variables—variables that were part of the static infrastructure such as type of roadway geometry and type of traffic control devices;
- 30% were traffic variables—variables associated with traffic movement and flow within the driving environment such as roadway level of service and where an event actually occurred relative to the roadway geometry;
- 43% were driver variables—variables associated with observed individual driver actions and behaviors.

These findings were not surprising compared to previous research such as Treat (1980), who reported finding 4.5% of factors were vehicle-related, 12.4% were environmental-related, and 70.7% were human-related. The following discussion looks at variable commonalities to create severity signatures and explore driver error conditions that may antagonize the driving environment resulting in traffic events. In addition, proxy measures for addition to TCT-like roadway evaluation methodologies are proposed. Differentiations between the severity levels are discussed as part of the summary.

5.1 Crash Events

As presented earlier, five non-injury crashes were captured and analyzed as a part of this investigation, and they accounted for 1% of all events. Crash events were defined as an actual collision between V1 (assumed to be at fault) and another object such as a different vehicle, roadway element, or pedestrian. The only crashes evaluated here appeared to suffer, at most, some degree of property damage to either the vehicle and/or the object it came into contact with. There were no known crashes that resulted in either bodily injury to the driver of V1 or another person impacted by the collision. Nor were there any known crashes that resulted in a fatality.

Surprisingly, all of the crash events observed in this study were straight path maneuvers. Recall that straight path maneuvers included lane changes and traveling straight through an intersection or on a roadway. Findings reported in the 100-car Naturalistic Driving Study also show that the majority of both crashes and near-crashes were related to straight path maneuvers primarily defined as a “going straight, ...” pre-event maneuver (Dingus, Klauer, et al., 2005). Anecdotally, in observing the high number of turn conflicts (37% overall) one would also expect there to have been a significant crash relationship with these conflicts. However, there were no actual crash events observed for turn

conflicts. This, however, is different from findings reported by Dingus, Klauer, et al. where almost 19% of crashes were associated with a pre-event right turn, left turn, or U-turn maneuver.

The crash events examined in this study could be placed into one of two categories: typical and atypical. The typical crash event was considered to be when the driver performs an action (such as swerving), which is an unexpected control maneuver, but might still be considered to be within a range of conventional driving norms or rules. Whereas, atypical crash events would be those where the driver performs an action (such as backing the vehicle in a travel lane) that is highly unexpected based on conventional driving norms or rules. Of the five non-injury crashes, two crashes (40%) were considered to be typical (i.e., a rear-end event and a lane change event), which have been found to be major crash types in previous research (Retting, Weinstein, Williams, and Preusser, 2001). The remaining three crashes (60%) were considered to be atypical (i.e., backing the vehicle in an active travel lane and a collision with a stationary object).

However, the reader should be cautioned as to the reliability of the final variable set associated with crashes based on only five events. Even so, there does appear to be a trend, in that these most severe events are not only rare occurrences, but they are also difficult to generalize due to their unique characteristics. The variables found to be most representative of the crashes were very similar to the actual conflict type description itself. For example, the variables of backing-up of the vehicle in a traffic lane and running off of the road were also conflict type labels. However, not all variables associated with crashes were unique to crash events. When reviewing event characteristics across severities, the crash variables of (1) running off of the road and (2) uncontrolled braking were found to also be highly associated with less severe events.

In general, there was a lack of evidence that site and traffic variables are factors for crash events (Table 31). The variables associated with crash events appear to primarily be driver actions. This is not surprising when you examine the models for general human error (e.g., Rasmussen 1986, Rasmussen, 1994, and Reason, 1990). As portrayed in these models, as a pattern becomes less familiar and the state of information degraded, it becomes more difficult for the person to achieve a desired goal state. In this case, the goal state was viewed as a desired absence of danger. In general, observed actions were extreme driving behaviors such as uncontrolled lateral and/or longitudinal vehicle control; or actions, such as backing a vehicle in a travel lane—that appeared to be intentional, resulting in unsafe circumstances. Whether intentional or unintentional, there appears to be a major departure in driver expectations of the driving environment at this severity level.

Considering the lack of associated external variables, the behaviors exhibited for crashes may be evidence of a mismatch between awareness and the driver's assumptions for the given driving environment. Although not demonstrable by the data collected in this study, awareness might be affected by driver's inattention to the forward view factors such as looking out another window, using a cell phone or other device, or talk to a vehicle passenger (Dingus, Klauer, et al., 2005). The aforementioned mismatch appears to be resulting in non-recognition or critically delayed recognition of environmental cues that then places the driver outside of a familiar pattern (or problem space). In turn, the driver's capacity to concurrently process task requirements (e.g., identify problem, determine course of action, maintain a level of safety) may be extraordinarily taxed. As a result, the driver fails to perform the proper corrective action, given these elements of increased cognitive demand, decreased awareness, and uncertainty, with respect to an appropriate reaction sequence.

This sequence then precipitates into either an appropriate action that was inadequately executed or possibly no action at all.

Table 31. Crash event signature and applicable driver error conditions.

Crash Event Signature	Observations of Driver Error Condition(s)
<ul style="list-style-type: none"> • Lack of apparent evidence that site variables are a factor • Lack of apparent evidence that traffic variables are a factor • Tendency towards unique or severe driving maneuvers • Extreme, uncontrolled lateral and/or longitudinal vehicle control 	<ul style="list-style-type: none"> • Lack of coordination in maintaining an absence of danger • Failure to maintain balanced control of the vehicle • A break in an association with a familiar pattern or routine • Infer and formulate a new and possibly untried action • Reflexive action, regardless of effects • Consequences may not be a consideration in the decision-making process • Shift in perception results in a mistake in judgment

5.2 Serious, Near-crash Events

Serious, near-crash events were defined as V1 having to perform an emergency action such as uncontrolled braking or a violent swerve to avoid a collision with another object (e.g., another vehicle, roadway element, or pedestrian). Thirty-five events were categorized as being serious, near-crashes which accounted for 10% of all evaluated events.

Events categorized as serious, near-crashes, like the crash events, were found to be significantly associated with straight path maneuvers. These events occurred primarily as problems with pedestrians crossing the roadway, lane changes, and lane keeping while performing a turn (i.e., conflicts with traffic in the adjacent lane when making a right-hand turn or with stationary objects when making a left-hand turn). Although categorically different from the crash event characteristics with respect to atypical behaviors, the characteristics found for serious, near-crash events seem as if they might be more archetypal of what one would expect to be antecedent of a more serious event. Therefore, serious, near-crash characteristics would be more indicative of a generally hazardous driving environment than actual crash events.

Based on the general characteristics found to be associated with serious, near-crash events, there is evidence of an information dense driving environment (Table 32). Indicators of an information dense driving environment are those of multilane roadways and intersections, sight distance limitations, inadequate or poorly located signage, and driver behaviors such as extreme to moderate lateral and longitudinal movements and advancing into traffic without adequate clearance. Findings reported by Dingus, Klauer, et al., (2005) also indicate there may be a relationship between information density in driving environment and near-crashes. Where, near-crashes tend to be affected by locale, divided roadways (assumed to have multiple lanes in each direction), and traffic density factors. When summed, these indicators point to a complex and possibly incongruent environment.

Unlike crashes, variables associated with serious, near-crash events are mixed between site, traffic, and driver factors, with the majority of variables being driver-related. In these situations, the state pattern may be unfamiliar, yet the information has not degraded to a point where the desired goal can not be met. In general, actions for serious, near-crashes were less extreme than driving behaviors exhibited in crashes—demonstrating a higher degree of control or recovery. If this is the circumstance, then it can be assumed that, although there may be a violation to expectations, the driver is able to perform a favorable corrective action. This would lead one to believe, based on the

models for general human error (e.g., Rasmussen 1986, Rasmussen, 1994, and Reason, 1990) that there may be problems with cue definition, recall, or attention.

With that said, one might deduce that the combined environmental factors are affecting the driver’s ability to predict traffic patterns and plan accordingly resulting in unintended actions. This may be manifesting from falsely anticipating other road user actions or lack of anticipation with respect to a change in the driving environment. Poor anticipation may be due to a mismatch between how the driving environment is functioning and what is expected, resulting in incorrect interpretations of what other road users will do. This would then also impact execution due to incorrect assessments of timing or distance, yet allowing the driver adequate time to recover, by avoiding an actual crash, with an appropriate action for the circumstances.

Table 32. Serious, near-crash event signature and driver error conditions.

Serious, Near-crash Event Signature	Observations of Driver Error Condition(s)
<ul style="list-style-type: none"> • Lack of apparent evidence that site variables are a factor • Event occurrence tends to be on multilane roadways and intersections • Tends to be inadequate signage • Tends to be view obstructions • Difficulties with lane change maneuvers and lane keeping during right turn maneuvers • Extreme to moderate lateral vehicle control problems ranging from running off the road to lane breaks • Extreme longitudinal vehicle control problems exhibited as uncontrolled braking • Advancing into traffic or with a maneuver without adequate clearance 	<ul style="list-style-type: none"> • Occluded views or limitations to sight distance • High attentional demand due to a busy environment (multiple distraction and input sources), divided attention problems • Violation of expectations or assumptions with respect to both motorized and nonmotorized traffic • Non-perception of another road user • Lack of or delays in recognition of environmental cues • Lack of salient information that may be due to inappropriately placed signage, a lack of signage, or too much signage that is difficult to discriminate • Adequate information to recognize a pattern and be able to process and act on a recovery plan

5.3 Near-crash Events

Near-crash events and serious error, hazard present events accounted for 328 events (88 (24% overall) and 240 (65% overall), respectively). Recall that near-crash events were defined as those where V1 had to perform a rapid yet controlled maneuver to avoid a collision. Whereas, serious error, hazard present events were defined as V1 being able to avoid a hazard with a timely controlled behavior. Although differentially defined, the two severity levels are grouped together into one category here because of near identical overlap in their associated characteristics.

As with crash and serious, near-crash events, these less severe near-crash events were primarily associated with straight path conflicts. The significantly correlated conflict types were identical for both severity levels, and were:

- General forward maneuvers—these occurred when V1 was traveling straight through an intersection or along a roadway, yet there was a conflict with another vehicle, a pedestrian, or a stationary object.
- Conflicts with oncoming traffic performing a left-hand turn—these occurred when V1 is traveling straight, but there is a problem with at least one oncoming vehicle that is performing a left-hand turn. This left-hand turn could have been at an intersection or along a roadway where the second vehicle was maneuvering into a driveway.
- Conflicts with a lead vehicle that had slowed or stopped—these occurred when V1 was behind another vehicle and appeared to have a problem after the lead vehicle had either slowed in the

traffic lane or stopped altogether. As the reader may have noticed, conflicts with a slowed or stopped lead vehicle have been a trend between all severity levels.

General characteristics (Table 33) of near-crash events included infrastructures that accommodated both motorized and non-motorized traffic, whether or not designed as such. The roadway functions ranged from primary arterial roads meant for mobility in suburban areas to urban access roads that provide passage points, to adjacent areas which tends to result in a wide variety of road user demands. The environmental elements that appear to result in problems for drivers where the presence of multiple lanes; traffic being controlled by a stop sign rather than, say, a red/amber/green traffic light; and, inadequate or poorly placed signage to warn, guide, and/or regulate traffic. Factors that affect roadway function such as arterial roads, multiple lanes, and locale (business/industrial areas) have also been reported in other research as troublesome for drivers (Dingus, Klauer, et al, 2005; Retting, et al., 2001). Stop sign controls and signage were not reported as apparent crash or near-crash variables.

Like crash and serious, near-crash events, driver’s tended to exhibit problems with lane keeping and lane changes along with advancing into traffic without adequate clearance—but to a lesser degree of severity. The main difference in observed driver performance was the appearance of traffic violations. More specifically, traffic violations tended to be drivers failing to heed traffic controls such as stopping for a stop sign and drivers failing to stop for a red light—especially when performing a right-hand turn (where a right-turn with a red light is permissible).

As stated, there appears to be some similarities between near-crash characteristics those found for crashes and serious, near-crashes. Those characteristics are that of having to control the vehicle in an information dense situation where the driver is required to remain vigilant and attentive for irregular changes in the driving scene. However, there are also differences in the types of characteristics that compose the near-crash events from those of the other two severity levels. In examining the general human error models once again, one might surmise that near-crashes are related to inadequacies in spatial-temporal coordination, attentional failures, and violations.

The primary difference is the appearance of violations and what appeared to be a disregard for common traffic rules and norms around controls. These behaviors may also be reflective of a busy driving environment where, the driver’s attention is divided in such a manner that adequate perception of environmental changes are not recognized as actual problems. In turn, the driver may become ignorant or desensitized of cues in the driving environment that should signal a change in perceived danger. Where, vigilance is also degraded and the lack of saliency in successive cues results in ignoring convention because a perceived absence of danger continues to be achieved. Therefore, the driver thinks the environment is safe and can proceed without worry of harm.

Table 33. Near-crash event signature and driver error conditions.

Near-crash Event Signature	Observations of Driver Error Condition(s)
<ul style="list-style-type: none"> • Event occurrence tends to be on roadways and offset 4-legged intersections (where at least one approach to the intersection is not perpendicular to the cross street) • Event occurrence tends to be pre- and post-intersection (versus within the intersection) locations on multilane roadways • The roadway function is primary arterial with separate 	<ul style="list-style-type: none"> • Deficiencies or failures in judgment where previously learned rules and procedures are misapplied • Lack of familiarity with a particular pattern • High attentional demand due to a busy environment • Lack of situational awareness due to too high information density • Deficiencies in vigilance and issues with successive

Near-crash Event Signature	Observations of Driver Error Condition(s)
<p>facilities for non-motorized traffic, to urban roads that support varying road user demands including non-motorized traffic, both accommodating high levels of continuous traffic flow.</p> <ul style="list-style-type: none"> • Tends to be inadequate or improper signage and regular obstacles in the roadway (i.e., motorized and non-motorized) • Tends to be a stop sign controlled location versus a red/amber/green traffic signal • Difficulties with oncoming traffic turning left or crossing into the travel lane and the pace of leading traffic • Traffic violations are apparent • Moderate to no lateral vehicle control problems with lane breaks being the extreme • Extreme to no lateral vehicle control problems with uncontrolled braking being the extreme • Lack of signal usage • Advancing into traffic or performing a maneuver without adequate clearance 	<p>stimulus</p> <ul style="list-style-type: none"> • Violations that may be routine or may be exceptional due to a lack of situational awareness

5.4 Proxy Measures

Based on the general findings and the event signatures, there are some apparent trends in driver operational problems within the roadway system. These trends are proceeding without adequate clearance, extreme to moderate problems with lateral and longitudinal vehicle control, committing violations, and atypical or extreme maneuvers. By and large, these behavioral trends can be used as proxy measures to evaluate roadway safety by identifying hazardous maneuvers associated with an event severity level. In addition, based on event signatures, one can then surmise which roadway elements might be affecting driver behavior and overall performance.

Suggested updates to TCT-like traffic engineering methodologies would be to add driver performance-related factors beyond vehicle speed into roadway sampling practices. Measures to be added should include type and degree of vehicle control with respect to frequency of:

- excessive acceleration and deceleration indicating violations in expected traffic patterns.
- proceeding without adequate clearance indicating that the combination of environmental cues and affordances may be affecting the driver's ability to predict traffic patterns and plan to proceed accordingly.
- violations of traffic laws and rules indicating a possible vigilance decrement and/or lack of saliency in successive cues that should alert the driver evoking a minor or precautionary corrective action.
- extreme maneuvers such as backing and inadequate lane keeping (e.g., swerving or extreme lane breaks that disrupt traffic flow, such as another driver having to take evasive action) indicating problems with pattern recognition and decision-making.

When this type of data is included with traditional traffic engineering measures, decisions can be made with regards to overall event severity for a given roadway system. In turn, this information could then be used to evaluate engineered countermeasures.

As stated, there are a number of apparent operational issues drivers are exhibiting in the roadway system. When comparing event severity, the common trend appears to be the factors of proceeding without adequate clearance, roadway control type, roadway function, variety of road users, and

vehicle control. Upon closer examination, these factors may aid in evaluating the degree of operational and safety problems in addition to more traditional roadway safety measures and mapped to more specific roadway elements that could be used as engineered solutions. Table 34 provides a number of specific roadway elements associated with driver performance and error conditions. In addition, engineering countermeasures are suggested to ultimately lessen the likelihood of errors leading to crashes and near-crashes.

Table 34. Traffic engineering countermeasures to reduce driver error conditions leading to operational problems.

Factor	Possible Countermeasures
Roadway control— Right-turn-on at a red traffic signal	<p>Introduce false signals into the environment to keep drivers vigilant. This may sound dangerous and as if one is trying to ‘trick’ drivers into thinking there are problems that need to be attended to, when there actually may not be. That is not the case here. The introduction of false signals could be in the form of an increased presence of law enforcement or electronic enforcement via automatic ticketing based on video surveillance techniques.</p> <p>Evaluate the design for nearby exit and entrance points relative to an intersection that is controlled by a red/amber/green traffic signal. If there are additional exit or entrance points close to the intersection (say, 100 meters or less) evaluate the design to make the right-on-red impermissible. That is, post as a ‘no right on red’ so there is a clear path for cross traffic that not only is entering the intersection but is also slowing to make an immediate exit after clearing the intersection. Or, so that traffic entering the roadway, say from an entrance ramp, is not competing with right turn traffic that is also accelerating and trying to jockey and maintain a position in the roadway.</p>
Roadway control—stop signs	<p>Locations controlled by a stop sign configuration (2-way to n-way) found to be troublesome should be re-evaluated for the possibility of a new design solution such as going from a 2-way stop sign configuration to a 4-way configuration. Or, if there is a high traffic demand (especially during peak travel periods) such as on an urban connector roadway that supports primarily motorized traffic between a primary arterial roadway and residential streets, then treatments such as a traffic circle or lighted intersection would be more applicable. However, one caution needs to be considered—that of accommodating nonmotorized traffic. It may seem like common sense, however if there is a high degree of nonmotorized traffic that needs to be accommodated, controls that actually stop traffic (i.e., stop sign, traffic signal) should be implemented versus controls designed for continuous traffic flow (i.e., traffic circles).</p>
General signage	<p>Clearly post right-of-way. Right-of-way is not always clearly identified through the use of stop signs, stop lines, or yield signs.</p> <p>The combination of stop signs and painted stopping lines assists drivers in understanding safe boundaries and provides redundancy that action needs to be taken. However, these controls need to be placed in proper sequence to the driving task. That is, if a stop sign and line are placed at a location based on a</p>

standard, as it ought to be in most cases, additional measures need to be taken to ensure that sight lines are not obstructed or obscured due to elements such as signage, parked traffic, buildings, or vegetation. If there is a temporary or permanent structure blocking the driver's line-of-sight, their decision-making with respect to when to proceed will be distorted.

The tendency is for there to only be a single yield sign posted where two roadway segments intersect, often with one segment merging into the other. Placement of the yield sign tends to be very near, if not at, the intersection of the two roadway segments. Given the driving aspects of vehicle speed, scan rates, and vehicle position maintenance, positioning a yield indicator at the end of roadway segment often does not allow the driver adequate time to prepare. There may also be the issue of missed cues, given the aspects of the driving task, which would indicate the need for redundancy. This would also call for the posting of a yield ahead warning sign in advance of the actual intersecting point.

Nonmotorized vehicle traffic	There is a need to include controls for varying types of road users at a roadway site. Problems with nonmotorized traffic might be alleviated with designated pedestrian signals. This can be achieved by the inclusion of well-timed pedestrian walk signals at locations controlled by red/amber/green traffic signals. Or, with lighted pathways armed via pedestrian activation for locations that are not controlled by red/amber/green traffic signals.
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5.5 Summary

The above discussion identified severity signatures and explored driver error conditions that might be result in traffic events due to severity characteristics. In general, one can see a trend of straight path maneuvers, lateral and longitudinal vehicle control, and complexity and information density of the driving environment as contributing to driver error and hence crashes and near-crashes. There were also differences between the severity levels. These differences were evident in the degree of control the driver appeared to have of the vehicle, type of control regulating the driving environment, and type of road users present in the driving environment. In combination, these trends resulted in driver performance related measures that should be included in roadway safety evaluations in addition to engineering countermeasures to reduce the likelihood of traffic events. The next section concludes this research effort with a prospective with respect to the original purpose and research questions used to scope and guide this research effort.

6 Conclusions and Recommendations

This research effort was driven by the idea that there is a nominal relationship between automotive crashes, near-crashes, and less severe incidents. In addition to a nominal relationship, it was hypothesized that there is a relationship between events of one severity with those of another severity based on observable characteristics of the driving environment. And, that these observable characteristics can be identified using methodologies such as the Traffic Conflict Technique.

The purpose of this research was to explore traffic event severity relationships, evaluate the potentiality of a hazardous event and develop a framework of observable event factors. In support of

this purpose, three research questions were examined to scope the investigation. The questions focused on (1) identification of observable characteristics that most significantly contribute to crashes and near-crashes; (2) examination of a hierarchical distribution of traffic events to afford greater predictability of crashes; and (3) identification of driver performance proxy variables for inclusion in roadway safety evaluative methodologies such as the TCT.

Data were collected in Washington, D. C. and two regions of Virginia and analyzed to validate previously reported severity distributions and identify variables associated with event severity levels. The results of the analysis found 69 observable variables to be associated with crashes and near-crashes. This was based on the analysis of 368 traffic events ranging in severity from non-injury crashes to serious errors. The variables were examined for trends that would illustrate direct and indirect relationships between the event severity levels of crashes, serious near-crashes, and near-crashes. A signature was generated for each severity level along with the identification of driver error conditions. Patterns were identified within and between the severity levels and proxy measures were established that can be used in evaluating roadways.

This research provides several levels of benefit to drivers and road designers and evaluators by shedding light not only on the correlation of event signatures and traffic events, but also in defining several driver performance related measures that should be included in roadway safety evaluations. By including these additional factors in reviewing designs, evaluators can make more intelligent, informed decisions regarding roadway system improvements, thereby benefiting drivers and designers. The following are concluding remarks with respect to event severity levels in the form of severity signatures and enhancements for roadway safety evaluation methodologies.

6.1 Event Severity Signature

A hierarchy of traffic events based on severity was found to hold true in this research effort. However, there were differences between the ratios reported for non-injury crashes and near-crashes in previous research compared to those found in this research effort. The ratios between non-injury crash and near-crash events found in this research were much smaller than those reported by Dingus, Hetrick, and Mollenhauer (1999), Mollenhauer (1998), and Older and Spice (1976). However, the more recent 100-car Naturalistic Driving Study performed by Dingus, Klauer, et al. (2005) reports ratios that are more similar to those found in this investigation. It is surmised that the discrepancy between ratios in earlier research and those reported in more recent studies is primarily due to improved data fidelity and an increased scale of understanding.

However, with increased understanding comes the responsibility to evolve from conjecture to supposition, definition, and theory. In an article addressing the issue evaluating driver distraction with respect to Intelligent Transportation System safety issues, Tijerina (2000) states that, “defining conflicts or ‘near misses’ in terms of evasive maneuvers is illogical in light of the fact that in a large percentage of crashes (e.g., 80% for some rear-end and lane change crash scenarios), there is no pre-crash evasive maneuver (Wiacek and Najm, 1999)” (p. 9). He goes on to say that the definition of a conflict should be in terms of the situation; that in essence, the surrounding circumstances need to be considered to fully understand the empirical correlations and implications that make-up an event.

This idea of definition by situation becomes very appealing when, after having teased-out individual event variables it can be difficult to then apply them back to a particular element of interest (e.g., infrastructure type, roadway site, or general traffic environment) for use in the identification of countermeasures. What became evident in this research is the idea of an event severity signature which is in support of the idea of defining problems by situation. Where, events are defined by a set of identifying characteristics versus being treated as a single variable. This is not a new idea, but it is one that can be forgotten when researchers narrow their scope of exploration in pursuing a question.

The event itself is a factor that is characterized by multiple variables. What has become apparent is that the scope of exploration with respect to traffic events has been on categorization through conflict type and then examining the behaviors of the driver within that conflict type. This is a noble pursuit; yet, this research indicates that valuable variables may be lost when focusing on conflict types. However, the severity signatures presented here are only a start with regards to a more holistic approach to traffic events and impact on safety.

6.1.1 Recommendations

- Further research needs to be done with large sample sizes to gain a better understanding of the nature of traffic events with regards to severity and the role that factors play in defining levels of severity. As stated earlier, the sample size of this study was small, especially with regards to the number of possible variables to track. Both findings from this study and a well defined finite standard set of variables should be validated.
- Additional research and policy discussions could occur to standardize severity definitions for event classifications to better enable cross-study comparisons. Event classifications should be formalized and a catalogue of events factors established. Crash databases, such as the General Estimate System (GES), establish a starting point. However, the information from the databases tends to support a limited understanding of variables that actually preclude any given event. Greater comprehension of event relationships could result in more appropriate infrastructure, technological, and/or policy changes to improve roadway safety.
- Joint research should be proposed to bring data from large-scale research efforts together to create and strengthen generalizations of event characteristics but to also model events from a larger general systems theory approach. Where, for example, data from an observational research effort such as this, a research effort such as SAVME (Ervin, et al., 2000), and a research effort such as the 100-car study (Dingus, Klauer, et al., 2005) is normalized and combined to test any number of hypotheses or products. The hypotheses or product tested could be safety standards, roadway safety evaluation techniques, in-vehicle system designs, or roadway enhancement designs.

6.2 Implications for Roadway Evaluation Techniques

The TCT-like methodology used in this research effort proved to be a valuable tool in observing the driving environment and collecting conflict and general traffic data. Conflict types, special events, traffic flow, traffic volume, and vehicle speed used in roadway evaluations are good determinants of general system usage with regards to traffic patterns and flow. However, these factors are too limited in scope to understand what combinations of variables in the environment are affecting drivers, in

turn under-representing the driving environment. As evidenced by the above discussion, roadway system factors beyond those used in TCT-like traffic engineering techniques and general roadway safety evaluations should be included in the methodologies.

When evaluating a current or prospective roadway system for safety guidelines are consulted as a part of the process to ensure that standards are being met. However, as reported by McGill, et al., (2005), individual standards may not expose drivers to hazardous situations, but the combination of individual standard designs may expose drivers to a hazardous situation. The dismissal of safety guidelines and standards is not being advocated here. What is being advocated is the that designs be reviewed not solely on infrastructure and traffic flow standards but also on information processing needs of the road users.

6.2.1 Recommendation

- When comparing event severity, the common trend appears to the factors of proceeding without adequate clearance, roadway control type, roadway function, variety of road users, and vehicle control. With closer examination, these factors may aid in evaluating the degree of operational and safety problems in addition to more traditional roadway safety measures. Engineering countermeasures were proposed that may assist drivers in decision-making to lessen the likelihood of hazardous actions. Suggested updates to traffic engineering evaluation methodologies would be add driver performance-related factor sampling with regards to vehicle control, violations, and failure to yield variables in additional to speed variables. Once this data is included with traditional traffic engineering data, decisions can be made with regards to overall severity of events for a given roadway system. In turn, resulting in more informed decision-making with regards to prioritizing which systems are in need of the greatest attention for improvements.

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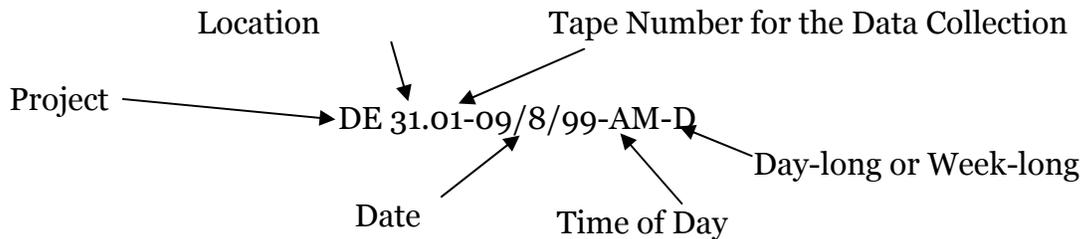
8 Appendix A: Data Extraction

Data is divided amongst three main categories of Location, Event, and Observed Driver Behaviors. Location data is information specific to each site such as the geometry, TCDs, and surrounding environment. Event data is specific to each traffic event and includes information such as event type, and weather and roadway conditions. Last are observable driver behaviors for each vehicle of the event. Variables within each of these data types are defined in the following sections.

Site Data

Location Name, Location Number, and Tape Label

The location number is an arbitrary number that has been assigned to each location. The location name is the actual street designation(s) at the site, such as 'North Main Street and University City Boulevard.' Tapes are labeled by project (DE), location number, and tape number for a given data collection session. Additional labeling elements are time-of-day data were collected (am, noon, pm), and whether data were for one day (D) or one week (W). (Note: additional data were collected as two sites for a week. This data collection was performed as part of another research study.) The following is an example of a tape label:



Location names and numbers are as follow:

No.	Location Name	No.	Location Name
01	Route 7, Margarity, Lisle/Ramada	17	Route 419 and Route 795
02	Route 28 and Route 29	18	Route 220/581 SB to Route 419 NB
03	Route 123 and Braddock	19	I-581 and Hershberger
04	Chain Bridge and Glebe	20	Rutgers
05	Glebe and 24 th	21	3500 Block of Orange Avenue
06	Arlington and Garfield	22	North Main, Progress, and McDonald
07	Pennsylvania and Minnesota	23	Owens and Harding
08	28 SB and Dulles exit	24	Tom's Creek, 460, and Givens
09	Carlin Spring and George Mason	25	Spring and Southgate
10	Route 50 WB to Rugby	26	Giles and Main
11	Route 28 (toward Route 29)	27	Church and Jackson
12	Hollins and Mason Hill	28	Pepper's Ferry (Rt. 114) and 460 East
13	Elm and Ferdinand	29	South Main and 460 East
14	Elm and Jefferson	30	Glade Road
15	Orange and Williamson	31	Route 21
16	23 rd and Colonial		

Region

Each location has been categorized into a prescribed region of town/rural, city, or metro as defined by the State of Virginia tax code.

0	Rural	Composed of sites in Blacksburg, Christiansburg, and SW Virginia
1	City	Composed of sites in and around Roanoke
2	Metro	Composed of sites in and around Washington DC

Site Description

Written narrative describing:

- Infrastructure characteristics
- Traffic paths, patterns, and cardinal orientation
- Type(s) of control
- General environment and topography

Site Geometry

This is the general physical configuration of the site.

0	Roadway segment	A roadway segment that serves as an access from one intersection to the next, or access to residence, business, or other adjacent properties. Even though the video may include an intersection, traffic behavior beyond the stop line, to enter the intersection or in the intersection, should not be included in the extraction of data for the roadway.
1	Merge	An interchange between two primary roads that often accommodates high volumes of traffic that needs to be kept open for service, safety, and efficiency. The merge can be any part of the entrance, roadway/ramp, or exit area of the interconnecting roadway of the interchange.
2	T-intersection	The joining of two roadways in which one roadway does not continue beyond the intersection.
3	4-legged intersection	The crossing of two roadways where the approach is continued through the intersection. The roadway segments are basically perpendicular, not be more than 30 degrees from normal (AASHTO, 1995).
4	Offset 4-legged intersection	The crossing of two roadways where the approach is continued through the intersection. However, the roadway segments are not perpendicular and exceed 30 degrees from normal (AASHTO, 1995).
5	Multi-leg intersection	Intersection with five or more intersecting legs. All legs should intersect at a common area.

Roadway Function

Describes the type and amount of traffic a roadway is designed to accommodate.

0	Group A	Rural principle arterial systems (interstates, freeways) for substantial travel and movement outside built-up areas, and rural minor arterial systems for linkages of cities, larger towns, and other traffic generators. Access and pedestrian traffic are not important.
1	Group B	Mainly primary arterials used in suburban areas with a low (or zero) concentration of buildings along the road. Function is mobility and may have limited access. Found in areas where land availability is limited, and separation of motorized traffic from nonmotorized traffic is not as pronounced as that of Group A. For pedestrian and bicycle traffic, there may be separate sidewalks or bicycle lanes along the shoulder (e.g., highway 460 bypass around Blacksburg and Christiansburg).
2	Group C	Mainly arterials used in a network of collectors in urban areas with high concentrations of buildings along the road. Main function is mobility although

		they provide access functions to the buildings directly adjacent to the street. Commonly, there are sidewalks on both sides, usually beyond a curb. May also have bicycle lanes on one side or parking lanes on both sides. Design and operating speeds are considerably lower than Groups A and B. Roads integrated into urban environment and development (e.g., Routes 28 and 29 in the Washington, DC area: main arterial roadways).
3	Group D	All urban roads for which the main purpose is to provide access possibilities to areas adjacent to the road. Terminating and originating traffic is present, and through traffic may be present at certain times of the day, which results in a number of varying road user demands. Often accompanied by heavy pedestrian and bicycle use (e.g., Church and Jackson in Blacksburg: provides secondary access to primary/main arterial roadways).
4	Group E	All local urban roads on which pedestrian use plays a key traffic role. Through traffic normally does not use these roads. They serve mainly residential, pedestrian, and communication functions with volumes of up to 250 vehicles per hour that generally does not disturb pedestrian traffic (e.g., suburban or residential streets).

Primary Control

0	Yield sign	Yield sign controlling traffic such as at the end of a ramp.
1	Stop sign	Stop sign controlling one or more legs of a roadway.
2	Flashing yellow and/or red light	When a flashing yellow light or flashing red light is used instead of a yield sign, stop sign, or GYR traffic signal.
3	G, Y, R signal—no arrows	The traffic signal only has green, yellow, and red balls controlling traffic for all directions.
4	G, Y, R signal—with arrows	The traffic signal uses green, yellow, and red balls, arrows, or a combination, to control traffic.
5	No control	No visible traffic sign or light controlling traffic.

Road Edge

Any additional surface beyond the delineated roadway.

0	Full shoulder—paved	Paved shoulder wide enough to accommodate the full width of a vehicle.
1	Full shoulder—soft	Gravel, dirt, or grass shoulder wide enough to accommodate the full width of a vehicle.
2	Full shoulder—jersey wall	Shoulder regardless of material, wide enough to accommodate the full width of a vehicle and is adjacent to a concrete wall barrier.
3	Partial shoulder—paved	Paved shoulder wide enough to accommodate approximately half the width of a vehicle.
4	Partial shoulder—soft	Gravel, dirt, or grass shoulder wide enough to accommodate approximately half the width of a vehicle.
5	Partial shoulder—jersey wall	Shoulder regardless of material, wide enough to accommodate approximately half the width of a vehicle and is adjacent to a concrete wall barrier.
6	No shoulder—curb	No designated or delineated roadway shoulder and the roadway edge is a curb.
7	No shoulder—parking spots	Street lined with parallel or diagonal parking spots.

Condition of Markings

General condition of markings at the site. Any type of roadway delineation such as directional arrows, lane lines, center lines, or painted medians.

0	Good	Easy to see and view roadway markings from a distance. Paint is in excellent to good condition and has very little wear.
1	Fair	Markings are still visible; however, wear is evident and they are starting to fade.
2	Poor	Markings need to be reapplied because they are not easy to see or view. Paint is almost all worn away and marking is very faint.
3	None	Markings are all worn away or were never applied.

Median

Division between lanes for same or opposite direction traffic.

0	Depressed	Median that is primarily below the grade of the roadway (e.g., grass median in divided highway).
1	Flush	Same level as the roadway (e.g., painted delineation).
2	Raised	Median that is higher than the roadway (e.g., curb).
3	None	There is no median.

Barriers

Traffic guards commonly used for safety or guidance.

0	Permanent	Stationary barriers such as guardrails, railings, or concrete walls.
1	Temporary	Moveable traffic barriers such as cones or barrels.
2	None	No barriers at the site.

Sidewalk

Includes sidewalks, walking paths, or bike paths.

0	Along all roadways	All roadways have a sidewalk on at least one side.
1	Along most roadways	Most of the roadways have a sidewalk on at least one side.
2	Along a few roadways	Only some of the roadways have a sidewalk on at least one side.
3	None	There are no sidewalks.

Obstruction

Objects that are obstacles in or to the side of the roadway that would hinder a driver's forward or side line-of-sight (view), general sight distance, or driving behavior.

0	Debris	Any objects in the roadway that would affect driving such as broken car components, gravel, wire, wood, or trash.
1	Stopped vehicle in roadway	Vehicle that has temporarily stopped or stalled in roadway, thus becoming an obstacle.
2	Vegetation	Any plants that are obstructing signs, signals, driver's view.
3	Pole	Traffic control, traffic sign, or advertisement poles.
4	Traffic sign or signal	A traffic sign or signal obstructing the view.
5	Advertisement	Signage other than official traffic control or warning signs.
6	Parked vehicle(s)	Parallel or diagonally parked vehicles aligning a roadway.
7	Other object	Objects not accounted for in the other categories.
8	None	No obstructions.

Posted Speed Limit

0	No speed limit (alley, parking lot)
X	Posted speed limit. The actual posted speed limit
99	Unknown

Event Data

Description

The event description should include information about all vehicles and the driver actions or reactions. Along with the description of driver actions and reactions, three event criteria are to be determined:

- **One vehicle was to be designated as V1 (Vehicle 1).** Each vehicle, pedestrian, or bicyclist involved in an event was assigned a V (vehicle) number. The V1 designation was always assigned to the driver, pedestrian, or bicyclist considered at fault in having caused or performed a precipitating action that resulted in a traffic event. Subsequent V numbers (V2, V3, etc.) represented drivers, pedestrians, or bicyclists who were directly or indirectly affected by V1. In cases where more than one vehicle appeared to have caused the precipitating action, the analyst had to use his/her best judgment in dissecting the event and labeling the driver considered to be most at fault.
- **Direction of travel was assigned to every vehicle.** Direction of travel was especially important in understanding the interaction between two or more vehicles. It allowed for easier understanding of where and why an event took place.
- **A descriptive characteristic was assigned to every vehicle.** A descriptive characteristic was assigned to each vehicle (e.g., blue pick-up) for easy identification. Along with the event time stamp, the vehicle characteristics aided analysts in quickly identifying events on the surveillance videotape.

The following are examples of an event description: the first description does not use the criteria described in the previous paragraph, while the second event description does use these criteria.

- **Event description not using the criteria:** V2 was turning and V1 started to go across intersection. V2 stopped then V1 stopped. V2 finished turn, V2 had right-of-way.
- **Event description using the criteria:** V2 (white van) turning left from WB Southgate to SB Tech Center stopped to wait for oncoming traffic on EB Southgate to pass. V1 (black jeep) was stopped at the stop sign for SB Spring/Tech Center. After V2 stopped, V1 started to proceed forward and had to quickly stop (beyond the crosswalk) because of the EB Southgate traffic. V1 then waited for all traffic to clear the intersection before proceeding forward again. It appeared as if V1 was only watching V2 and did not notice the EB traffic.

Data Collection Period

Data collection period of when the event occurred.

0	Morning
1	Noon
2	Evening

Time of Incident

More exacting time stamp data than the Data Collection Period. The timestamp breakdown was in hours:minutes:seconds.

Hour of Incident

Two digit entry for hour of day using military time from 00 to 23 (e.g., 00 = midnight, 06 = 6:00 a.m., 12 = noon, 15 = 3:00 p.m.).

Minute of Incident

Two digit entry for minute within the hour of day ranging from 00 to 59.

Second of Incident

Two digit entry for second within the minute ranging from 00 to 59.

Number of Vehicles

The observed number of vehicles directly involved in the event or impacted by consequences of the event.

Maneuver Types and Conflict Types

Maneuver Types are noted as single digit table entry, whereas corresponding Conflict types are double or triple digit table entries.

1	Left turn (Vehicle 1 performed a left turn at an intersection.)
10	Conflict with cross traffic from right
11	Conflict with cross traffic from left
12	Conflict with cross traffic from right, turning left
13	Conflict with cross traffic from left, turning left
14	Conflict with cross traffic from left, turning right
15	Conflict with oncoming through traffic
16	Conflict with oncoming traffic turning right
17	Conflict with oncoming traffic turning left
18	Conflict with adjacent turn traffic
19	U-turn, conflict with cross traffic
100	U-turn, conflict with oncoming traffic
101	Conflict with pedestrian or bicycle
102	Conflict with stationary object (e.g., road edge)
2	Right turn (Vehicle 1 performed a right turn at an intersection.)
20	Conflict with cross traffic from right
21	Conflict with cross traffic from left
22	Conflict with cross traffic turning left
23	Conflict with oncoming traffic turning left
24	Conflict with adjacent through traffic
25	Conflict with adjacent turn traffic
26	Right-on-red, conflict with cross traffic from left
27	Right-on-red, conflict with oncoming traffic, turning left
28	Conflict with pedestrian or bicycle
3	Lane change (Vehicle 1 moving from one lane to a same-direction adjacent lane.)
30	To right, conflict with through traffic in right lane
31	To right, conflict with cross traffic turning right-on-red
32	To right, conflict with oncoming traffic turning left
33	To left, conflict with through traffic in left lane
34	To left, conflict with traffic in both lanes
35	To left, conflict with cross traffic
36	To left, to left-turn-only-lane then back to left through lane
37	From right-turn-only-lane, conflict with adjacent through traffic to left
38	Conflict with vehicles traveling in outer lanes trying to move into the same opening in inner lane
4	Same Direction (Vehicle 1 slows and/or changes direction.)
40	Conflict with slowed/stopped lead vehicle
41	Conflict with lead vehicle having slowed/stopped to turn
42	Conflict with adjacent parked vehicles
43	Backing, conflict with following vehicle
44	Backing, conflict with object other than vehicle
5	Forward (Vehicle 1 moving either straight through an intersection or on a street.)
50	Conflict with oncoming traffic turning right
51	Conflict with oncoming traffic turning left
52	Conflict with cross traffic from right
53	Conflict with cross traffic from left

54	Conflict with pedestrian crossing from right
55	Conflict with pedestrian crossing from left
56	Conflict with stationery object
57	Wrong way on one-way, conflict with oncoming through traffic
6	Entering Ramp (Vehicle 1 moving from street to ramp auxiliary land or directly to ramp proper.)
60	Conflict with traffic exiting ramp
61	Conflict with lead vehicle having slowed/stopped
62	Conflict with through traffic
7	Ramp Proper (Vehicle 1 slows, stops, or makes a lane change on the ramp.)
70	Same direction, conflict with lead vehicle having stopped
71	Lane change to left, conflict with traffic in left ramp lane
72	Lane change to right, conflict with traffic in right ramp lane
8	Exiting Ramp (Vehicle 1 moving from a ramp proper or ramp auxiliary lane to street.)
80	Same direction, conflict with lead vehicle having stopped
81	Lane change to left, conflict with traffic in left ramp lane
82	Lane change to right, conflict with traffic in right ramp lane
83	Conflict with through traffic
9	Pedestrian/Bicycle (When a pedestrian or bicyclist enters the path of vehicle that had the right-of-way.)
90	Conflict with traffic on far-side of intersection
91	Conflict with traffic on near-side of intersection
92	Conflict with adjacent traffic
93	Conflict with opposing through traffic

Level of Service

Subjective measure of traffic density at time of an event

0	LOS A	Represents free flow. Individual users 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.
1	LOS B	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, because the presence of others in the traffic stream begins to affect individual behavior.
2	LOS C	The range of stable flow, but marks the beginning of the range of flow in which the operation of individual uses becomes significantly affected by the 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.
3	LOS D	Represents 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.
4	LOS E	Represents 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.

5	LOS F	Used to define forced or breakdown flow. This condition exists whenever 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.
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Relation to Junction, Merge, or Roadway

Location of event occurrence relative to the site.

1	Pre-intersection
2	Within intersection
3	Post-intersection
4	Driveway, alley access, etc.
5	Exiting ramp
6	Entering ramp
7	Roadway
8	Other
9	Unknown

Number of Lanes

The number of travel lanes available to vehicle 1. That is, the number of travel lanes in the direction that Vehicle 1 was moving that could have been used to navigate.

0	Illegal action, not actual lane for the maneuver
1	One lane
2	Two lanes
3	Three lanes
4	Four lanes
5	Five lanes
6	Six lanes
7	Seven lanes
9	Unknown

Debris in Roadway

Debris conditions observed to have a possible affect on the event.

0	Clear	No debris
1	Sand or gravel	
2	Small-sized debris	Debris such as broken and crushed taillights that driver did not hesitate to drive over
3	Medium-sized debris	Debris such as small pieces of wood, cans, trash resulting in driver possibly having to slow down for (approach cautiously) to avoid
4	Large-sized debris	Debris such as lumber, pieces of tire, or wire resulting in driver having to maneuver around
5	Other	

Surface Treatment Condition

Poor pavement or concrete conditions observed to have a possible affect on the event.

0	Not applicable	Category not applicable to event
1	Rough or washboard	Event occurred on a area of roadway that was rough or worn into a washboard pattern
2	Broken or cracked	Event occurred on a area of roadway that had a broken or cracked surface (start of a pot hole)
3	Pot hole(s)	Event occurred on a area of roadway in which there was a noticeable pot hole

Markings Condition

Poor marking or delineation conditions observed to have a possible affect on the event.

0	Not applicable	Category not applicable to event
1	Lane lines	Poor or missing lane line markings
2	Directional arrows	Poor or missing directional arrows for lane
3	Median delineation	Poor or missing median delineation
4	Pedestrian crossing	Poor or missing pedestrian crossing
5	Other type of marking	Poor or missing marking to aid in navigation

TCD Condition

Traffic Control Device conditions observed to have a possible affect on the event.

0	Not applicable	Category not applicable to event
1	TCD not working	TCD not working or not working properly
2	TCD location	Traffic control device height, position, and/or mounting type may have made it difficult for driver to see or differentiate from other controls
3	Obstructed	Sign or signal was occluded from view by another object (e.g., vegetation)
4	No pedestrian signal	

Signage

Missing signage that may have had an effect on the event. The following were treated as an individual non-categorical, nominal variables (i.e., observed or unobserved).

0	None	Variable is not applicable
1	Regulatory signs	None or few

0	None	Variable is not applicable
1	Warning signs	None or few

0	None	Variable is not applicable
1	Directional signs	None or few

Vehicle Size

The following was treated as an individual non-categorical, nominal variable (i.e., observed or unobserved).

0	None	Variable not observed
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1	Vehicle size	Size of vehicle appeared to be too large for infrastructure allowances
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Severity Rating

Objects that are obstacles in or to the side of the roadway that would hinder a driver's forward or side line-of-sight (view), general sight distance, or driving behavior.

Severity Rating	Hazard Category	Definition
1	Error, no hazard present	Poor driving behavior that did not cause a conflict or result in an interaction with another vehicle or object.
2	Error, hazard present	Precautionary braking or lane change with no risk or minimal risk of a near-crash.
3	Serious error, hazard present	Controlled acceleration, deceleration, lane change, and/or a warning behavior such as sound the horn with slight risk or a near-crash.
4	Near-crash	Rapid controlled acceleration, deceleration, lane change, or stopping to avoid a crash.
5	Serious near-crash	Emergency braking or violent swerve to avoid a crash, resulting in a very near-crash situation.
6	Non-injury crash	Crash resulting in only property damage.
7	Injury crash	Crash resulting in bodily injury and/or property damage.
8	Fatality	Crash resulting in death.

Weather Conditions

0	Sunny/bright/ clear	Clear sky.
1	Partially cloudy	Combination of clear sky and clouds.
2	Cloudy/overcast	Little to no sun due to clouds.
3	Light precipitation	Light drizzle or sprinkle that does not leave enough water on the roadway to create spray from other vehicles.

Visibility Conditions

0	Unlimited	No problems being caused by weather or sun
1	Glare	Low sun angle in front of vehicle
2	Fog	Early morning low-lying fog
3	Windshield wipers	Windshield wipers were in use because of precipitation (not because driver was cleaning windshield)
4	Other	Another visibility factor undefined above

Event Obstacle

0	None	No obstacles were observed (category is not applicable)
1	Pedestrian	
2	Bicyclist	
3	Animal	
4	Other vehicle(s)	
5	Other obstacle	Vegetation, debris

Limitations to Sight Distance at Time of Event

Although logically grouped, the following were treated as individual non-categorical, nominal variables (treated as observed or unobserved).

0	None	Variable is not applicable
1	Other traffic	Larger vehicles or multiple vehicles (e.g., line of vehicles)
0	None	Variable is not applicable
1	Roadway geometry	Curve or hill or retaining wall
0	None	Variable is not applicable
1	Signage	
0	None	Variable is not applicable
1	Pedestrian or Bicycle	
0	None	Variable is not applicable
1	Vegetation	
0	None	Variable is not applicable
1	Other obstacle	

Observed Driver Behavior Data

Signal Usage

0	Signal not required	Category not applicable to event
1	Incorrect signal	Wrong signal was used (e.g., right signal on when turning left)
2	Correct signal on in advance	Able to see signal blink at least twice (≥ 2) before performing maneuver
3	Correct signal not on in advance	Signal did not blink at least twice (> 2 times) before performing maneuver. As when a driver signals when performing a maneuver, instead of before starting the maneuver
4	Signal not used	No sign of signal being activated at all
5	Unknown	Signal should have been used, but unable to tell from video if signal was used

Lateral Vehicle Control

0	No deviation (normal driving)	Driver kept original heading
1	Deviation in lane to right	Vehicle path changes towards right of original heading but driver keeps vehicle within the lane lines
2	Deviation in lane to left	Vehicle path changes towards left of original heading but driver keeps vehicle within the lane lines
3	Deviations in lane in both directions	Vehicle path changes to either right or left of center (original heading), but driver keeps the vehicle within the lane lines; then proceeds to move in the opposite direction, moving past center of the lane, but once again, without exceeding the lane (e.g., weaving within the lane)

4	Close to center line or road edge marking	Vehicle is positioned off-center to the general lane and tires are near lane markings (without having crossed the markings)
5	Lane break to right	At least one tire of vehicle crosses a lane marking on the right side of the vehicle
6	Lane break to left	At least one tire of vehicle crosses a lane marking on the left side of the vehicle
7	Lane break in both directions	At least one tire of vehicle crosses a lane marking on either left or right side and then proceeds to maneuver to other side of lane to cross opposite lane marking
8	Lane change	Driver made a lane change to either the right or the left
9	Ran off road	Drove off road onto shoulder or curb with at least one wheel
10	Unknown	Unable to identify lateral vehicle control from the video or notes

Longitudinal Vehicle Control

0	Normal driving	Driver is performing as expected
1	Decelerating (no brake lights)	Slowing without braking
2	Anticipatory braking or stopping	Driver slowed or stopped without provocation from other traffic.
3	Unanticipated/controlled braking or stopping	Driver was braked or stopped quickly and continued to maintain vehicle control
4	Uncontrolled braking or stopping	Driver braked or stopped quickly, but was unable to control vehicle during maneuver.
5	Skidding	Excessive braking resulting in the wheels to be locked with vehicle sliding and tires may be screeching
6	Accelerating	Moving noticeably faster than previously moving from either stopped/slowed position or from an observable steady pace
7	Unknown	Unable to tell from the video or field notes

Vehicle Control while Turning

0	None	Category not applicable to event
1	Under compensate on curve or turn	Turning too tight for roadway geometry
2	Over compensate on curve or turn	Turning too wide for roadway geometry
3	U-turn maneuver	Driver performing a U-turn
4	Turned into an incorrect lane	Driver did not remain in proper lane upon completing the turn, such as turning into a right through lane versus the left-most through lane
5	Proceeded forward/straight from a turn lane	Driver did not turn and instead proceed straight through an intersection
6	Turned from a through-only lane	

Vehicle Control while Merging (ramp)

0	None	Category not applicable to event
1	Difficulty entering roadway from a merge ramp	

2	Difficult exiting roadway onto a merge ramp	
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Observed Distraction

0	None	Category not applicable to event
1	Internal to vehicle	Examples: reading, cellphone, vehicle center console, cassette or CD.
2	On-road, external to vehicle	Examples: pedestrian, bicycle, animal
3	Off-road, external to vehicle	Examples: pedestrian, bicycle, animal

Failure to Respond

0	None	Category not applicable to event
1	Failed to respond to control	Did not heed control (includes TCDs, signs, and markings)
2	Failed to respond to emergency vehicle	Did not yield or maneuver out of the path of an emergency vehicle

Failure to Yield Right-of-Way

0	None	Category not applicable to event
1	Failure to yield right-of-way—general	Driver proceeds when other traffic has the legal right-of-way (e.g., lane change, merging into traffic, or blocking an intersection or roadway)
2	Failure to yield right-of-way—right turn on red light	Driver does not stop before turning right for a red traffic signal
3	Failed to yield right-of-way to pedestrian(s)	When pedestrians have right of way (i.e., crosswalks) and moving with traffic

Violations--Stopping

0	None	Category not applicable to event
1	Ran red light or stop sign	Driver does not stop for a TCD (red traffic signal or a stop sign)
2	Rolling stop	Driver noticeably decelerates, but does not stop for a TCD prior to entering intersection
3	Stopped on or beyond stop line at an intersection	Resulted in vehicle being forward at intersection or blocking pedestrian walkway, but did not block intersection or roadway for other traffic to proceed

Violations--Turning

0	None	Category not applicable to event
1	Illegal U-turn	Driver performs a U-turn at a location that is posted no U-turn
2	Illegal left turn	Driver performs a left turn at a location that is posted no left turn
3	Illegal right turn	Driver performs a right turn at a location that is posted no right turn
4	Wrong way on one-way	Proceeding opposite of posted direction

Violations--Passing

0	None	Category not applicable to event
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1	Passing in a no-passing zone	Driver passing other traffic in violation of roadway markings (solid line) or posted no-passing zone
2	Driving on shoulder	Using shoulder as a travel lane and by-passing traffic

Forcefulness

0	None	Category not applicable to event
1	Forced another vehicle out of lane	Driver's action resulted in another vehicle having to maneuver out of present lane (onto another portion of the roadway) to avoid collision
2	Forced another vehicle off roadway	Driver's action resulted in another vehicle having to maneuver off of roadway to avoid collision

Avoiding

0	None	Category not applicable to event
1	Avoiding obstruction in road	Evasive maneuver to avoid an object in the roadway (other than another vehicle)
2	Avoiding another vehicle	Evasive action such as suddenly changing lanes to avoid another vehicle
3	Avoiding active emergency vehicle	Responding to an emergency vehicle with lights and/or sirens on

Difficulties Navigating—Intersection

Although logically grouped, the following were treated as individual non-categorical, nominal variables (i.e., observed or unobserved).

0	None	Variable is not applicable
1	Intersection general	Driver had general difficulty navigating the intersection

0	None	Variable is not applicable
1	Intersection angle	Angle of intersection resulted in difficulties maneuvering

0	None	Variable is not applicable
1	Intersection width	Too narrow for maneuver

0	None	Variable is not applicable
1	Grade of intersection approach	Incline or decline into the intersection

Difficulties Navigating—Ramp

0	None	Category not applicable to event
1	Ramp general	Driver had general difficulty navigating the ramp
2	Ramp proper	Driver had difficulty navigating (keeping a steady position) the ramp proper
3	Entrance onto roadway	Driver had difficulty navigating off or ramp onto roadway
4	Exit from roadway	Driver had difficulty navigating off of roadway onto ramp

Difficulties Navigating—Roadway

The following was treated as an individual non-categorical, nominal variables (i.e., observed or unobserved).

0	None	Variable not observed
1	Roadway general	Driver had general difficulty navigating the roadway (e.g., narrow)

Difficulties Navigating—Alignment

Although logically grouped, the following were treated as individual non-categorical, nominal variables (treated as observed or unobserved).

0	None	Variable not observed
1	Superelevation	Visible crown in horizontal alignment of roadway that appeared to affect maneuver

0	None	Variable not observed
1	Curve	Driver had difficulty maneuvering a non-crested vertical curve (change in horizontal alignment)

0	None	Variable not observed
1	Undulation	Undulation in the vertical alignment (topography) that appeared to affect maneuver

0	None	Variable not observed
1	Grade	Incline or decline in vertical alignment that appeared to affect maneuver

0	None	Variable not observed
1	Crested vertical curve	Curve on a hill that appeared to affect maneuver

Gesturing

Although logically grouped, the following were treated as individual non-categorical, nominal variables (treated as observed or unobserved).

0	None	Variable not observed
1	Sounding horn	A driver sounded their vehicle horn as a part of observed event

0	None	Variable not observed
1	Flashing headlights	

0	None	Variable not observed
1	Yelling/Shouting	

0	None	Variable not observed
1	Gesturing with hands	

General Behaviors

The following were treated as an individual non-categorical, nominal variables (i.e., observed or unobserved).

0	None	Variable not observed
1	Vehicle size	Size of vehicle appeared to be too large for infrastructure allowances
0	None	Variable not observed
1	Improper backing or backed-up in traffic	
0	None	Variable not observed
1	Following	Mimicking lead vehicle behavior, maneuvering as if in a train or procession (e.g., following a lead vehicle in proceeding with a right-turn-on red without first stopping to perform maneuver)
0	None	Variable not observed
1	Pulled into traffic or proceeded without clearance	Very limited room to enter traffic, may be exhibited by cutting-off other traffic, forcing self into a line of traffic, blocking an intersection, or forceful merging
0	None	Variable not observed
1	Following closely	Following lead vehicle with less than one car length between the two vehicles
0	None	Variable not observed
1	Speed	Speed of event vehicle was noticeably different from that of surrounding traffic
0	None	Variable not observed
1	Inadequate reaction speed	Failure to proceed or proceeded slowly at a green light; or, late braking although adequate room between vehicles for a slow controlled deceleration
0	None	Variable not observed
1	Defensive maneuver	Driving maneuver (reactive) due to a maneuver performed by another driver
0	None	Variable not observed
1	General traffic congestion	All traffic was noticeably slowed or stopped
0	None	Variable not observed
1	Entered intersection on an amber light	Driver entered intersection when traffic signal was already amber
0	None	Variable not observed
1	Creeping	Having stopped for a TCD, but then very slowly moving forward
0	None	Variable not observed

1	Entered (or started to enter) intersection on a red light	Driver stopped at a traffic light, but started to enter the intersection prior to receiving a green signal. Does not include right-on-red maneuvers.
0	None	Variable not observed
1	No room to respond to emergency vehicle	Driver was unable to move out of the way of an active emergency vehicle

9 Appendix B: Incident Report Form

Date: _____ Location: _____

Time: _____

Weather Conditions: _____ Road Surface

Conditions: _____

Sketch of Site and Conflict



Description

Primary Maneuver(s) (circle all that applicable):				
Incident	Aggressive Behavior	Willful Action	Improper Behavior	Infrastructure

10 Appendix C: Site Inventory Form

Date: _____

Location: _____

Weather conditions: _____

Road conditions: _____

Total number of tapes: _____

Observers: _____

Observation times: _____

Traffic count times: _____

Drive-through time: _____

Detailed sketch of site observed (sketch of site indicating the location of roadway/environmental elements and roadway orientation (N,S,E,W):

Detailed site description:

Additional description of site sketch including:

- *Location of signage and controls relative to traffic*
- *Roadway markings*
- *Road names and direction (N,S,E,W)*
- *Number and direction of through lanes*
- *Number and direction of turn lanes*
- *Through lanes splitting into multiple lanes at intersections/merges*
- *Bike lanes*
- *Pedestrian lanes*

Detailed site inventory:

Take pictures of all legs of intersection/roadway and account primarily for signage and control:

- *Signals (blinking or solid—warning or control, balls or arrows—directions of arrows, and/or timing— set or triggered by traffic)*
- *Roadway markings or lack of roadway markings*
- *Road names*
- *Missing signs or signals*
- *Visibility of signs and signals*
- *Environmental factors such as vegetation, bicyclists, and/or pedestrians*
- *Other directional, instructional, or warning signage/markings*

Special concerns/general observations:

Such as:

- *Noticeable/repeatable problems with traffic patterns*
- *Noticeable infrastructure problems*
- *Description of what drivers/traffic is doing despite controls/enforcement*

11 Appendix D: Institutional Review Board Approval



Office of Sponsored Programs

301 Burruss Hall
Blacksburg, VA, 24061-0249
(540)231-5281 Fax: (540)231-4384

MEMORANDUM

TO: W. W. Wierwille, T. A. Dingus, J M. Hankey, C. A. Kieliszwski
Center for Transportatation Research 0536

FROM: H. T. Hurd 
Director

DATE: June 15, 1999

SUBJECT: IRB EXEMPTION APPROVAL/"Driver Critical Incident
Surveillance Study; Identification and Evaluation of Driver
Errors Project"- IRB #99-183

I have reviewed your request to the IRB for exemption for the above referenced project. I concur that the research falls within the exempt status.

Best wishes.

HTH/baj

cc: R. J. Beaton

12 Appendix E: Chi-Square Values

This appendix contains correlations χ^2 goodness-of-fit results for all predictor variables ($\alpha = 0.05$).

Variable	χ^2	df	Asymptotic Significance	Variable	χ^2	df	Asymptotic Significance
Site Variables	-----	--	-----	Driver Performance Variables	-----	--	-----
Region—Rural	51.750	1	0.000	Pulled into traffic or Proceeded without clearance	7.348	1	0.007
Region—City	73.087	1	0.000	Entered intersection on red light	352.174	1	0.000
Region—Metro	11.837	1	0.001	Inadequate reaction speed	241.315	1	0.000
Geometry—Roadway segment	261.141	1	0.000	Failure to respond to primary control	254.446	1	0.000
Geometry—Merge	92.000	1	0.000	Failure to respond to an active emergency vehicle	360.043	1	0.000
Geometry—T-intersection	169.837	1	0.000	Lateral vehicle control—Lane change	90.011	1	0.000
Geometry—4-legged intersection	113.087	1	0.000	Lateral vehicle control—Deviation in lane in both directions	352.315	1	0.000
Geometry—Offset 4-legged intersection	303.141	1	0.000	Lateral vehicle control—Ran off road	348.272	1	0.000
Geometry—Multi-legged intersection	98.098	1	0.000	Vehicle turn control—Under compensate	332.880	1	0.000
Geometry—All intersection types	43.141	1	0.000	Vehicle turn control—Over compensate	332.880	1	0.000
Road function—Group A	247.837	1	0.000	Backing-up	317.837	1	0.000
Road function—Group B	51.750	1	0.000	Vehicle turn control—U-turn	336.696	1	0.000
Road function—Group C	11.130	1	0.001	Vehicle turn control—Turned into incorrect lane	244.565	1	0.000
Road function—Group D	172.565	1	0.000	Vehicle turn control—Proceeded forward from a turn lane	360.043	1	0.000
Road function—Group E	329.087	1	0.000	Defensive maneuver	225.391	1	0.000
Primary control—Yield sign	113.087	1	0.000	Avoiding—Obstruction in roadway	344.391	1	0.000
Primary control—Stop sign	119.837	1	0.000	No room to respond to an active emergency vehicle	364.011	1	0.000
Primary control—G,Y,R signal without turn arrows	169.837	1	0.000	Gesturing—Sounding horn	340.533	1	0.000
Primary control—G, Y, R signal with turn arrows	48.793	1	0.000	Avoiding—Another vehicle	340.533	1	0.000
Primary control—None	254.446	1	0.000	Violation stopping—Ran red light or stop sign	288.793	1	0.000
Road edge—Paved full shoulder	186.533	1	0.000	Violation stopping—Rolling stop	306.783	1	0.000
Road edge—Soft full shoulder	321.565	1	0.000	Failure to yield right-of-way--General	6.261	1	0.012
Road edge—Paved partial shoulder	219.174	1	0.000	Failure to yield right-of-way—Right turn on red light	306.783	1	0.000
Road edge—Soft partial shoulder	186.533	1	0.000	Violation turning—Illegal U-turn	340.533	1	0.000
Markings—Good condition	11.837	1	0.001	Violations passing—Passing in a no passing zone	364.011	1	0.000
Markings—Fair condition	82.272	1	0.000	Following closely	195.174	1	0.000
Markings—Poor condition	186.533	1	0.000	Force another vehicle out of lane	340.533	1	0.000
Markings—None	364.011	1	0.000	Speed of event vehicle	146.261	1	0.000

Variable	χ^2	df	Asymptotic Significance	Variable	χ^2	df	Asymptotic Significance
Median—Depressed	100.174	1	0.000	Observed difficulties navigating—Intersection angle	285.261	1	0.000
Median—Flush	321.565	1	0.000	Observed difficulties navigating—Intersection width	325.315	1	0.000
Median—Raised	78.533	1	0.000	Observed difficulties navigating—Intersection grade	348.272	1	0.000
Median—None	2.446	1	0.118	Observed difficulties navigating—Ramp	169.837	1	0.000
Barrier—Permanent	27.174	1	0.000	Observed difficulties navigating—Roadway	344.391	1	0.000
Barrier—None	27.174	1	0.000	Observed difficulties navigating—Alignment/Curve	325.315	1	0.000
Sidewalk—Along all roadways	148.793	1	0.000	Observed difficulties navigating—Alignment/Undulation	340.533	1	0.000
Sidewalk—Along most roadways	62.783	1	0.000	Observed difficulties navigating—Grade	321.565	1	0.000
Sidewalk—Along few roadways	241.315	1	0.000	Violations turning—Illegal left turn	299.522	1	0.000
Sidewalk—None	7.348	1	0.007	Violations turning—Illegal right turn	336.696	1	0.000
Obstruction--Vegetation	102.272	1	0.000	Violations turning—Wrong way on one-way	348.272	1	0.000
Obstruction—Advertisement signs	321.565	1	0.000	Violations passing—Driving on shoulder	340.533	1	0.000
Obstruction—Other	321.565	1	0.000	Avoiding active emergency vehicle	364.011	1	0.000
Obstruction—None	57.924	1	0.000	Violation stopping—Stopped beyond stop line	251.130	1	0.000
Posted speed limit	135.804	5	0.000	Creeping into intersection	295.924	1	0.000
Traffic Variables	----	--	----	Vehicle control while turning—Turned from through-only lane	340.533	1	0.000
Hour event occurred	223.853	12	0.000	Following	288.793	1	0.000
Relation--Pre-intersection	271.348	1	0.000	Lateral vehicle control—Lane break in both directions	257.783	1	0.000
Relation—Within intersection	0.011	1	0.917	Lateral vehicle control—No deviation	20.098	1	0.000
Relation--Post-intersection	225.391	1	0.000	Lateral vehicle control—Deviation in lane to right	292.348	1	0.000
Relation—Driveway, alley access, etc.	261.141	1	0.000	Lateral vehicle control—Deviation in lane to left	295.924	1	0.000
Relation—Exiting ramp	306.783	1	0.000	Lateral vehicle control—Lane break to right	213.043	1	0.000
Relation—Entering ramp	251.130	1	0.000	Lateral vehicle control—Lane break to left	180.880	1	0.000
Relation—Roadway	219.174	1	0.000	Lateral vehicle control—Unknown	356.098	1	0.000
Lanes—None, illegal action	306.783	1	0.000	Longitudinal vehicle control—Decelerating	348.272	1	0.000
Lanes—1	26.098	1	0.000	Longitudinal vehicle control—Anticipatory braking	183.696	1	0.000
Lanes—2	92.000	1	0.000	Longitudinal vehicle control—Unanticipated controlled braking	24.011	1	0.000
Lanes—3	271.348	1	0.000	Longitudinal vehicle control—uncontrolled braking	336.696	1	0.000
Lanes—4	364.011	1	0.000	Longitudinal vehicle control—Skidding		1	0.000

Variable	χ^2	df	Asymptotic Significance	Variable	χ^2	df	Asymptotic Significance
Weather—Sunny	104.391	1	0.000	Longitudinal vehicle control—Accelerating	59.522	1	0.000
Weather—Partly cloudy	175.315	1	0.000	Longitudinal vehicle control—Normal driving	219.174	1	0.000
Weather—Cloudy/Overcast	261.141	1	0.000	Longitudinal vehicle control—Unknown	340.533	1	0.000
Visibility—Unlimited	344.391	1	0.000	Signal usage—Signal not required	9.783	1	0.002
Visibility—Glare	356.098	1	0.000	Signal usage—Incorrect signal	352.174	1	0.000
Visibility—Fog	356.098	1	0.000	Signal usage—Correct signal on in advance	153.924	1	0.000
Debris on roadway—Clear/None	364.011	1	0.000	Signal usage—Correct signal not on in advance		1	0.000
Debris on Roadway—Sand	364.011	1	0.000	Signal usage—Signal not used	106.533	1	0.000
Level of Service A	156.522	1	0.000	Signal usage—Unknown	186.533	1	0.000
Level of Service B	115.315	1	0.000				
Level of Service C	2.130	1	0.144				
Level of Service D	204.011	1	0.000				
General traffic congestion	133.924						
Event obstacle—Other obstacle	360.043	1	0.000				
Event obstacle—Pedestrian	362.011	1	0.000				
Event obstacle—Bicyclist	356.098	1	0.000				
Event obstacle—Other vehicle(s)	189.391	1	0.000				
Good surface condition	364.011	1	0.000				
Rough surface condition	364.011	1	0.000				
Markings conditions—Lane lines	360.043	1	0.000				
Markings conditions—Median delineation	360.043	1	0.000				
Markings conditions—Other type of marking	364.011	1	0.000				
Missing regulatory sign(s)	332.880	1	0.000				
Missing warning sign(s)	325.315	1	0.000				
Missing directional or guide sign(s)	299.522	1	0.000				
No pedestrian signal	364.011	1	0.000				
Limitations to sight distance—Other traffic	295.924	1	0.000				
Limitations to sight distance—Geometry	251.130	1	0.000				
Limitations to sight distance—Signage	360.043	1	0.000				
Limitations to sight distance—Pedestrian/Bicyclist	364.011	1	0.000				
Limitations to sight distance—Vegetation	348.272	1	0.000				
Limitations to sight distance—Other	356.098	1	0.000				
Size of event vehicle	336.696	1	0.000				
Location of event	221.842	30	0.000				

13 Appendix F: Contingency Coefficient Tables

This appendix contains correlations between all of the individual levels of severity, maneuver type, and conflict type criterion variables and all predictor variables. Values that are grayed-out were not found to be significant ($\alpha = 0.05$).

13.1 Severity Contingency Coefficient Tables

Contingency correlations between severity levels and all observed site-related variables (N = 368).

		Severity 3	Severity 4	Severity 5	Severity 6
Region—Rural	Coefficient	0.037	0.007	0.061	0.022
	Significance	0.479	0.895	0.240	0.671
Region—City	Coefficient	0.095	0.091	0.015	0.020
	Significance	0.067	0.081	0.781	0.698
Region—Metro	Coefficient	0.052	0.089	0.044	0.002
	Significance	0.319	0.087	0.394	0.962
Geometry—Roadway segment	Coefficient	0.044	0.046	0.008	0.034
	Significance	0.397	0.380	0.873	0.510
Geometry—Merge	Coefficient	0.066	0.044	0.048	0.014
	Significance	0.206	0.397	0.356	0.795
Geometry—T-intersection	Coefficient	0.008	0.002	0.010	0.051
	Significance	0.876	0.971	0.851	0.325
Geometry—4-legged intersection	Coefficient	0.062	0.055	0.040	0.050
	Significance	0.234	0.289	0.442	0.338
Geometry—Offset 4-legged intersection	Coefficient	0.079	0.063	0.027	0.026
	Significance	0.129	0.229	0.602	0.620
Geometry—Multi-legged intersection	Coefficient	0.067	0.070	0.010	0.043
	Significance	0.197	0.178	0.847	0.406
Geometry—All intersection types	Coefficient	0.035	0.014	0.049	0.032
	Significance	0.497	0.782	0.346	0.537
Road function—Group A	Coefficient	0.050	0.069	0.004	0.037
	Significance	0.334	0.184	0.931	0.480
Road function—Group B	Coefficient	0.110	0.089	0.061	0.028
	Significance	0.034	0.087	0.240	0.585
Road function—Group C	Coefficient	0.022	0.017	0.046	0.092
	Significance	0.678	0.738	0.375	0.077
Road function—Group D	Coefficient	0.157	0.119	0.064	0.051
	Significance	0.002	0.021	0.220	0.330
Road function—Group E	Coefficient	0.018	0.054	0.116	0.020
	Significance	0.725	0.296	0.025	0.707
Primary control—Yield sign	Coefficient	0.102	0.067	0.071	0.006
	Significance	0.049	0.197	0.172	0.902
Primary control—Stop sign	Coefficient	0.076	0.091	0.012	0.053
	Significance	0.144	0.080	0.824	0.310
Primary control—G,Y,R signal without turn arrows	Coefficient	0.007	0.033	0.041	0.013
	Significance	0.887	0.529	0.435	0.808
Primary control—G, Y, R signal with turn arrows	Coefficient	0.004	0.028	0.022	0.030
	Significance	0.943	0.596	0.667	0.569
Primary control—None	Coefficient	0.057	0.055	0.002	0.036
	Significance	0.273	0.288	0.974	0.495
Road edge—Paved full shoulder	Coefficient	0.058	0.078	0.001	0.048
	Significance	0.266	0.132	0.984	0.356
Road edge—Soft full shoulder	Coefficient	0.027	0.005	0.045	0.022
	Significance	0.611	0.928	0.390	0.679
Road edge—Paved partial shoulder	Coefficient	0.007	0.001	0.000	0.032
	Significance	0.893	0.987	0.998	0.543
Road edge—Soft partial shoulder	Coefficient	0.007	0.048	0.078	0.048
	Significance	0.892	0.352	0.134	0.356
Road edge—Curb (no shoulder)	Coefficient	0.050	0.022	0.071	0.055
	Significance	0.337	0.668	0.175	0.286
Markings—Good condition	Coefficient	0.040	0.037	0.007	0.045
	Significance	0.439	0.473	0.896	0.385
Markings—Fair condition	Coefficient	0.042	0.069	0.047	0.036
	Significance	0.418	0.183	0.369	0.486
Markings—Poor condition	Coefficient	0.009	0.030	0.052	0.019
	Significance	0.860	0.560	0.321	0.720
Markings—None	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Median—Depressed	Coefficient	0.059	0.029	0.057	0.011
	Significance	0.260	0.575	0.273	0.836
Median—Flush	Coefficient	0.027	0.005	0.045	0.022
	Significance	0.611	0.928	0.390	0.679
Median—Raised	Coefficient	0.044	0.024	0.071	0.087
	Significance	0.397	0.645	0.171	0.093
Median—None	Coefficient	0.020	0.005	0.001	0.061
	Significance	0.695	0.919	0.979	0.242
Barrier—Permanent	Coefficient	0.040	0.013	0.024	0.057
	Significance	0.440	0.808	0.643	0.270
Barrier—None	Coefficient	0.040	0.013	0.024	0.057
	Significance	0.440	0.808	0.643	0.270

		Severity 3	Severity 4	Severity 5	Severity 6
Sidewalk—Along all roadways	Coefficient	0.078	0.050	0.057	0.005
	Significance	0.132	0.339	0.275	0.917
Sidewalk—Along most roadways	Coefficient	0.018	0.030	0.006	0.024
	Significance	0.730	0.560	0.916	0.644
Sidewalk—Along few roadways	Coefficient	0.035	0.057	0.042	0.042
	Significance	0.496	0.273	0.421	0.421
Sidewalk—None	Coefficient	0.024	0.023	0.074	0.007
	Significance	0.651	0.660	0.154	0.894
Obstruction—Vegetation	Coefficient	0.017	0.003	0.028	0.010
	Significance	0.745	0.955	0.594	0.847
Obstruction—Advertisement signs	Coefficient	0.090	0.112	0.007	0.022
	Significance	0.082	0.031	0.888	0.679
Obstruction—Other	Coefficient	0.027	0.005	0.045	0.022
	Significance	0.611	0.928	0.390	0.679
Obstruction—None	Coefficient	0.030	0.048	0.011	0.026
	Significance	0.569	0.357	0.829	0.618
Posted speed limit	Coefficient	0.087	0.101	0.085	0.077
	Significance	0.734	0.584	0.752	0.821

Contingency correlations between severity levels and all observed traffic-related variables (N = 368).

		Severity 3	Severity 4	Severity 5	Severity 6
Hour event occurred	Coefficient	0.222	0.141	0.170	0.255
	Significance	0.088	0.827	0.537	0.012
Relation—Pre-intersection	Coefficient	0.023	0.030	0.017	0.059
	Significance	0.656	0.562	0.743	0.256
Relation—Within intersection	Coefficient	0.030	0.022	0.045	0.071
	Significance	0.562	0.667	0.393	0.173
Relation—Post-intersection	Coefficient	0.035	0.012	0.024	0.041
	Significance	0.501	0.824	0.646	0.432
Relation—Driveway, alley access, etc.	Coefficient	0.040	0.025	0.043	0.034
	Significance	0.437	0.629	0.413	0.510
Relation—Exiting ramp	Coefficient	0.012	0.068	0.069	0.025
	Significance	0.815	0.193	0.185	0.631
Relation—Entering ramp	Coefficient	0.038	0.053	0.001	0.036
	Significance	0.468	0.309	0.978	0.487
Relation—Roadway	Coefficient	0.025	0.041	0.116	0.042
	Significance	0.632	0.432	0.025	0.419
Lanes—None, illegal action	Coefficient	0.016	0.005	0.024	0.025
	Significance	0.762	0.917	0.649	0.631
Lanes—1	Coefficient	0.023	0.043	0.022	0.008
	Significance	0.657	0.405	0.669	0.877
Lanes—2	Coefficient	0.013	0.029	0.005	0.041
	Significance	0.800	0.572	0.918	0.435
Lanes—3	Coefficient	0.001	0.030	0.055	0.032
	Significance	0.985	0.562	0.290	0.535
Lanes—4	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Weather—Sunny	Coefficient	0.039	0.022	0.113	0.046
	Significance	0.451	0.679	0.030	0.376
Weather—Partly cloudy	Coefficient	0.045	0.024	0.112	0.015
	Significance	0.393	0.644	0.030	0.779
Weather—Cloudy/Overcast	Coefficient	0.002	0.002	0.026	0.053
	Significance	0.972	0.976	0.617	0.311
Visibility—Unlimited	Coefficient	0.094	0.072	0.042	0.015
	Significance	0.071	0.166	0.423	0.772
Visibility—Glare	Coefficient	0.066	0.051	0.029	0.011
	Significance	0.204	0.330	0.573	0.838
Visibility—Fog	Coefficient	0.066	0.051	0.029	0.011
	Significance	0.204	0.330	0.573	0.838
Debris on roadway—Clear/None	Coefficient	0.071	0.029	0.159	0.006
	Significance	0.170	0.575	0.002	0.906
Debris on Roadway—Sand	Coefficient	0.071	0.029	0.159	0.006
	Significance	0.170	0.575	0.002	0.906
Level of Service A	Coefficient	0.041	0.022	0.071	0.070
	Significance	0.429	0.674	0.172	0.179
Level of Service B	Coefficient	0.030	0.036	0.007	0.006
	Significance	0.566	0.485	0.899	0.913
Level of Service C	Coefficient	0.010	0.068	0.077	0.015
	Significance	0.849	0.190	0.137	0.780
Level of Service D	Coefficient	0.040	0.043	0.015	0.045
	Significance	0.441	0.412	0.778	0.389
Level of Service E	Coefficient	0.041	0.028	0.031	0.015
	Significance	0.430	0.585	0.547	0.772
Number of vehicles in event	Coefficient	0.146	0.154	0.118	0.412
	Significance	0.530	0.444	0.816	0.000
General traffic congestion	Coefficient	0.034	0.023	0.001	0.058
	Significance	0.512	0.655	0.980	0.263
Event obstacle—Other obstacle	Coefficient	0.024	0.041	0.101	0.009
	Significance	0.650	0.427	0.050	0.868
Event obstacle—Pedestrian	Coefficient	0.071	0.029	0.159	0.006
	Significance	0.170	0.575	0.002	0.906
Event obstacle—Bicyclist	Coefficient	0.003	0.020	0.029	0.011
	Significance	0.958	0.701	0.573	0.838

		Severity 3	Severity 4	Severity 5	Severity 6
Event obstacle—Other vehicle(s)	Coefficient	0.129	0.029	0.159	0.020
	Significance	0.013	0.583	0.002	0.704
Good surface condition	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Rough surface condition	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Markings conditions—Lane lines	Coefficient	0.024	0.045	0.024	0.009
	Significance	0.650	0.386	0.646	0.868
Markings conditions—Median delineation	Coefficient	0.054	0.041	0.024	0.009
	Significance	0.300	0.427	0.646	0.868
Markings conditions—Other type of marking	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Missing regulatory sign(s)	Coefficient	0.005	0.006	0.009	0.019
	Significance	0.926	0.904	0.868	0.721
Missing warning sign(s)	Coefficient	0.061	0.024	0.057	0.021
	Significance	0.241	0.651	0.275	0.693
Missing directional or guide sign(s)	Coefficient	0.086	0.068	0.073	0.082
	Significance	0.098	0.192	0.158	0.115
No pedestrian signal	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Limitations to sight distance—Other traffic	Coefficient	0.016	0.013	0.034	0.027
	Significance	0.763	0.801	0.517	0.599
Limitations to sight distance—Geometry	Coefficient	0.018	0.030	0.001	0.036
	Significance	0.736	0.559	0.978	0.487
Limitations to sight distance—Signage	Coefficient	0.024	0.045	0.024	0.009
	Significance	0.650	0.386	0.646	0.868
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Limitations to sight distance—Vegetation	Coefficient	0.013	0.066	0.121	0.014
	Significance	0.805	0.207	0.019	0.792
Limitations to sight distance—Other	Coefficient	0.066	0.051	0.029	0.011
	Significance	0.204	0.330	0.573	0.838
Size of event vehicle	Coefficient	0.009	0.004	0.048	0.142
	Significance	0.870	0.942	0.354	0.006
Location of event	Coefficient	0.287	0.274	0.246	0.298
	Significance	0.323	0.470	0.787	0.214

Contingency correlations between severity levels and all observed driver performance-related variables (N = 368).

		Severity 3	Severity 4	Severity 5	Severity 6
Pulled into traffic or Proceeded without clearance	Coefficient	0.115	0.067	0.111	0.054
	Significance	0.026	0.198	0.032	0.297
Entered intersection on red light	Coefficient	0.076	0.059	0.034	0.012
	Significance	0.142	0.260	0.514	0.813
Inadequate reaction speed	Coefficient	0.074	0.008	0.115	0.042
	Significance	0.153	0.878	0.026	0.421
Failure to respond to primary control	Coefficient	0.037	0.009	0.065	0.049
	Significance	0.482	0.856	0.213	0.348
Failure to respond to an active emergency vehicle	Coefficient	0.024	0.041	0.101	0.009
	Significance	0.650	0.427	0.050	0.868
Failure to yield right-of-way to pedestrian	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Lateral vehicle control—Close to center line or road edge marking	Coefficient	0.003	0.020	0.029	0.011
	Significance	0.958	0.701	0.573	0.838
Lateral vehicle control—Lane change	Coefficient	0.151	0.070	0.109	0.093
	Significance	0.003	0.181	0.050	0.072
Lateral vehicle control—Deviation in lane in both directions	Coefficient	0.039	0.014	0.003	0.116
	Significance	0.451	0.791	0.962	0.025
Lateral vehicle control—Ran off road	Coefficient	0.111	0.011	0.042	0.365
	Significance	0.033	0.836	0.421	0.000
Vehicle turn control—Under compensate	Coefficient	0.032	0.006	0.009	0.132
	Significance	0.538	0.904	0.868	0.011
Vehicle turn control—Over compensate	Coefficient	0.069	0.117	0.051	0.019
	Significance	0.185	0.024	0.325	0.721
Backing-up	Coefficient	0.046	0.038	0.038	0.226
	Significance	0.381	0.463	0.462	0.000
Vehicle turn control—U-turn	Coefficient	0.070	0.040	0.048	0.017
	Significance	0.181	0.444	0.354	0.737
Vehicle turn control—Turned into incorrect lane	Coefficient	0.023	0.063	0.039	0.037
	Significance	0.657	0.226	0.449	0.473
Vehicle turn control—Proceeded forward from a turn lane	Coefficient	0.024	0.041	0.024	0.297
	Significance	0.650	0.427	0.646	0.000
Defensive maneuver	Coefficient	0.111	0.131	0.006	0.041
	Significance	0.032	0.012	0.911	0.432
Avoiding—Obstruction in roadway	Coefficient	0.086	0.028	0.031	0.168
	Significance	0.098	0.585	0.547	0.001
No room to respond to an active emergency vehicle	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Gesturing—Sounding horn	Coefficient	0.024	0.015	0.023	0.016
	Significance	0.651	0.770	0.664	0.754
Avoiding—Another vehicle	Coefficient	0.107	0.108	0.023	0.016
	Significance	0.040	0.037	0.664	0.754
Violation stopping—Ran red light or stop sign	Coefficient	0.042	0.027	0.040	0.029
	Significance	0.424	0.606	0.442	0.580

		Severity 3	Severity 4	Severity 5	Severity 6
Violation stopping—Rolling stop	Coefficient	0.016	0.026	0.024	0.090
	Significance	0.762	0.621	0.649	0.084
Failure to yield right-of-way--General	Coefficient	0.053	0.003	0.041	0.102
	Significance	0.304	0.949	0.427	0.048
Failure to yield right-of-way—Right turn on red light	Coefficient	0.040	0.005	0.022	0.090
	Significance	0.441	0.917	0.677	0.084
Violation turning—Illegal U-turn	Coefficient	0.060	0.031	0.045	0.016
	Significance	0.250	0.547	0.386	0.754
Entered intersection on an amber light	Coefficient	0.036	0.011	0.038	0.014
	Significance	0.485	0.836	0.465	0.792
Violations passing—Passing in a no passing zone	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Following closely	Coefficient	0.023	0.018	0.020	0.022
	Significance	0.657	0.733	0.695	0.673
Force another vehicle out of lane	Coefficient	0.147	0.108	0.090	0.016
	Significance	0.004	0.037	0.083	0.754
Speed of event vehicle	Coefficient	0.010	0.053	0.084	0.056
	Significance	0.854	0.305	0.106	0.284
Observed difficulties navigating—Intersection angle	Coefficient	0.016	0.007	0.004	0.030
	Significance	0.763	0.893	0.945	0.570
Observed difficulties navigating—Intersection width	Coefficient	0.006	0.024	0.052	0.021
	Significance	0.911	0.651	0.320	0.693
Observed difficulties navigating—Intersection grade	Coefficient	0.013	0.044	0.038	0.014
	Significance	0.805	0.396	0.465	0.792
Observed difficulties navigating—Ramp	Coefficient	0.069	0.067	0.015	0.076
	Significance	0.182	0.195	0.767	0.141
Observed difficulties navigating—Roadway	Coefficient	0.004	0.028	0.042	0.015
	Significance	0.940	0.585	0.423	0.772
Observed difficulties navigating—Alignment/Curve	Coefficient	0.028	0.061	0.003	0.116
	Significance	0.595	0.242	0.962	0.025
Observed difficulties navigating—Alignment/ Undulation	Coefficient	0.018	0.015	0.045	0.016
	Significance	0.728	0.770	0.386	0.754
Observed difficulties navigating—Grade	Coefficient	0.006	0.041	0.059	0.022
	Significance	0.915	0.437	0.254	0.679
Violations turning—Illegal left turn	Coefficient	0.020	0.079	0.073	0.027
	Significance	0.708	0.127	0.158	0.610
Violations turning—Illegal right turn	Coefficient	0.009	0.004	0.015	0.017
	Significance	0.870	0.942	0.771	0.737
Violations turning—Wrong way on one-way	Coefficient	0.036	0.011	0.038	0.014
	Significance	0.485	0.836	0.465	0.792
Violations passing—Driving on shoulder	Coefficient	0.024	0.015	0.023	0.016
	Significance	0.651	0.770	0.664	0.754
Avoiding active emergency vehicle	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Violation stopping—Stopped beyond stop line	Coefficient	0.023	0.015	0.001	0.036
	Significance	0.661	0.777	0.978	0.487
Creeping into intersection	Coefficient	0.093	0.101	0.008	0.027
	Significance	0.074	0.050	0.877	0.599
Vehicle control while turning—Turned from through-only lane	Coefficient	0.060	0.031	0.045	0.016
	Significance	0.250	0.547	0.386	0.754
Following	Coefficient	0.007	0.028	0.000	0.072
	Significance	0.886	0.590	0.998	0.165
Lateral vehicle control—Lane break in both directions	Coefficient	0.074	0.066	0.005	0.051
	Significance	0.154	0.207	0.924	0.330
Lateral vehicle control—No deviation	Coefficient	0.173	0.159	0.049	0.004
	Significance	0.001	0.002	0.344	0.938
Lateral vehicle control—Deviation in lane to right	Coefficient	0.076	0.118	0.037	0.028
	Significance	0.142	0.023	0.479	0.589
Lateral vehicle control—Deviation in lane to left	Coefficient	0.036	0.013	0.050	0.027
	Significance	0.491	0.801	0.338	0.599
Lateral vehicle control—Lane break to right	Coefficient	0.151	0.107	0.108	0.043
	Significance	0.003	0.039	0.037	0.407
Lateral vehicle control—Lane break to left	Coefficient	0.046	0.051	0.032	0.082
	Significance	0.378	0.329	0.540	0.114
Lateral vehicle control—Unknown	Coefficient	0.066	0.051	0.029	0.011
	Significance	0.204	0.330	0.573	0.838
Longitudinal vehicle control—Decelerating	Coefficient	0.085	0.066	0.038	0.014
	Significance	0.100	0.207	0.465	0.792
Longitudinal vehicle control—Anticipatory braking	Coefficient	0.156	0.088	0.108	0.049
	Significance	0.002	0.090	0.038	0.350
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient	0.039	0.108	0.058	0.090
	Significance	0.448	0.037	0.265	0.083
Longitudinal vehicle control—uncontrolled braking	Coefficient	0.200	0.083	0.316	0.291
	Significance	0.000	0.109	0.000	0.000
Longitudinal vehicle control—Skidding	Coefficient	0.061	0.020	0.029	0.243
	Significance	0.244	0.701	0.573	0.000
Longitudinal vehicle control—Accelerating	Coefficient	0.059	0.037	0.071	0.076
	Significance	0.257	0.472	0.170	0.142
Longitudinal vehicle control—Normal driving	Coefficient	0.082	0.101	0.029	0.105
	Significance	0.113	0.053	0.578	0.043
Longitudinal vehicle control—Unknown	Coefficient	0.107	0.108	0.023	0.016
	Significance	0.040	0.037	0.664	0.754
Signal usage—Signal not required	Coefficient	0.076	0.049	0.068	0.043
	Significance	0.145	0.343	0.189	0.407
Signal usage—Incorrect signal	Coefficient	0.076	0.059	0.034	0.012
	Significance	0.142	0.260	0.514	0.813
Signal usage—Correct signal on in advance	Coefficient	0.036	0.024	0.020	0.007
	Significance	0.493	0.641	0.703	0.890

		Severity 3	Severity 4	Severity 5	Severity 6
Signal usage—Correct signal not on in advance	Coefficient	0.018	0.078	0.090	0.016
	Significance	0.728	0.134	0.083	0.754
Signal usage—Signal not used	Coefficient	0.153	0.145	0.064	0.064
	Significance	0.003	0.005	0.219	0.217
Signal usage—Unknown	Coefficient	0.088	0.085	0.027	0.019
	Significance	0.090	0.104	0.598	0.720

Contingency correlations between severity levels and all maneuver and conflict types (N = 368).

		Severity 3	Severity 4	Severity 5	Severity 6
Left Turn Maneuver	Coefficient	0.044	0.077	0.014	0.067
	Significance	0.396	0.138	0.787	0.197
Conflict 10	Coefficient	0.023	0.045	0.020	0.024
	Significance	0.665	0.382	0.701	0.643
Conflict 11	Coefficient	0.026	0.045	0.032	0.023
	Significance	0.619	0.389	0.535	0.654
Conflict 12	Coefficient	0.063	0.055	0.032	0.023
	Significance	0.223	0.291	0.535	0.654
Conflict 13	Coefficient	0.033	0.064	0.034	0.012
	Significance	0.521	0.219	0.514	0.813
Conflict 14	Coefficient	0.054	0.041	0.024	0.009
	Significance	0.300	0.427	0.646	0.868
Conflict 15	Coefficient	0.024	0.066	0.045	0.030
	Significance	0.651	0.207	0.383	0.561
Conflict 16	Coefficient	0.061	0.090	0.029	0.011
	Significance	0.244	0.081	0.573	0.838
Conflict 17	Coefficient	0.061	0.020	0.073	0.011
	Significance	0.244	0.701	0.158	0.838
Conflict 18	Coefficient	0.036	0.011	0.038	0.014
	Significance	0.485	0.836	0.465	0.792
Conflict 19	Coefficient	0.003	0.020	0.029	0.011
	Significance	0.958	0.701	0.573	0.838
Conflict 100	Coefficient	0.054	0.041	0.024	0.009
	Significance	0.300	0.427	0.646	0.868
Conflict 101	Coefficient	0.054	0.041	0.024	0.009
	Significance	0.300	0.427	0.646	0.868
Conflict 102	Coefficient	0.071	0.029	0.159	0.006
	Significance	0.170	0.575	0.002	0.906
Right Turn Maneuver	Coefficient	0.052	0.038	0.045	0.044
	Significance	0.321	0.460	0.383	0.395
Conflict 20	Coefficient	0.062	0.044	0.042	0.014
	Significance	0.233	0.396	0.421	0.792
Conflict 21	Coefficient	0.044	0.026	0.024	0.025
	Significance	0.401	0.621	0.649	0.631
Conflict 23	Coefficient	0.088	0.064	0.055	0.012
	Significance	0.089	0.219	0.288	0.813
Conflict 24	Coefficient	0.031	0.040	0.015	0.017
	Significance	0.557	0.444	0.771	0.737
Conflict 25	Coefficient	0.101	0.045	0.101	0.009
	Significance	0.052	0.386	0.050	0.868
Conflict 26	Coefficient	0.086	0.078	0.031	0.015
	Significance	0.098	0.131	0.547	0.772
Conflict 27	Coefficient	0.076	0.059	0.034	0.012
	Significance	0.142	0.260	0.514	0.813
Conflict 28	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Lane Change Maneuver	Coefficient	0.086	0.004	0.120	0.033
	Significance	0.099	0.939	0.021	0.526
Conflict 30	Coefficient	0.023	0.019	0.074	0.024
	Significance	0.665	0.717	0.157	0.643
Conflict 31	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Conflict 33	Coefficient	0.062	0.016	0.091	0.078
	Significance	0.237	0.764	0.078	0.131
Conflict 34	Coefficient	0.024	0.045	0.024	0.009
	Significance	0.650	0.386	0.646	0.868
Conflict 35	Coefficient	0.024	0.045	0.024	0.009
	Significance	0.650	0.386	0.646	0.868
Conflict 38	Coefficient	0.024	0.041	0.101	0.009
	Significance	0.650	0.427	0.050	0.868
Same Direction Maneuver	Coefficient	0.091	0.097	0.043	0.091
	Significance	0.078	0.061	0.409	0.079
Conflict 40	Coefficient	0.128	0.125	0.026	0.001
	Significance	0.014	0.016	0.617	0.983
Conflict 41	Coefficient	0.012	0.037	0.024	0.025
	Significance	0.815	0.482	0.649	0.631
Conflict 42	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Conflict 43	Coefficient	0.024	0.041	0.024	0.297
	Significance	0.650	0.427	0.646	0.000
Conflict 44	Coefficient	0.071	0.029	0.017	0.406
	Significance	0.170	0.575	0.745	0.000
Forward Maneuver	Coefficient	0.152	0.126	0.079	0.037
	Significance	0.003	0.015	0.127	0.474

		Severity 3	Severity 4	Severity 5	Severity 6
Conflict 50	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Conflict 51	Coefficient	0.154	0.119	0.069	0.025
	Significance	0.003	0.022	0.185	0.631
Conflict 52	Coefficient	0.101	0.078	0.045	0.016
	Significance	0.051	0.134	0.386	0.754
Conflict 53	Coefficient	0.094	0.072	0.042	0.015
	Significance	0.071	0.166	0.423	0.772
Conflict 54	Coefficient	0.071	0.029	0.159	0.006
	Significance	0.170	0.575	0.002	0.906
Conflict 56	Coefficient	0.024	0.041	0.024	0.297
	Significance	0.650	0.427	0.646	0.000
Conflict 57	Coefficient	0.013	0.044	0.038	0.014
	Significance	0.805	0.396	0.465	0.792
Enter Ramp Maneuver	Coefficient	0.053	0.063	0.003	0.020
	Significance	0.306	0.227	0.957	0.707
Conflict 60	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Conflict 61	Coefficient	0.061	0.090	0.029	0.011
	Significance	0.244	0.081	0.573	0.838
Conflict 62	Coefficient	0.041	0.028	0.031	0.015
	Significance	0.430	0.585	0.547	0.772
Ramp Proper Maneuver	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Conflict 71	Coefficient	0.071	0.093	0.017	0.006
	Significance	0.170	0.074	0.745	0.906
Exit Ramp Maneuver	Coefficient	0.027	0.055	0.021	0.040
	Significance	0.610	0.288	0.682	0.438
Conflict 80	Coefficient	0.004	0.022	0.016	0.023
	Significance	0.941	0.677	0.758	0.654
Conflict 83	Coefficient	0.030	0.051	0.014	0.032
	Significance	0.570	0.326	0.790	0.543
Pedestrian/Bicycle Maneuver	Coefficient	0.024	0.015	0.023	0.016
	Significance	0.651	0.770	0.664	0.754
Conflict 90	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906
Conflict 91	Coefficient	0.062	0.044	0.042	0.014
	Significance	0.233	0.396	0.421	0.792
Conflict 93	Coefficient	0.038	0.029	0.017	0.006
	Significance	0.465	0.575	0.745	0.906

13.2 Left Turn Contingency Correlation Tables

Correlations between left turn maneuver and conflict types and all site-related variables (N = 368).

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Region—Rural	Coefficient	0.048	0.020	0.019	0.199	0.042	0.05	0.005	0.061	0.069	0.079	0.061	0.050	0.030	0.035
	Significance	0.353	0.696	0.713	0.000	0.416	0.339	0.931	0.241	0.184	0.129	0.241	0.339	0.566	0.500
Region—City	Coefficient	0.017	0.066	0.036	0.060	0.065	0.037	0.091	0.011	0.011	0.020	0.011	0.046	0.046	0.032
	Significance	0.741	0.204	0.496	0.252	0.213	0.480	0.081	0.827	0.827	0.698	0.827	0.380	0.380	0.535
Region—Metro	Coefficient	0.030	0.079	0.050	0.136	0.019	0.013	0.078	0.047	0.075	0.093	0.047	0.088	0.013	0.062
	Significance	0.565	0.127	0.334	0.009	0.714	0.796	0.132	0.365	0.147	0.074	0.365	0.089	0.796	0.230
Geometry—Roadway segment	Coefficient	0.120	0.009	0.005	0.058	0.031	0.022	0.075	0.027	0.027	0.034	0.027	0.022	0.022	0.015
	Significance	0.020	0.859	0.917	0.265	0.556	0.678	0.147	0.611	0.611	0.510	0.611	0.678	0.678	0.770
Geometry—Merge	Coefficient	0.302	0.118	0.114	0.114	0.060	0.043	0.147	0.052	0.052	0.068	0.052	0.043	0.043	0.030
	Significance	0.000	0.022	0.028	0.028	0.246	0.413	0.004	0.315	0.315	0.194	0.315	0.413	0.413	0.563
Geometry—T-intersection	Coefficient	0.109	0.240	0.048	0.048	0.097	0.032	0.101	0.040	0.040	0.051	0.040	0.032	0.032	0.119
	Significance	0.035	0.000	0.355	0.355	0.063	0.535	0.052	0.447	0.447	0.325	0.447	0.535	0.535	0.022
Geometry—4-legged intersection	Coefficient	0.175	0.077	0.030	0.164	0.007	0.049	0.130	0.096	0.106	0.024	0.024	0.040	0.040	0.028
	Significance	0.001	0.138	0.564	0.001	0.896	0.345	0.012	0.064	0.644	0.041	0.644	0.448	0.448	0.592
Geometry—Offset 4-legged intersection	Coefficient	0.054	0.045	0.091	0.044	0.023	0.016	0.050	0.123	0.020	0.026	0.020	0.158	0.016	0.011
	Significance	0.301	0.384	0.079	0.401	0.658	0.755	0.336	0.017	0.702	0.620	0.702	0.002	0.755	0.826
Geometry—Multi-legged intersection	Coefficient	0.102	0.012	0.086	0.053	0.002	0.042	0.041	0.051	0.090	0.043	0.090	0.045	0.130	0.029
	Significance	0.049	0.819	0.096	0.304	0.969	0.423	0.432	0.326	0.084	0.406	0.084	0.393	0.012	0.572
Geometry—All intersection types	Coefficient	0.340	0.114	0.108	0.138	0.073	0.027	0.178	0.063	0.063	0.082	0.063	0.052	0.052	0.037
	Significance	0.000	0.027	0.037	0.008	0.159	0.605	0.001	0.224	0.224	0.115	0.224	0.321	0.321	0.483
Road function—Group A	Coefficient	0.177	0.065	0.062	0.062	0.033	0.023	0.081	0.028	0.028	0.037	0.028	0.023	0.023	0.016
	Significance	0.001	0.215	0.231	0.231	0.528	0.656	0.120	0.585	0.585	0.480	0.585	0.656	0.656	0.753
Road function—Group B	Coefficient	0.127	0.039	0.133	0.011	0.098	0.03	0.077	0.061	0.061	0.079	0.061	0.050	0.050	0.073
	Significance	0.014	0.455	0.010	0.826	0.058	0.566	0.139	0.241	0.241	0.129	0.241	0.339	0.339	0.137
Road function—Group C	Coefficient	0.144	0.022	0.035	0.064	0.035	0.062	0.057	0.015	0.047	0.139	0.107	0.013	0.088	0.044
	Significance	0.005	0.667	0.500	0.220	0.505	0.234	0.274	0.778	0.370	0.007	0.038	0.802	0.091	0.401
Road function—Group D	Coefficient	0.080	0.014	0.146	0.047	0.045	0.069	0.042	0.126	0.044	0.051	0.039	0.069	0.032	0.023
	Significance	0.122	0.792	0.005	0.367	0.384	0.183	0.416	0.015	0.402	0.330	0.452	0.183	0.540	0.665
Road function—Group E	Coefficient	0.059	0.034	0.054	0.054	0.018	0.012	0.095	0.015	0.015	0.020	0.015	0.012	0.012	0.009
	Significance	0.256	0.509	0.299	0.299	0.737	0.813	0.069	0.771	0.771	0.707	0.771	0.813	0.813	0.867
Primary control—Yield sign	Coefficient	0.293	0.110	0.106	0.106	0.056	0.04	0.137	0.048	0.048	0.063	0.048	0.040	0.040	0.028
	Significance	0.000	0.034	0.041	0.041	0.282	0.448	0.008	0.352	0.352	0.228	0.352	0.448	0.448	0.592
Primary control—Stop sign	Coefficient	0.129	0.074	0.069	0.170	0.009	0.051	0.110	0.026	0.026	0.061	0.026	0.039	0.039	0.027
	Significance	0.013	0.154	0.186	0.001	0.863	0.324	0.033	0.615	0.615	0.239	0.615	0.458	0.458	0.601
Primary control—G, Y, R signal without turn arrows	Coefficient	0.041	0.053	0.106	0.048	0.046	0.032	0.021	0.040	0.124	0.076	0.040	0.068	0.167	0.023
	Significance	0.427	0.313	0.041	0.355	0.38	0.535	0.687	0.447	0.016	0.141	0.447	0.189	0.001	0.662
Primary control—G, Y, R signal with turn arrows	Coefficient	0.187	0.209	0.044	0.017	0.097	0.05	0.089	0.068	0.062	0.071	0.068	0.029	0.050	0.076
	Significance	0.000	0.000	0.396	0.748	0.062	0.333	0.088	0.193	0.235	0.173	0.193	0.579	0.333	0.142
Primary control—None	Coefficient	0.105	0.013	0.009	0.060	0.032	0.11	0.078	0.027	0.027	0.036	0.027	0.022	0.022	0.016
	Significance	0.042	0.802	0.860	0.247	0.542	0.034	0.133	0.598	0.598	0.495	0.598	0.667	0.667	0.761
Road edge—Paved full shoulder	Coefficient	0.229	0.084	0.081	0.081	0.043	0.03	0.105	0.037	0.037	0.048	0.037	0.030	0.030	0.021
	Significance	0.000	0.105	0.118	0.118	0.409	0.561	0.042	0.476	0.476	0.356	0.476	0.561	0.561	0.681
Road edge—Soft full shoulder	Coefficient	0.105	0.038	0.036	0.036	0.019	0.014	0.047	0.017	0.017	0.022	0.017	0.014	0.014	0.010
	Significance	0.044	0.468	0.484	0.484	0.712	0.795	0.363	0.749	0.749	0.679	0.749	0.795	0.795	0.854
Road edge—Paved partial shoulder	Coefficient	0.008	0.056	0.027	0.107	0.045	0.027	0.057	0.033	0.033	0.042	0.033	0.027	0.027	0.019
	Significance	0.883	0.286	0.608	0.040	0.390	0.611	0.271	0.532	0.532	0.419	0.532	0.611	0.611	0.719
Road edge—Soft partial shoulder	Coefficient	0.038	0.084	0.041	0.120	0.032	0.03	0.022	0.037	0.037	0.048	0.037	0.030	0.030	0.021
	Significance	0.469	0.105	0.430	0.021	0.544	0.561	0.673	0.476	0.476	0.356	0.476	0.561	0.561	0.681
Road edge—Curb (no shoulder)	Coefficient	0.230	0.097	0.116	0.083	0.014	0.065	0.113	0.079	0.079	0.102	0.079	0.065	0.065	0.046
	Significance	0.000	0.061	0.025	0.109	0.791	0.214	0.030	0.127	0.127	0.048	0.127	0.214	0.214	0.380
Markings—Good condition	Coefficient	0.256	0.188	0.065	0.065	0.072	0.062	0.104	0.014	0.047	0.093	0.014	0.013	0.088	0.062
	Significance	0.000	0.000	0.212	0.212	0.165	0.237	0.046	0.785	0.365	0.074	0.785	0.796	0.089	0.230

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Markings—Fair condition	Coefficient Significance	0.169 0.001	0.185 0.000	0.042 0.418	0.086 0.096	0.056 0.281	0.044 0.396	0.075 0.151	0.054 0.298	0.083 0.112	0.036 0.486	0.014 0.783	0.040 0.447	0.123 0.018	0.087 0.094
Markings—Poor condition	Coefficient Significance	0.158 0.002	0.033 0.528	0.040 0.445	0.198 0.000	0.032 0.544	0.03 0.561	0.054 0.301	0.049 0.348	0.037 0.476	0.085 0.101	0.037 0.476	0.030 0.561	0.030 0.561	0.021 0.681
Markings—None	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.0040 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Median—Depressed	Coefficient Significance	0.171 0.001	0.019 0.717	0.078 0.134	0.022 0.677	0.003 0.959	0.041 0.427	0.118 0.023	0.051 0.330	0.051 0.330	0.066 0.207	0.051 0.330	0.041 0.427	0.041 0.427	0.029 0.575
Median—Flush	Coefficient Significance	0.105 0.044	0.038 0.468	0.036 0.484	0.036 0.484	0.019 0.712	0.014 0.795	0.047 0.363	0.017 0.749	0.017 0.749	0.022 0.679	0.017 0.749	0.014 0.795	0.014 0.795	0.010 0.854
Median—Raised	Coefficient Significance	0.007 0.896	0.124 0.016	0.007 0.886	0.088 0.089	0.063 0.222	0.038 0.460	0.030 0.564	0.081 0.119	0.055 0.291	0.190 0.000	0.148 0.004	0.121 0.019	0.038 0.460	0.032 0.544
Median—None	Coefficient Significance	0.189 0.000	0.140 0.007	0.073 0.160	0.073 0.160	0.061 0.241	0.006 0.908	0.144 0.005	0.023 0.660	0.098 0.059	0.108 0.038	0.083 0.109	0.068 0.191	0.006 0.908	0.057 0.277
Barrier—Permanent	Coefficient Significance	0.077 0.141	0.101 0.053	0.003 0.956	0.062 0.235	0.030 0.570	0.056 0.283	0.061 0.240	0.006 0.911	0.068 0.188	0.009 0.867	0.057 0.274	0.097 0.061	0.021 0.689	0.069 0.186
Barrier—None	Coefficient Significance	0.077 0.141	0.101 0.053	0.003 0.956	0.062 0.235	0.030 0.570	0.056 0.283	0.061 0.240	0.006 0.911	0.068 0.188	0.009 0.867	0.057 0.274	0.097 0.061	0.021 0.689	0.069 0.186
Sidewalk—Along all roadways	Coefficient Significance	0.072 0.165	0.062 0.237	0.090 0.083	0.093 0.072	0.049 0.343	0.035 0.503	0.110 0.033	0.036 0.495	0.043 0.412	0.126 0.015	0.043 0.412	0.155 0.003	0.061 0.243	0.025 0.637
Sidewalk—Along most roadways	Coefficient Significance	0.154 0.003	0.167 0.001	0.003 0.948	0.121 0.020	0.105 0.044	0.048 0.361	0.055 0.287	0.058 0.262	0.074 0.154	0.075 0.147	0.058 0.262	0.048 0.361	0.034 0.520	0.081 0.120
Sidewalk—Along few roadways	Coefficient Significance	0.057 0.274	0.067 0.200	0.064 0.216	0.064 0.216	0.034 0.514	0.101 0.050	0.083 0.108	0.073 0.158	0.029 0.573	0.121 0.019	0.174 0.001	0.024 0.646	0.024 0.646	0.017 0.745
Sidewalk—None	Coefficient Significance	0.164 0.001	0.068 0.194	0.029 0.578	0.000 0.995	0.038 0.466	0.011 0.840	0.088 0.209	0.018 0.736	0.018 0.736	0.101 0.051	0.018 0.736	0.064 0.219	0.064 0.219	0.045 0.385
Obstruction—Vegetation	Coefficient Significance	0.066 0.202	0.174 0.001	0.010 0.843	0.077 0.139	0.065 0.212	0.046 0.379	0.012 0.825	0.050 0.333	0.050 0.333	0.045 0.386	0.050 0.333	0.046 0.379	0.046 0.379	0.093 0.072
Obstruction—Advertisement signs	Coefficient Significance	0.142 0.006	0.038 0.468	0.036 0.484	0.273 0.000	0.127 0.014	0.014 0.795	0.079 0.130	0.017 0.749	0.017 0.749	0.022 0.679	0.017 0.749	0.014 0.795	0.014 0.795	0.010 0.854
Obstruction—Other	Coefficient Significance	0.105 0.044	0.038 0.468	0.036 0.484	0.036 0.484	0.019 0.712	0.014 0.795	0.047 0.363	0.017 0.749	0.017 0.749	0.022 0.679	0.017 0.749	0.014 0.795	0.014 0.795	0.010 0.854
Obstruction—None	Coefficient Significance	0.076 0.144	0.133 0.010	0.038 0.468	0.038 0.644	0.102 0.049	0.032 0.540	0.002 0.977	0.059 0.253	0.059 0.253	0.025 0.629	0.059 0.253	0.032 0.540	0.032 0.540	0.079 0.128
Posted speed limit	Coefficient Significance	0.333 0.000	0.209 0.005	0.158 0.093	0.183 0.025	0.101 0.583	0.094 0.652	0.174 0.042	0.080 0.794	0.197 0.011	0.164 0.069	0.116 0.418	0.123 0.337	0.168 0.057	0.067 0.895

Correlations between left turn maneuver and conflict types and all traffic-related variables (N = 368).

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Hour event occurred	Coefficient Significance	0.139 0.840	0.241 0.031	0.146 0.780	0.193 0.290	0.154 0.704	0.142 0.821	0.205 0.911	0.128 0.911	0.106 0.980	0.194 0.278	0.141 0.825	0.109 0.974	0.451 0.000	0.122 0.935
Relation—Pre-intersection	Coefficient Significance	0.132 0.010	0.057 0.276	0.001 0.991	0.055 0.293	0.029 0.579	0.020 0.696	0.071 0.172	0.025 0.632	0.025 0.632	0.032 0.535	0.025 0.632	0.020 0.696	0.020 0.696	0.014 0.782
Relation—Within intersection	Coefficient Significance	0.319 0.000	0.042 0.417	0.001 0.983	0.196 0.000	0.105 0.043	0.000 0.994	0.210 0.000	0.031 0.556	0.031 0.556	0.117 0.024	0.091 0.080	0.074 0.154	0.074 0.154	0.052 0.310
Relation—Post-intersection	Coefficient Significance	0.079 0.131	0.104 0.045	0.069 0.183	0.069 0.183	0.037 0.483	0.026 0.620	0.090 0.084	0.065 0.209	0.032 0.544	0.041 0.432	0.032 0.544	0.026 0.620	0.026 0.620	0.148 0.004
Relation—Driveway, alley access, etc.	Coefficient Significance	0.089 0.086	0.042 0.424	0.250 0.000	0.058 0.265	0.031 0.556	0.022 0.678	0.008 0.881	0.027 0.611	0.085 0.100	0.034 0.510	0.027 0.611	0.022 0.678	0.022 0.678	0.015 0.770
Relation—Exiting ramp	Coefficient Significance	0.091 0.080	0.044 0.399	0.042 0.416	0.042 0.416	0.022 0.668	0.163 0.002	0.055 0.291	0.019 0.711	0.019 0.711	0.025 0.631	0.019 0.711	0.016 0.762	0.016 0.762	0.011 0.831
Relation—Entering ramp	Coefficient Significance	0.174 0.001	0.063 0.222	0.061 0.239	0.061 0.239	0.032 0.535	0.023 0.662	0.079 0.126	0.028 0.591	0.028 0.591	0.036 0.487	0.028 0.591	0.023 0.662	0.023 0.662	0.016 0.757
Relation—Roadway	Coefficient Significance	0.202 0.000	0.074 0.156	0.071 0.171	0.071 0.171	0.038 0.470	0.027 0.611	0.092 0.075	0.033 0.532	0.033 0.532	0.042 0.419	0.033 0.532	0.027 0.611	0.027 0.611	0.019 0.719

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Lanes—None, illegal action	Coefficient Significance	0.094 0.071	0.044 0.399	0.027 0.601	0.042 0.416	0.022 0.668	0.016 0.762	0.000 0.000	0.019 0.711	0.019 0.711	0.025 0.631	0.391 0.000	0.163 0.002	0.163 0.002	0.011 0.831
Lanes—1	Coefficient Significance	0.172 0.001	0.099 0.055	0.004 0.939	0.121 0.019	0.080 0.126	0.056 0.280	0.103 0.047	0.069 0.186	0.069 0.186	0.057 0.276	0.118 0.022	0.020 0.695	0.020 0.695	0.040 0.446
Lanes—2	Coefficient Significance	0.140 0.007	0.055 0.287	0.016 0.753	0.082 0.116	0.060 0.246	0.043 0.413	0.071 0.171	0.052 0.315	0.052 0.315	0.094 0.069	0.052 0.315	0.043 0.413	0.043 0.413	0.030 0.563
Lanes—3	Coefficient Significance	0.156 0.002	0.057 0.276	0.055 0.293	0.055 0.293	0.029 0.579	0.020 0.696	0.071 0.172	0.025 0.632	0.025 0.632	0.032 0.535	0.025 0.632	0.020 0.696	0.020 0.696	0.014 0.782
Lanes—4	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Weather—Sunny	Coefficient Significance	0.078 0.133	0.081 0.119	0.076 0.144	0.043 0.413	0.058 0.267	0.041 0.434	0.017 0.750	0.050 0.337	0.050 0.337	0.101 0.051	0.021 0.682	0.046 0.372	0.046 0.372	0.029 0.580
Weather—Partly cloudy	Coefficient Significance	0.019 0.715	0.050 0.335	0.046 0.379	0.046 0.379	0.045 0.389	0.032 0.544	0.045 0.392	0.039 0.457	0.039 0.457	0.143 0.006	0.039 0.070	0.070 0.176	0.070 0.176	0.022 0.668
Weather—Cloudy/Overcast	Coefficient Significance	0.097 0.061	0.060 0.247	0.058 0.265	0.005 0.917	0.031 0.556	0.022 0.678	0.034 0.516	0.027 0.611	0.027 0.611	0.034 0.510	0.085 0.100	0.022 0.678	0.022 0.678	0.015 0.770
Visibility—Unlimited	Coefficient Significance	0.075 0.148	0.027 0.611	0.086 0.097	0.086 0.097	0.190 0.000	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.010 0.855	0.007 0.897
Visibility—Glare	Coefficient Significance	0.156 0.002	0.019 0.720	0.139 0.007	0.139 0.007	0.271 0.000	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Visibility—Fog	Coefficient Significance	0.052 0.319	0.019 0.720	0.018 0.729	0.018 0.729	0.010 0.855	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Debris on roadway— Clear/None	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Debris on Roadway—Sand	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Level of Service A	Coefficient Significance	0.135 0.009	0.014 0.785	0.021 0.684	0.204 0.000	0.021 0.686	0.034 0.515	0.030 0.570	0.042 0.425	0.042 0.425	0.008 0.877	0.038 0.464	0.063 0.222	0.034 0.515	0.113 0.029
Level of Service B	Coefficient Significance	0.106 0.040	0.076 0.143	0.071 0.171	0.003 0.957	0.056 0.285	0.050 0.338	0.029 0.581	0.025 0.635	0.025 0.635	0.062 0.232	0.025 0.635	0.039 0.451	0.039 0.451	0.028 0.595
Level of Service C	Coefficient Significance	0.012 0.816	0.084 0.104	0.044 0.402	0.098 0.058	0.008 0.878	0.068 0.189	0.031 0.553	0.037 0.107	0.037 0.475	0.015 0.780	0.023 0.654	0.006 0.914	0.004 0.126	0.048 0.353
Level of Service D	Coefficient Significance	0.049 0.342	0.079 0.130	0.034 0.520	0.038 0.144	0.038 0.461	0.082 0.114	0.053 0.545	0.145 0.005	0.035 0.506	0.095 0.066	0.035 0.506	0.028 0.587	0.028 0.587	0.020 0.702
Level of Service E	Coefficient Significance	0.026 0.622	0.082 0.116	0.086 0.097	0.026 0.623	0.013 0.796	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.010 0.855	0.007 0.897
Number of vehicles in event	Coefficient Significance	0.136 0.648	0.068 0.995	0.197 0.095	0.135 0.659	0.042 1.000	0.052 0.999	0.085 0.976	0.069 0.995	0.039 1.000	0.051 1.000	0.130 0.702	0.052 0.999	0.146 0.531	0.406 0.000
General traffic congestion	Coefficient Significance	0.032 0.534	0.034 0.519	0.079 0.129	0.028 0.595	0.052 0.317	0.056 0.283	0.044 0.399	0.031 0.556	0.045 0.387	0.059 0.255	0.045 0.387	0.037 0.481	0.037 0.481	0.026 0.618
Event obstacle—Other obstacle	Coefficient Significance	0.043 0.406	0.015 0.770	0.176 0.001	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Event obstacle—Pedestrian	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Event obstacle—Bicyclist	Coefficient Significance	0.018 0.729	0.019 0.720	0.018 0.729	0.018 0.729	0.010 0.855	0.007 0.898	0.101 0.052	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Event obstacle—Other vehicle(s)	Coefficient Significance	0.075 0.151	0.035 0.505	0.001 0.986	0.162 0.002	0.042 0.415	0.030 0.565	0.040 0.440	0.135 0.009	0.050 0.338	0.048 0.361	0.050 0.338	0.030 0.565	0.030 0.565	0.021 0.685
Good surface condition	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Rough surface condition	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Markings conditions—Lane lines	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Markings conditions—Median delineation	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Markings conditions—Other type of marking	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Missing regulatory sign(s)	Coefficient Significance	0.050 0.338	0.033 0.531	0.031 0.546	0.031 0.546	0.017 0.750	0.012 0.822	0.032 0.542	0.014 0.783	0.014 0.783	0.019 0.721	0.014 0.783	0.012 0.822	0.012 0.822	0.008 0.874

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Missing warning sign(s)	Coefficient Significance	0.010 0.843	0.044 0.393	0.131 0.011	0.035 0.503	0.018 0.724	0.013 0.803	0.045 0.385	0.016 0.760	0.016 0.760	0.021 0.693	0.016 0.760	0.013 0.803	0.013 0.803	0.009 0.860
Missing directional or guide sign(s)	Coefficient Significance	0.071 0.170	0.080 0.122	0.045 0.387	0.045 0.387	0.024 0.648	0.017 0.748	0.058 0.261	0.021 0.693	0.021 0.693	0.027 0.610	0.021 0.693	0.017 0.748	0.017 0.748	0.012 0.820
No pedestrian signal	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Limitations to sight distance—Other traffic	Coefficient Significance	0.122 0.019	0.014 0.788	0.082 0.116	0.145 0.005	0.024 0.639	0.017 0.741	0.041 0.429	0.021 0.685	0.115 0.027	0.027 0.599	0.021 0.685	0.017 0.741	0.017 0.741	0.012 0.815
Limitations to sight distance—Geometry	Coefficient Significance	0.024 0.641	0.015 0.776	0.090 0.085	0.090 0.085	0.061 0.245	0.023 0.662	0.079 0.126	0.028 0.128	0.028 0.591	0.036 0.487	0.028 0.591	0.023 0.662	0.023 0.662	0.016 0.757
Limitations to sight distance—Signage	Coefficient Significance	0.043 0.406	0.169 0.001	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.007 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Limitations to sight distance—Vegetation	Coefficient Significance	0.149 0.004	0.094 0.070	0.217 0.000	0.099 0.057	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Limitations to sight distance—Other	Coefficient Significance	0.018 0.729	0.019 0.720	0.139 0.007	0.018 0.729	0.010 0.855	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Size of event vehicle	Coefficient Significance	0.042 0.418	0.031 0.556	0.068 0.194	0.030 0.570	0.016 0.764	0.011 0.833	0.038 0.460	0.014 0.795	0.014 0.795	0.017 0.737	0.014 0.795	0.011 0.833	0.011 0.833	0.008 0.881
Location of event	Coefficient Significance	0.457 0.000	0.375 0.001	0.296 0.230	0.387 0.000	0.223 0.936	0.460 0.000	0.374 0.001	0.263 0.606	0.256 0.680	0.300 0.193	0.379 0.001	0.264 0.597	0.186 0.997	0.157 0.000

Correlations between left turn maneuver and conflict types and all driver performance-related variables (N = 368).

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Pulled into traffic or Proceeded without clearance	Coefficient Significance	0.187 0.000	0.016 0.766	0.142 0.006	0.057 0.273	0.120 0.020	0.085 0.102	0.115 0.026	0.018 0.736	0.078 0.131	0.040 0.438	0.104 0.045	0.064 0.219	0.064 0.219	0.045 0.385
Entered intersection on red light	Coefficient Significance	0.060 0.249	0.022 0.678	0.021 0.689	0.021 0.689	0.011 0.833	0.008 0.882	0.027 0.604	0.010 0.855	0.010 0.855	0.012 0.813	0.010 0.855	0.008 0.882	0.008 0.882	0.005 0.916
Inadequate reaction speed	Coefficient Significance	0.036 0.495	0.074 0.157	0.016 0.758	0.016 0.758	0.034 0.514	0.024 0.646	0.045 0.383	0.029 0.573	0.029 0.573	0.038 0.465	0.029 0.573	0.024 0.646	0.024 0.646	0.159 0.002
Failure to respond to primary control	Coefficient Significance	0.030 0.562	0.013 0.802	0.093 0.074	0.009 0.860	0.062 0.230	0.022 0.667	0.003 0.961	0.027 0.598	0.027 0.598	0.036 0.495	0.081 0.119	0.022 0.667	0.022 0.667	0.016 0.761
Failure to respond to an active emergency vehicle	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Failure to yield right-of-way to pedestrian	Coefficient Significance	0.091 0.081	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.577 0.000	0.003 0.958
Lateral vehicle control—Close to center line or road edge marking	Coefficient Significance	0.088 0.091	0.019 0.720	0.139 0.007	0.018 0.729	0.010 0.855	0.375 0.000	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Lateral vehicle control—Lane change	Coefficient Significance	0.185 0.000	0.070 0.180	0.115 0.027	0.115 0.027	0.061 0.242	0.043 0.410	0.123 0.017	0.053 0.312	0.053 0.312	0.093 0.312	0.053 0.312	0.043 0.410	0.043 0.410	0.030 0.560
Lateral vehicle control—Deviation in lane in both directions	Coefficient Significance	0.010 0.843	0.044 0.393	0.048 0.352	0.035 0.503	0.018 0.724	0.200 0.000	0.045 0.385	0.016 0.760	0.016 0.760	0.021 0.693	0.016 0.760	0.013 0.803	0.013 0.803	0.009 0.860
Lateral vehicle control—Ran off road	Coefficient Significance	0.013 0.805	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.406 0.000
Vehicle turn control—Under compensate	Coefficient Significance	0.032 0.545	0.033 0.531	0.060 0.246	0.031 0.546	0.017 0.750	0.012 0.822	0.104 0.045	0.014 0.783	0.014 0.783	0.019 0.721	0.014 0.783	0.012 0.822	0.012 0.822	0.008 0.874
Vehicle turn control—Over compensate	Coefficient Significance	0.152 0.003	0.448 0.000	0.031 0.546	0.031 0.546	0.017 0.750	0.012 0.822	0.041 0.433	0.014 0.783	0.014 0.783	0.019 0.721	0.014 0.783	0.012 0.822	0.012 0.822	0.008 0.874
Backing-up	Coefficient Significance	0.007 0.888	0.039 0.449	0.039 0.456	0.115 0.026	0.020 0.700	0.014 0.786	0.049 0.343	0.017 0.739	0.017 0.739	0.022 0.667	0.017 0.739	0.014 0.786	0.014 0.786	0.010 0.848
Vehicle turn control—U-turn	Coefficient Significance	0.171 0.001	0.031 0.556	0.030 0.570	0.030 0.570	0.016 0.764	0.011 0.833	0.038 0.460	0.014 0.795	0.014 0.795	0.017 0.737	0.520 0.000	0.444 0.000	0.236 0.000	0.008 0.881

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Vehicle turn control—Turned into incorrect lane	Coefficient Significance	0.184 0.000	0.257 0.000	0.063 0.224	0.063 0.224	0.033 0.521	0.024 0.651	0.005 0.926	0.177 0.001	0.029 0.579	0.276 0.000	0.177 0.001	0.024 0.651	0.024 0.651	0.017 0.749
Vehicle turn control—Proceeded forward from a turn lane	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Defensive maneuver	Coefficient Significance	0.142 0.006	0.060 0.246	0.069 0.183	0.112 0.030	0.037 0.483	0.026 0.620	0.054 0.299	0.160 0.002	0.160 0.002	0.041 0.432	0.065 0.209	0.026 0.620	0.093 0.075	0.018 0.727
Avoiding—Obstruction in roadway	Coefficient Significance	0.024 0.644	0.082 0.116	0.026 0.623	0.026 0.623	0.013 0.796	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.019 0.855	0.007 0.897
No room to respond to an active emergency vehicle	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Gesturing—Sounding horn	Coefficient Significance	0.034 0.518	0.072 0.168	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Avoiding—Another vehicle	Coefficient Significance	0.034 0.518	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.046 0.375	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Violation stopping—Ran red light or stop sign	Coefficient Significance	0.049 0.347	0.051 0.331	0.073 0.158	0.049 0.348	0.196 0.000	0.018 0.727	0.081 0.117	0.022 0.669	0.022 0.669	0.029 0.580	0.022 0.669	0.018 0.727	0.018 0.727	0.013 0.805
Violation stopping—Rolling stop	Coefficient Significance	0.001 0.979	0.044 0.399	0.096 0.063	0.096 0.063	0.022 0.668	0.016 0.762	0.059 0.291	0.019 0.711	0.019 0.711	0.025 0.631	0.019 0.711	0.016 0.762	0.016 0.762	0.011 0.831
Failure to yield right-of-way--General	Coefficient Significance	0.216 0.000	0.013 0.799	0.139 0.007	0.083 0.109	0.119 0.022	0.084 0.106	0.113 0.030	0.042 0.416	0.079 0.127	0.086 0.097	0.019 0.722	0.010 0.852	0.010 0.852	0.046 0.380
Failure to yield right-of-way--Right turn on red light	Coefficient Significance	0.091 0.080	0.044 0.399	0.042 0.416	0.042 0.416	0.022 0.668	0.016 0.762	0.000 0.000	0.019 0.711	0.019 0.711	0.025 0.631	0.019 0.711	0.016 0.762	0.016 0.762	0.011 0.831
Violation turning—Illegal U-turn	Coefficient Significance	0.149 0.004	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.546 0.000	0.252 0.000	0.252 0.000	0.007 0.889
Entered intersection on an amber light	Coefficient Significance	0.042 0.425	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.161 0.002	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Violations passing—Passing in a no passing zone	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Following closely	Coefficient Significance	0.204 0.000	0.081 0.117	0.037 0.473	0.042 0.130	0.029 0.425	0.029 0.574	0.102 0.050	0.029 0.490	0.029 0.490	0.036 0.372	0.029 0.490	0.026 0.574	0.026 0.574	0.021 0.691
Force another vehicle out of lane	Coefficient Significance	0.080 0.126	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Speed of event vehicle	Coefficient Significance	0.078 0.134	0.063 0.229	0.015 0.772	0.021 0.680	0.050 0.338	0.060 0.249	0.007 0.890	0.035 0.506	0.043 0.408	0.056 0.284	0.043 0.408	0.035 0.500	0.035 0.500	0.025 0.634
Observed difficulties navigating—Intersection angle	Coefficient Significance	0.146 0.005	0.052 0.319	0.186 0.000	0.010 0.851	0.026 0.612	0.019 0.721	0.030 0.570	0.023 0.661	0.226 0.000	0.069 0.183	0.023 0.661	0.019 0.721	0.136 0.008	0.013 0.801
Observed difficulties navigating—Intersection width	Coefficient Significance	0.120 0.020	0.036 0.488	0.211 0.000	0.048 0.352	0.018 0.724	0.013 0.803	0.045 0.385	0.016 0.760	0.159 0.002	0.116 0.025	0.016 0.760	0.013 0.803	0.013 0.803	0.009 0.860
Observed difficulties navigating—Intersection grade	Coefficient Significance	0.013 0.805	0.024 0.643	0.099 0.057	0.023 0.654	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Observed difficulties navigating—Ramp	Coefficient Significance	0.243 0.000	0.090 0.084	0.087 0.096	0.087 0.096	0.046 0.380	0.032 0.535	0.112 0.030	0.040 0.447	0.040 0.447	0.051 0.325	0.040 0.447	0.032 0.535	0.032 0.535	0.023 0.662
Observed difficulties navigating—Roadway	Coefficient Significance	0.074 0.157	0.027 0.611	0.026 0.623	0.026 0.623	0.013 0.796	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.010 0.855	0.007 0.897
Observed difficulties navigating—Alignment/Curve	Coefficient Significance	0.063 0.222	0.036 0.488	0.035 0.503	0.035 0.503	0.134 0.009	0.013 0.803	0.045 0.385	0.016 0.760	0.016 0.760	0.021 0.693	0.016 0.760	0.013 0.803	0.013 0.803	0.009 0.860
Observed difficulties navigating—Alignment/Undulation	Coefficient Significance	0.058 0.262	0.072 0.168	0.076 0.143	0.076 0.143	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Observed difficulties navigating—Grade	Coefficient Significance	0.001 0.982	0.039 0.448	0.036 0.484	0.043 0.404	0.127 0.014	0.014 0.795	0.047 0.363	0.017 0.749	0.017 0.749	0.022 0.679	0.017 0.749	0.014 0.795	0.014 0.795	0.010 0.854
Violations turning—Illegal left turn	Coefficient Significance	0.242 0.000	0.080 0.122	0.086 0.097	0.045 0.387	0.214 0.000	0.017 0.748	0.097 0.061	0.021 0.693	0.021 0.693	0.082 0.115	0.119 0.022	0.153 0.003	0.153 0.003	0.012 0.820
Violations turning—Illegal right turn	Coefficient Significance	0.085 0.101	0.031 0.556	0.030 0.570	0.030 0.570	0.016 0.764	0.011 0.833	0.038 0.460	0.014 0.795	0.014 0.795	0.017 0.737	0.014 0.795	0.011 0.833	0.011 0.833	0.008 0.881

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Violations turning—Wrong way on one-way	Coefficient Significance	0.067 0.197	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Violations passing—Driving on shoulder	Coefficient Significance	0.080 0.126	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Avoiding active emergency vehicle	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.091 0.080	0.063 0.222	0.090 0.085	0.234 0.000	0.152 0.003	0.023 0.662	0.079 0.126	0.028 0.591	0.079 0.128	0.036 0.487	0.028 0.591	0.023 0.662	0.023 0.662	0.016 0.757
Creeping into intersection	Coefficient Significance	0.037 0.477	0.048 0.356	0.082 0.116	0.145 0.005	0.094 0.071	0.017 0.741	0.060 0.248	0.021 0.685	0.021 0.685	0.027 0.599	0.021 0.685	0.017 0.741	0.017 0.741	0.012 0.815
Vehicle control while turning—Turned from through-only lane	Coefficient Significance	0.034 0.518	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.154 0.003	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Following	Coefficient Significance	0.005 0.920	0.009 0.870	0.049 0.348	0.049 0.348	0.026 0.621	0.018 0.727	0.129 0.013	0.022 0.669	0.022 0.669	0.029 0.580	0.022 0.669	0.018 0.727	0.018 0.727	0.013 0.805
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.078 0.131	0.039 0.454	0.007 0.888	0.059 0.256	0.031 0.549	0.022 0.673	0.077 0.140	0.027 0.604	0.027 0.604	0.051 0.330	0.027 0.604	0.022 0.673	0.022 0.673	0.016 0.765
Lateral vehicle control—No deviation	Coefficient Significance	0.053 0.304	0.201 0.000	0.069 0.185	0.069 0.185	0.029 0.582	0.018 0.733	0.042 0.422	0.009 0.859	0.009 0.859	0.052 0.315	0.053 0.310	0.093 0.072	0.018 0.733	0.066 0.204
Lateral vehicle control—Deviation in lane to right	Coefficient Significance	0.057 0.274	0.190 0.000	0.048 0.360	0.048 0.360	0.025 0.630	0.018 0.734	0.037 0.476	0.022 0.677	0.022 0.677	0.028 0.589	0.022 0.677	0.144 0.005	0.018 0.734	0.013 0.810
Lateral vehicle control—Deviation in lane to left	Coefficient Significance	0.177 0.001	0.014 0.788	0.018 0.733	0.082 0.116	0.094 0.071	0.148 0.004	0.141 0.006	0.021 0.685	0.115 0.027	0.027 0.599	0.021 0.685	0.017 0.741	0.017 0.741	0.012 0.815
Lateral vehicle control—Lane break to right	Coefficient Significance	0.060 0.245	0.215 0.000	0.073 0.160	0.029 0.571	0.039 0.459	0.027 0.601	0.095 0.068	0.060 0.252	0.033 0.522	0.101 0.052	0.151 0.003	0.027 0.601	0.027 0.601	0.140 0.007
Lateral vehicle control—Lane break to left	Coefficient Significance	0.116 0.025	0.048 0.358	0.004 0.944	0.083 0.110	0.044 0.399	0.031 0.552	0.077 0.141	0.038 0.466	0.038 0.466	0.017 0.750	0.038 0.466	0.072 0.163	0.022 0.163	0.022 0.675
Lateral vehicle control—Unknown	Coefficient Significance	0.052 0.319	0.019 0.720	0.018 0.729	0.018 0.729	0.007 0.855	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Longitudinal vehicle control—Decelerating	Coefficient Significance	0.013 0.805	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.067 0.201	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Longitudinal vehicle control—Anticipatory braking	Coefficient Significance	0.060 0.252	0.085 0.101	0.038 0.466	0.002 0.967	0.043 0.404	0.074 0.157	0.106 0.040	0.038 0.471	0.048 0.359	0.084 0.107	0.048 0.359	0.031 0.556	0.031 0.556	0.022 0.678
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient Significance	0.067 0.200	0.040 0.440	0.006 0.905	0.111 0.033	0.080 0.121	0.057 0.275	0.036 0.486	0.055 0.290	0.055 0.290	0.007 0.897	0.055 0.290	0.020 0.708	0.096 0.066	0.040 0.441
Longitudinal vehicle control—Uncontrolled braking	Coefficient Significance	0.042 0.418	0.031 0.556	0.030 0.570	0.030 0.570	0.016 0.764	0.011 0.833	0.038 0.460	0.014 0.795	0.014 0.795	0.017 0.737	0.014 0.795	0.011 0.833	0.011 0.833	0.330 0.000
Longitudinal vehicle control—Skidding	Coefficient Significance	0.052 0.319	0.019 0.720	0.018 0.729	0.018 0.729	0.010 0.855	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Longitudinal vehicle control—Accelerating	Coefficient Significance	0.038 0.460	0.045 0.383	0.056 0.280	0.098 0.058	0.159 0.002	0.032 0.533	0.125 0.016	0.059 0.256	0.059 0.256	0.076 0.142	0.059 0.256	0.048 0.354	0.048 0.354	0.034 0.513
Longitudinal vehicle control—Normal driving	Coefficient Significance	0.047 0.365	0.031 0.555	0.071 0.171	0.027 0.608	0.038 0.470	0.027 0.611	0.013 0.800	0.062 0.231	0.033 0.532	0.032 0.543	0.033 0.532	0.089 0.085	0.027 0.611	0.019 0.719
Longitudinal vehicle control—Unknown	Coefficient Significance	0.012 0.812	0.072 0.168	0.028 0.595	0.076 0.143	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Signal usage—Signal not required	Coefficient Significance	0.165 0.001	0.036 0.495	0.110 0.033	0.033 0.528	0.036 0.492	0.063 0.229	0.105 0.043	0.016 0.382	0.016 0.764	0.099 0.056	0.016 0.764	0.012 0.815	0.063 0.229	0.044 0.396
Signal usage—Incorrect signal	Coefficient Significance	0.060 0.249	0.022 0.678	0.021 0.689	0.021 0.689	0.011 0.833	0.008 0.882	0.027 0.604	0.010 0.855	0.010 0.855	0.012 0.813	0.010 0.855	0.008 0.882	0.008 0.882	0.005 0.916
Signal usage—Correct signal on in advance	Coefficient Significance	0.146 0.005	0.084 0.104	0.018 0.735	0.018 0.735	0.156 0.002	0.063 0.229	0.144 0.005	0.042 0.421	0.116 0.025	0.054 0.421	0.042 0.421	0.063 0.229	0.034 0.511	0.024 0.643
Signal usage—Correct signal not on in advance	Coefficient Significance	0.012 0.812	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.351 0.000
Signal usage—Signal not used	Coefficient Significance	0.015 0.779	0.015 0.771	0.059 0.253	0.026 0.620	0.057 0.270	0.047 0.365	0.035 0.502	0.050 0.341	0.050 0.341	0.102 0.049	0.022 0.673	0.040 0.437	0.047 0.365	0.029 0.583
Signal usage—Unknown	Coefficient Significance	0.070 0.180	0.006 0.904	0.120 0.021	0.041 0.430	0.043 0.409	0.030 0.561	0.054 0.301	0.037 0.476	0.037 0.476	0.085 0.101	0.049 0.348	0.030 0.561	0.075 0.151	0.021 0.681

Correlations between left turn maneuver and conflict types and right turn, lane change, same direction, forward, ramp, and pedestrian/bicyclist maneuvers and conflict types (N = 368).

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Left Turn Maneuver	Coefficient Significance	----													
Conflict 10	Coefficient Significance	0.338 0.000	----												
Conflict 11	Coefficient Significance	0.368 0.000	0.041 0.432	----											
Conflict 12	Coefficient Significance	0.328 0.000	0.041 0.432	0.04 0.448	----										
Conflict 13	Coefficient Significance	0.180 0.000	0.022 0.678	0.021 0.689	0.021 0.689	----									
Conflict 14	Coefficient Significance	0.128 0.013	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	----								
Conflict 15	Coefficient Significance	0.411 0.000	0.053 0.307	0.051 0.325	0.051 0.325	0.027 0.604	0.019 0.714	----							
Conflict 16	Coefficient Significance	0.156 0.002	0.019 0.720	0.018 0.729	0.018 0.729	0.018 0.855	0.007 0.898	0.023 0.653	----						
Conflict 17	Coefficient Significance	0.156 0.002	0.019 0.720	0.018 0.729	0.018 0.729	0.010 0.855	0.007 0.898	0.023 0.653	0.008 0.875	----					
Conflict 18	Coefficient Significance	0.201 0.000	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	----				
Conflict 19	Coefficient Significance	0.156 0.002	0.019 0.720	0.018 0.729	0.018 0.729	0.010 0.855	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	----			
Conflict 100	Coefficient Significance	0.128 0.013	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.808	----		
Conflict 101	Coefficient Significance	0.128 0.013	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	----	
Conflict 102	Coefficient Significance	0.091 0.081	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	----
Right Turn Maneuver	Coefficient Significance	0.212 0.000	0.078 0.135	0.075 0.149	0.075 0.149	0.040 0.447	0.028 0.592	0.097 0.061	0.034 0.511	0.034 0.511	0.044 0.395	0.034 0.511	0.028 0.592	0.028 0.592	0.020 0.705
Conflict 20	Coefficient Significance	0.067 0.197	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Conflict 21	Coefficient Significance	0.121 0.019	0.044 0.399	0.042 0.416	0.042 0.416	0.022 0.668	0.016 0.762	0.055 0.291	0.019 0.711	0.019 0.711	0.025 0.631	0.019 0.711	0.016 0.762	0.016 0.762	0.011 0.831
Conflict 23	Coefficient Significance	0.060 0.249	0.022 0.678	0.021 0.689	0.021 0.689	0.011 0.833	0.008 0.882	0.027 0.604	0.010 0.855	0.010 0.855	0.012 0.813	0.010 0.855	0.008 0.882	0.008 0.882	0.005 0.916
Conflict 24	Coefficient Significance	0.085 0.101	0.031 0.556	0.030 0.570	0.030 0.570	0.016 0.764	0.011 0.833	0.038 0.460	0.014 0.795	0.014 0.795	0.014 0.737	0.014 0.795	0.011 0.833	0.011 0.833	0.008 0.881
Conflict 25	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.007 0.868	0.009 0.808	0.005 0.917	0.005 0.917	0.004 0.941
Conflict 26	Coefficient Significance	0.074 0.157	0.027 0.611	0.026 0.623	0.026 0.623	0.013 0.796	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.010 0.855	0.007 0.897
Conflict 27	Coefficient Significance	0.060 0.249	0.022 0.678	0.021 0.689	0.021 0.689	0.011 0.833	0.008 0.882	0.027 0.604	0.010 0.855	0.010 0.855	0.012 0.813	0.010 0.855	0.008 0.882	0.008 0.882	0.005 0.916
Conflict 28	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Lane Change Maneuver	Coefficient Significance	0.199 0.000	0.073 0.161	0.070 0.177	0.070 0.177	0.037 0.476	0.026 0.616	0.091 0.079	0.032 0.538	0.032 0.538	0.042 0.425	0.032 0.538	0.026 0.616	0.026 0.616	0.018 0.723
Conflict 30	Coefficient Significance	0.117 0.023	0.042 0.415	0.041 0.432	0.041 0.432	0.022 0.678	0.015 0.770	0.053 0.307	0.019 0.720	0.019 0.720	0.024 0.643	0.019 0.720	0.015 0.770	0.015 0.770	0.011 0.836
Conflict 31	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 33	Coefficient Significance	0.133 0.010	0.048 0.356	0.046 0.373	0.046 0.373	0.024 0.639	0.017 0.741	0.060 0.248	0.021 0.685	0.021 0.685	0.027 0.599	0.021 0.685	0.017 0.741	0.017 0.741	0.012 0.815

		Left Turn Maneuver	Conflict 10	Conflict 11	Conflict 12	Conflict 13	Conflict 14	Conflict 15	Conflict 16	Conflict 17	Conflict 18	Conflict 19	Conflict 100	Conflict 101	Conflict 102
Conflict 34	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Conflict 35	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Conflict 38	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Same Direction Maneuver	Coefficient Significance	0.320 0.000	0.121 0.020	0.117 0.024	0.117 0.024	0.062 0.236	0.044 0.403	0.151 0.003	0.053 0.305	0.053 0.305	0.069 0.184	0.053 0.305	0.044 0.403	0.044 0.403	0.031 0.555
Conflict 40	Coefficient Significance	0.279 0.000	0.104 0.045	0.100 0.054	0.100 0.054	0.053 0.309	0.037 0.473	0.130 0.012	0.046 0.379	0.046 0.379	0.059 0.255	0.046 0.379	0.037 0.473	0.037 0.473	0.026 0.612
Conflict 41	Coefficient Significance	0.121 0.019	0.044 0.399	0.042 0.416	0.042 0.416	0.022 0.668	0.016 0.762	0.055 0.291	0.019 0.711	0.019 0.711	0.025 0.631	0.019 0.711	0.016 0.762	0.016 0.762	0.011 0.831
Conflict 42	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 43	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Conflict 44	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Forward Maneuver	Coefficient Significance	0.191 0.000	0.070 0.180	0.067 0.195	0.067 0.195	0.036 0.495	0.025 0.630	0.087 0.093	0.031 0.555	0.031 0.555	0.040 0.445	0.031 0.555	0.025 0.630	0.025 0.630	0.018 0.734
Conflict 50	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 51	Coefficient Significance	0.121 0.019	0.044 0.399	0.042 0.416	0.042 0.416	0.022 0.668	0.016 0.762	0.055 0.291	0.019 0.711	0.019 0.711	0.025 0.631	0.019 0.711	0.016 0.762	0.016 0.762	0.011 0.831
Conflict 52	Coefficient Significance	0.080 0.126	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Conflict 53	Coefficient Significance	0.074 0.157	0.027 0.611	0.026 0.623	0.026 0.623	0.013 0.796	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.010 0.855	0.007 0.897
Conflict 54	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 56	Coefficient Significance	0.042 0.416	0.015 0.770	0.015 0.778	0.015 0.778	0.008 0.882	0.005 0.917	0.019 0.714	0.007 0.898	0.007 0.898	0.009 0.868	0.007 0.898	0.005 0.917	0.005 0.917	0.004 0.941
Conflict 57	Coefficient Significance	0.067 0.197	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.03 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Enter Ramp Maneuver	Coefficient Significance	0.095 0.066	0.034 0.509	0.033 0.524	0.033 0.524	0.018 0.737	0.012 0.813	0.043 0.408	0.015 0.771	0.015 0.771	0.020 0.707	0.015 0.813	0.012 0.813	0.012 0.813	0.009 0.867
Conflict 60	Coefficient Significance	0.03 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 61	Coefficient Significance	0.052 0.319	0.019 0.720	0.018 0.729	0.018 0.729	0.010 0.855	0.007 0.898	0.023 0.653	0.008 0.875	0.008 0.875	0.011 0.838	0.008 0.875	0.007 0.898	0.007 0.898	0.005 0.928
Conflict 62	Coefficient Significance	0.074 0.157	0.027 0.611	0.026 0.623	0.026 0.623	0.013 0.796	0.010 0.855	0.033 0.524	0.012 0.823	0.012 0.823	0.015 0.772	0.012 0.823	0.010 0.855	0.010 0.855	0.007 0.897
Ramp Proper Maneuver	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 71	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Exit Ramp Maneuver	Coefficient Significance	0.194 0.000	0.071 0.173	0.068 0.189	0.068 0.189	0.036 0.489	0.025 0.625	0.089 0.088	0.031 0.549	0.031 0.549	0.040 0.438	0.031 0.549	0.025 0.625	0.025 0.625	0.018 0.730
Conflict 80	Coefficient Significance	0.113 0.029	0.041 0.432	0.040 0.448	0.040 0.448	0.021 0.689	0.015 0.778	0.051 0.325	0.018 0.729	0.018 0.729	0.023 0.654	0.018 0.729	0.015 0.778	0.015 0.778	0.010 0.842
Conflict 83	Coefficient Significance	0.153 0.003	0.056 0.286	0.054 0.303	0.054 0.303	0.028 0.587	0.020 0.702	0.070 0.181	0.024 0.639	0.024 0.639	0.032 0.543	0.024 0.639	0.020 0.702	0.020 0.702	0.014 0.787
Pedestrian/Bicycle Maneuver	Coefficient Significance	0.080 0.126	0.029 0.582	0.028 0.595	0.028 0.595	0.015 0.779	0.010 0.843	0.036 0.490	0.013 0.809	0.013 0.809	0.016 0.754	0.013 0.809	0.010 0.843	0.010 0.843	0.007 0.889
Conflict 90	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958
Conflict 91	Coefficient Significance	0.067 0.197	0.024 0.643	0.023 0.654	0.023 0.654	0.012 0.813	0.009 0.868	0.030 0.561	0.011 0.838	0.011 0.838	0.014 0.792	0.011 0.838	0.009 0.868	0.009 0.868	0.006 0.906
Conflict 93	Coefficient Significance	0.030 0.566	0.011 0.836	0.010 0.842	0.010 0.842	0.005 0.916	0.004 0.941	0.013 0.796	0.005 0.928	0.005 0.928	0.006 0.906	0.005 0.928	0.004 0.941	0.004 0.941	0.003 0.958

13.3 Right Turn Contingency Correlation Tables

Correlations between right turn maneuver and conflict types and all site-related variables (N = 368).

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Region—Rural	Coefficient Significance	0.151 0.003	0.171 0.001	0.086 0.098	0.154 0.003	0.139 0.007	0.050 0.339	0.086 0.096	0.070 0.175	0.035 0.500
Region—City	Coefficient Significance	0.087 0.094	0.072 0.163	0.076 0.143	0.065 0.213	0.092 0.077	0.046 0.380	0.079 0.126	0.006 0.903	0.032 0.535
Region—Metro	Coefficient Significance	0.065 0.214	0.097 0.060	0.149 0.004	0.087 0.093	0.049 0.351	0.088 0.089	0.153 0.003	0.072 0.165	0.062 0.230
Geometry—Roadway segment	Coefficient Significance	0.110 0.034	0.034 0.510	0.062 0.232	0.031 0.556	0.044 0.403	0.022 0.678	0.038 0.470	0.031 0.556	0.015 0.770
Geometry—Merge	Coefficient Significance	0.028 0.585	0.014 0.795	0.031 0.555	0.060 0.246	0.170 0.001	0.043 0.413	0.074 0.154	0.060 0.246	0.030 0.563
Geometry—T-intersection	Coefficient Significance	0.014 0.788	0.013 0.808	0.016 0.762	0.097 0.063	0.065 0.211	0.032 0.535	0.002 0.966	0.046 0.380	0.119 0.022
Geometry—4-legged intersection	Coefficient Significance	0.113 0.029	0.006 0.902	0.141 0.006	0.070 0.180	0.035 0.501	0.040 0.448	0.069 0.186	0.192 0.000	0.028 0.592
Geometry—Offset 4-legged intersection	Coefficient Significance	0.083 0.111	0.026 0.620	0.047 0.368	0.023 0.658	0.033 0.529	0.016 0.755	0.028 0.587	0.023 0.658	0.011 0.826
Geometry—Multi-legged intersection	Coefficient Significance	0.017 0.747	0.043 0.406	0.058 0.264	0.059 0.256	0.041 0.435	0.130 0.012	0.175 0.001	0.059 0.256	0.029 0.572
Geometry—All intersection types	Coefficient Significance	0.089 0.086	0.032 0.537	0.064 0.219	0.073 0.159	0.132 0.010	0.052 0.321	0.090 0.084	0.073 0.159	0.037 0.483
Road function—Group A	Coefficient Significance	0.118 0.023	0.037 0.480	0.067 0.199	0.033 0.528	0.047 0.369	0.023 0.656	0.040 0.438	0.033 0.528	0.016 0.753
Road function—Group B	Coefficient Significance	0.007 0.899	0.028 0.585	0.029 0.581	0.014 0.786	0.139 0.007	0.050 0.339	0.040 0.437	0.070 0.175	0.077 0.137
Road function—Group C	Coefficient Significance	0.050 0.337	0.045 0.393	0.043 0.404	0.035 0.505	0.049 0.344	0.088 0.091	0.109 0.035	0.124 0.017	0.044 0.401
Road function—Group D	Coefficient Significance	0.017 0.746	0.014 0.793	0.090 0.082	0.098 0.059	0.064 0.216	0.032 0.540	0.056 0.285	0.045 0.384	0.023 0.665
Road function—Group E	Coefficient Significance	0.038 0.467	0.020 0.707	0.127 0.014	0.018 0.737	0.025 0.633	0.012 0.813	0.022 0.680	0.018 0.737	0.009 0.867
Primary control—Yield sign	Coefficient Significance	0.005 0.925	0.006 0.902	0.018 0.728	0.056 0.282	0.186 0.000	0.040 0.448	0.069 0.186	0.056 0.282	0.028 0.592
Primary control—Stop sign	Coefficient Significance	0.122 0.019	0.053 0.310	0.208 0.000	0.197 0.000	0.078 0.135	0.039 0.458	0.067 0.197	0.055 0.293	0.027 0.601
Primary control—G,Y,R signal without turn arrows	Coefficient Significance	0.098 0.060	0.013 0.808	0.057 0.276	0.046 0.380	0.065 0.211	0.032 0.535	0.002 0.966	0.046 0.380	0.023 0.662
Primary control—G, Y, R signal with turn arrows	Coefficient Significance	0.042 0.421	0.030 0.569	0.088 0.090	0.071 0.170	0.022 0.677	0.108 0.038	0.141 0.006	0.152 0.003	0.076 0.142
Primary control—None	Coefficient Significance	0.114 0.028	0.036 0.495	0.065 0.215	0.032 0.542	0.045 0.386	0.022 0.667	0.039 0.454	0.032 0.542	0.016 0.761
Road edge—Paved full shoulder	Coefficient Significance	0.153 0.003	0.048 0.356	0.087 0.093	0.043 0.409	0.061 0.241	0.030 0.561	0.053 0.311	0.043 0.409	0.021 0.681
Road edge—Soft full shoulder	Coefficient Significance	0.069 0.183	0.022 0.679	0.039 0.453	0.019 0.712	0.027 0.600	0.014 0.795	0.024 0.650	0.019 0.712	0.010 0.854
Road edge—Paved partial shoulder	Coefficient Significance	0.172 0.001	0.105 0.043	0.091 0.081	0.038 0.470	0.286 0.000	0.027 0.611	0.046 0.375	0.038 0.470	0.019 0.719
Road edge—Soft partial shoulder	Coefficient Significance	0.061 0.239	0.048 0.356	0.026 0.613	0.032 0.544	0.061 0.241	0.030 0.561	0.053 0.311	0.043 0.409	0.021 0.681
Road edge—Curb (no shoulder)	Coefficient Significance	0.066 0.203	0.008 0.874	0.001 0.982	0.039 0.454	0.094 0.069	0.065 0.214	0.112 0.030	0.092 0.078	0.046 0.380

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Markings—Good condition	Coefficient	0.048	0.045	0.015	0.034	0.086	0.062	0.020	0.019	0.062
	Significance	0.357	0.385	0.769	0.512	0.097	0.237	0.699	0.714	0.230
Markings—Fair condition	Coefficient	0.113	0.017	0.097	0.063	0.089	0.044	0.020	0.003	0.087
	Significance	0.028	0.745	0.062	0.229	0.087	0.396	0.696	0.951	0.094
Markings—Poor condition	Coefficient	0.079	0.085	0.102	0.032	0.008	0.030	0.053	0.032	0.021
	Significance	0.130	0.101	0.050	0.544	0.877	0.561	0.311	0.544	0.681
Markings—None	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Median—Depressed	Coefficient	0.019	0.044	0.005	0.059	0.176	0.041	0.072	0.059	0.029
	Significance	0.712	0.396	0.917	0.260	0.001	0.427	0.166	0.260	0.575
Median—Flush	Coefficient	0.069	0.022	0.039	0.019	0.027	0.014	0.024	0.019	0.010
	Significance	0.183	0.679	0.453	0.712	0.600	0.795	0.650	0.712	0.854
Median—Raised	Coefficient	0.030	0.071	0.069	0.063	0.006	0.121	0.162	0.113	0.032
	Significance	0.564	0.172	0.184	0.222	0.902	0.019	0.002	0.029	0.544
Median—None	Coefficient	0.019	0.033	0.071	0.113	0.136	0.068	0.075	0.044	0.057
	Significance	0.722	0.525	0.174	0.029	0.008	0.191	0.147	0.398	0.277
Barrier—Permanent	Coefficient	0.004	0.040	0.078	0.025	0.074	0.097	0.168	0.030	0.069
	Significance	0.935	0.443	0.133	0.633	0.155	0.061	0.001	0.570	0.186
Barrier—None	Coefficient	0.004	0.040	0.078	0.025	0.074	0.097	0.168	0.030	0.069
	Significance	0.935	0.443	0.133	0.633	0.155	0.061	0.001	0.570	0.186
Sidewalk—Along all roadways	Coefficient	0.093	0.055	0.032	0.049	0.070	0.035	0.005	0.018	0.025
	Significance	0.074	0.288	0.545	0.343	0.177	0.503	0.921	0.723	0.637
Sidewalk—Along most roadways	Coefficient	0.027	0.079	0.020	0.161	0.096	0.048	0.036	0.047	0.081
	Significance	0.604	0.130	0.696	0.002	0.065	0.361	0.492	0.362	0.120
Sidewalk—Along few roadways	Coefficient	0.128	0.038	0.069	0.034	0.078	0.222	0.243	0.055	0.017
	Significance	0.013	0.465	0.185	0.514	0.131	0.000	0.000	0.288	0.745
Sidewalk—None	Coefficient	0.029	0.007	0.084	0.091	0.096	0.064	0.111	0.091	0.045
	Significance	0.577	0.894	0.106	0.081	0.064	0.219	0.032	0.081	0.385
Obstruction—Vegetation	Coefficient	0.094	0.065	0.025	0.058	0.083	0.041	0.029	0.058	0.093
	Significance	0.071	0.210	0.638	0.263	0.112	0.430	0.573	0.263	0.072
Obstruction—Advertisement signs	Coefficient	0.023	0.022	0.036	0.127	0.027	0.014	0.024	0.019	0.010
	Significance	0.657	0.679	0.491	0.014	0.600	0.795	0.650	0.712	0.854
Obstruction—Other	Coefficient	0.069	0.022	0.039	0.019	0.027	0.014	0.024	0.019	0.010
	Significance	0.183	0.679	0.453	0.712	0.600	0.795	0.650	0.712	0.854
Obstruction—None	Coefficient	0.105	0.077	0.024	0.012	0.098	0.049	0.009	0.069	0.079
	Significance	0.044	0.139	0.645	0.821	0.060	0.351	0.865	0.186	0.128
Posted speed limit	Coefficient	0.211	0.115	0.125	0.250	0.259	0.094	0.139	0.156	0.067
	Significance	0.004	0.429	0.326	0.000	0.000	0.652	0.202	0.104	0.895

Correlations between right turn maneuver and conflict types and all traffic-related variables (N = 368).

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Hour event occurred	Coefficient	0.241	0.345	0.203	0.148	0.160	0.148	0.260	0.088	0.173
	Significance	0.031	0.000	0.203	0.766	0.645	0.764	0.009	0.996	0.504
Relation—Pre-intersection	Coefficient	0.072	0.032	0.059	0.029	0.041	0.123	0.035	0.029	0.014
	Significance	0.166	0.535	0.259	0.579	0.430	0.017	0.496	0.579	0.782
Relation—Within intersection	Coefficient	0.100	0.024	0.028	0.105	0.074	0.000	0.086	0.105	0.052
	Significance	0.053	0.644	0.594	0.043	0.157	0.994	0.097	0.043	0.314
Relation—Post-intersection	Coefficient	0.131	0.109	0.096	0.037	0.127	0.026	0.024	0.037	0.018
	Significance	0.011	0.035	0.063	0.483	0.014	0.620	0.646	0.483	0.727
Relation—Driveway, alley access, etc.	Coefficient	0.042	0.034	0.037	0.031	0.162	0.022	0.038	0.031	0.015
	Significance	0.421	0.510	0.483	0.556	0.002	0.678	0.470	0.556	0.770
Relation—Exiting ramp	Coefficient	0.080	0.025	0.045	0.022	0.032	0.016	0.027	0.022	0.011
	Significance	0.122	0.631	0.383	0.668	0.542	0.762	0.599	0.668	0.831
Relation—Entering ramp	Coefficient	0.116	0.036	0.066	0.032	0.046	0.023	0.040	0.032	0.016
	Significance	0.025	0.487	0.207	0.535	0.377	0.662	0.446	0.535	0.757

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Relation—Roadway	Coefficient Significance	0.109 0.035	0.042 0.419	0.035 0.507	0.038 0.470	0.053 0.305	0.027 0.611	0.046 0.375	0.038 0.470	0.019 0.719
Lanes—None, illegal action	Coefficient Significance	0.040 0.440	0.025 0.631	0.045 0.383	0.022 0.668	0.032 0.542	0.163 0.002	0.027 0.599	0.022 0.668	0.011 0.831
Lanes—1	Coefficient Significance	0.083 0.111	0.041 0.436	0.106 0.040	0.080 0.126	0.036 0.488	0.097 0.062	0.124 0.017	0.080 0.126	0.040 0.446
Lanes—2	Coefficient Significance	0.028 0.585	0.014 0.795	0.092 0.077	0.060 0.246	0.000 1.000	0.043 0.413	0.171 0.001	0.060 0.246	0.030 0.563
Lanes—3	Coefficient Significance	0.072 0.166	0.032 0.535	0.007 0.896	0.029 0.579	0.041 0.430	0.020 0.696	0.035 0.496	0.029 0.579	0.014 0.782
Lanes—4	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Weather—Sunny	Coefficient Significance	0.063 0.226	0.046 0.376	0.008 0.875	0.127 0.014	0.038 0.463	0.041 0.434	0.081 0.120	0.004 0.938	0.029 0.580
Weather—Partly cloudy	Coefficient Significance	0.088 0.091	0.015 0.779	0.056 0.282	0.099 0.055	0.012 0.813	0.032 0.544	0.063 0.223	0.028 0.597	0.022 0.668
Weather—Cloudy/Overcast	Coefficient Significance	0.019 0.715	0.053 0.311	0.062 0.232	0.066 0.201	0.044 0.403	0.022 0.678	0.042 0.421	0.031 0.556	0.015 0.770
Visibility—Unlimited	Coefficient Significance	0.049 0.351	0.015 0.772	0.027 0.599	0.013 0.796	0.019 0.713	0.010 0.855	0.017 0.751	0.013 0.796	0.007 0.897
Visibility—Glare	Coefficient Significance	0.034 0.511	0.011 0.838	0.019 0.711	0.010 0.855	0.014 0.795	0.007 0.898	0.012 0.823	0.010 0.855	0.005 0.928
Visibility—Fog	Coefficient Significance	0.034 0.511	0.011 0.838	0.019 0.711	0.010 0.855	0.014 0.795	0.007 0.898	0.012 0.823	0.010 0.855	0.005 0.928
Debris on roadway—Clear/None	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Debris on Roadway—Sand	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Level of Service A	Coefficient Significance	0.043 0.406	0.070 0.179	0.063 0.229	0.090 0.084	0.068 0.189	0.034 0.515	0.059 0.257	0.021 0.686	0.024 0.646
Level of Service B	Coefficient Significance	0.037 0.476	0.051 0.328	0.047 0.362	0.071 0.174	0.079 0.129	0.039 0.451	0.087 0.095	0.056 0.285	0.028 0.595
Level of Service C	Coefficient Significance	0.004 0.937	0.062 0.237	0.037 0.476	0.097 0.062	0.049 0.350	0.080 0.126	0.010 0.851	0.060 0.245	0.056 0.280
Level of Service D	Coefficient Significance	0.003 0.953	0.045 0.389	0.038 0.464	0.040 0.442	0.110 0.034	0.028 0.587	0.049 0.345	0.040 0.442	0.020 0.702
Level of Service E	Coefficient Significance	0.016 0.756	0.015 0.772	0.078 0.136	0.013 0.796	0.019 0.713	0.010 0.855	0.017 0.751	0.013 0.796	0.007 0.897
Number of vehicles in event	Coefficient Significance	0.181 0.188	0.089 0.967	0.108 0.887	0.042 1.000	0.337 0.000	0.056 0.999	0.060 0.998	0.042 1.000	0.096 0.947
General traffic congestion	Coefficient Significance	0.039 0.459	0.058 0.263	0.094 0.070	0.052 0.317	0.112 0.031	0.037 0.481	0.010 0.844	0.052 0.317	0.026 0.618
Event obstacle—Other obstacle	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Event obstacle—Pedestrian	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Event obstacle—Bicyclist	Coefficient Significance	0.057 0.273	0.011 0.838	0.019 0.711	0.010 0.855	0.014 0.795	0.007 0.898	0.012 0.823	0.010 0.855	0.499 0.000
Event obstacle—Other vehicle(s)	Coefficient Significance	0.035 0.497	0.048 0.361	0.028 0.588	0.107 0.038	0.100 0.055	0.030 0.565	0.052 0.316	0.042 0.415	0.021 0.685
Good surface condition	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Rough surface condition	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Markings conditions—Lane lines	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Markings conditions—Median delineation	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Markings conditions—Other type of marking	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Missing regulatory sign(s)	Coefficient	0.007	0.019	0.034	0.017	0.097	0.012	0.020	0.017	0.008
	Significance	0.898	0.721	0.517	0.750	0.063	0.822	0.696	0.750	0.874
Missing warning sign(s)	Coefficient	0.030	0.021	0.041	0.018	0.026	0.013	0.023	0.018	0.285
	Significance	0.563	0.693	0.434	0.724	0.616	0.803	0.665	0.724	0.000
Missing directional or guide sign(s)	Coefficient	0.048	0.027	0.048	0.024	0.053	0.017	0.029	0.024	0.012
	Significance	0.361	0.610	0.354	0.648	0.313	0.748	0.575	0.648	0.820
No pedestrian signal	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Limitations to sight distance—Other traffic	Coefficient	0.097	0.078	0.050	0.024	0.132	0.017	0.030	0.208	0.012
	Significance	0.062	0.131	0.340	0.639	0.010	0.741	0.564	0.000	0.815
Limitations to sight distance—Geometry	Coefficient	0.116	0.047	0.019	0.032	0.086	0.023	0.185	0.061	0.016
	Significance	0.025	0.366	0.723	0.535	0.098	0.662	0.000	0.245	0.757
Limitations to sight distance—Signage	Coefficient	0.028	0.009	0.016	0.008	0.011	0.005	0.010	0.008	0.004
	Significance	0.592	0.868	0.762	0.882	0.833	0.917	0.855	0.882	0.941
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient	0.137	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.707
	Significance	0.008	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.000
Limitations to sight distance—Vegetation	Coefficient	0.044	0.014	0.025	0.012	0.017	0.009	0.015	0.012	0.006
	Significance	0.395	0.792	0.631	0.813	0.737	0.868	0.772	0.813	0.906
Limitations to sight distance—Other	Coefficient	0.057	0.011	0.128	0.010	0.014	0.007	0.012	0.010	0.005
	Significance	0.273	0.838	0.013	0.855	0.795	0.898	0.823	0.855	0.928
Size of event vehicle	Coefficient	0.056	0.017	0.032	0.016	0.105	0.236	0.019	0.016	0.008
	Significance	0.280	0.737	0.542	0.764	0.043	0.000	0.713	0.764	0.881
Location of event	Coefficient	0.422	0.231	0.312	0.352	0.447	0.288	0.331	0.482	0.157
	Significance	0.000	0.894	0.112	0.007	0.000	0.313	0.036	0.000	0.000

Correlations between right turn maneuver and conflict types and all driver performance-related variables (N = 368).

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Pulled into traffic or Proceeded without clearance	Coefficient	0.152	0.007	0.163	0.038	0.096	0.085	0.062	0.038	0.045
	Significance	0.003	0.894	0.002	0.466	0.064	0.102	0.236	0.466	0.385
Entered intersection on red light	Coefficient	0.040	0.012	0.022	0.011	0.016	0.008	0.013	0.011	0.005
	Significance	0.447	0.813	0.668	0.833	0.764	0.882	0.796	0.833	0.916
Inadequate reaction speed	Coefficient	0.011	0.042	0.022	0.034	0.015	0.024	0.042	0.034	0.017
	Significance	0.840	0.421	0.677	0.514	0.771	0.646	0.423	0.514	0.745
Failure to respond to primary control	Coefficient	0.150	0.049	0.031	0.062	0.022	0.110	0.038	0.155	0.016
	Significance	0.004	0.348	0.548	0.23	0.675	0.034	0.464	0.003	0.761
Failure to respond to an active emergency vehicle	Coefficient	0.028	0.009	0.016	0.008	0.011	0.005	0.010	0.008	0.004
	Significance	0.592	0.868	0.762	0.882	0.833	0.917	0.855	0.882	0.941
Failure to yield right-of-way to pedestrian	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Lateral vehicle control—Close to center line or road edge marking	Coefficient	0.034	0.011	0.019	0.010	0.014	0.007	0.012	0.010	0.005
	Significance	0.511	0.838	0.711	0.855	0.795	0.898	0.823	0.855	0.928
Lateral vehicle control—Lane change	Coefficient	0.026	0.040	0.063	0.061	0.209	0.042	0.025	0.061	0.030
	Significance	0.618	0.445	0.229	0.242	0.000	0.420	0.625	0.242	0.560
Lateral vehicle control—Deviation in lane in both directions	Coefficient	0.018	0.116	0.037	0.018	0.026	0.013	0.023	0.018	0.009
	Significance	0.729	0.025	0.473	0.724	0.616	0.803	0.665	0.724	0.860
Lateral vehicle control—Ran off road	Coefficient	0.027	0.014	0.025	0.012	0.017	0.009	0.168	0.012	0.006
	Significance	0.610	0.792	0.631	0.813	0.737	0.868	0.001	0.813	0.906
Vehicle turn control—Under compensate	Coefficient	0.007	0.019	0.034	0.017	0.024	0.012	0.017	0.118	0.008
	Significance	0.898	0.721	0.517	0.750	0.651	0.822	0.023	0.750	0.874
Vehicle turn control—Over compensate	Coefficient	0.046	0.132	0.034	0.017	0.097	0.012	0.020	0.017	0.008
	Significance	0.372	0.011	0.517	0.750	0.063	0.822	0.696	0.750	0.874
Backing-up	Coefficient	0.072	0.022	0.041	0.020	0.029	0.014	0.025	0.020	0.010
	Significance	0.165	0.667	0.434	0.700	0.584	0.786	0.636	0.700	0.848
Vehicle turn control—U-turn	Coefficient	0.056	0.017	0.032	0.016	0.022	0.011	0.019	0.016	0.008
	Significance	0.280	0.737	0.542	0.764	0.670	0.833	0.713	0.764	0.881

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Vehicle turn control—Turned into incorrect lane	Coefficient Significance	0.188 0.000	0.044 0.403	0.070 0.179	0.033 0.521	0.144 0.005	0.103 0.046	0.178 0.001	0.033 0.521	0.017 0.749
Vehicle turn control—Proceeded forward from a turn lane	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Defensive maneuver	Coefficient Significance	0.026 0.613	0.034 0.509	0.096 0.063	0.048 0.361	0.052 0.318	0.026 0.620	0.045 0.388	0.037 0.483	0.018 0.727
Avoiding—Obstruction in roadway	Coefficient Significance	0.049 0.351	0.015 0.772	0.027 0.599	0.013 0.796	0.019 0.713	0.010 0.855	0.017 0.751	0.013 0.796	0.007 0.897
No room to respond to an active emergency vehicle	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Gesturing—Sounding horn	Coefficient Significance	0.053 0.313	0.016 0.754	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Avoiding—Another vehicle	Coefficient Significance	0.008 0.885	0.016 0.754	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.138 0.008	0.015 0.779	0.007 0.889
Violation stopping—Ran red light or stop sign	Coefficient Significance	0.084 0.107	0.072 0.165	0.005 0.924	0.087 0.094	0.037 0.482	0.140 0.007	0.032 0.543	0.087 0.094	0.013 0.805
Violation stopping—Rolling stop	Coefficient Significance	0.197 0.000	0.090 0.084	0.085 0.102	0.228 0.000	0.032 0.542	0.016 0.762	0.078 0.136	0.106 0.042	0.011 0.831
Failure to yield right-of-way--General	Coefficient Significance	0.083 0.112	0.008 0.874	0.108 0.037	0.014 0.791	0.094 0.069	0.010 0.852	0.069 0.182	0.014 0.791	0.046 0.380
Failure to yield right-of-way—Right turn on red light	Coefficient Significance	0.235 0.000	0.025 0.631	0.045 0.383	0.022 0.668	0.032 0.542	0.016 0.762	0.446 0.000	0.341 0.000	0.011 0.831
Violation turning—Illegal U-turn	Coefficient Significance	0.053 0.313	0.016 0.754	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Entered intersection on an amber light	Coefficient Significance	0.044 0.395	0.014 0.792	0.025 0.631	0.012 0.813	0.017 0.737	0.009 0.868	0.015 0.772	0.012 0.813	0.006 0.906
Violations passing—Passing in a no passing zone	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Following closely	Coefficient Significance	0.148 0.004	0.046 0.372	0.084 0.105	0.042 0.425	0.059 0.257	0.029 0.574	0.051 0.327	0.042 0.425	0.021 0.691
Force another vehicle out of lane	Coefficient Significance	0.008 0.885	0.154 0.003	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Speed of event vehicle	Coefficient Significance	0.032 0.542	0.056 0.284	0.001 0.977	0.018 0.735	0.025 0.631	0.035 0.500	0.006 0.908	0.050 0.338	0.025 0.634
Observed difficulties navigating—Intersection angle	Coefficient Significance	0.026 0.618	0.030 0.570	0.054 0.302	0.026 0.612	0.041 0.431	0.019 0.721	0.032 0.533	0.084 0.107	0.013 0.801
Observed difficulties navigating—Intersection width	Coefficient Significance	0.018 0.729	0.021 0.693	0.037 0.473	0.018 0.724	0.083 0.110	0.013 0.803	0.023 0.665	0.018 0.724	0.009 0.860
Observed difficulties navigating—Intersection grade	Coefficient Significance	0.044 0.395	0.014 0.792	0.025 0.631	0.012 0.813	0.017 0.737	0.009 0.868	0.015 0.772	0.012 0.813	0.006 0.906
Observed difficulties navigating—Ramp	Coefficient Significance	0.081 0.119	0.013 0.808	0.016 0.762	0.046 0.380	0.186 0.000	0.068 0.189	0.002 0.966	0.046 0.380	0.023 0.662
Observed difficulties navigating—Roadway	Coefficient Significance	0.049 0.351	0.015 0.772	0.027 0.599	0.013 0.796	0.019 0.713	0.010 0.855	0.017 0.751	0.013 0.796	0.007 0.897
Observed difficulties navigating—Alignment/Curve	Coefficient Significance	0.018 0.729	0.021 0.693	0.041 0.434	0.018 0.724	0.026 0.616	0.013 0.803	0.023 0.665	0.018 0.724	0.009 0.860
Observed difficulties navigating—Alignment/ Undulation	Coefficient Significance	0.008 0.885	0.016 0.754	0.068 0.193	0.015 0.779	0.021 0.690	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Observed difficulties navigating—Grade	Coefficient Significance	0.069 0.183	0.022 0.679	0.036 0.491	0.019 0.712	0.077 0.137	0.014 0.795	0.024 0.650	0.127 0.014	0.010 0.854
Violations turning—Illegal left turn	Coefficient Significance	0.085 0.100	0.027 0.610	0.048 0.354	0.024 0.648	0.034 0.517	0.017 0.748	0.029 0.575	0.024 0.648	0.012 0.820
Violations turning—Illegal right turn	Coefficient Significance	0.167 0.001	0.142 0.006	0.032 0.542	0.016 0.764	0.105 0.043	0.236 0.000	0.127 0.014	0.016 0.764	0.008 0.881
Violations turning—Wrong way on one-way	Coefficient Significance	0.044 0.395	0.014 0.792	0.025 0.631	0.012 0.813	0.017 0.737	0.009 0.868	0.015 0.772	0.012 0.813	0.006 0.906
Violations passing—Driving on shoulder	Coefficient Significance	0.185 0.000	0.154 0.003	0.163 0.002	0.015 0.779	0.021 0.690	0.010 0.843	0.138 0.008	0.015 0.779	0.007 0.889
Avoiding active emergency vehicle	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.144 0.005	0.047 0.366	0.019 0.723	0.061 0.245	0.046 0.377	0.108 0.038	0.185 0.000	0.152 0.003	0.016 0.757
Creeping into intersection	Coefficient Significance	0.133 0.010	0.027 0.599	0.130 0.012	0.024 0.639	0.035 0.505	0.148 0.004	0.067 0.199	0.094 0.071	0.012 0.815
Vehicle control while turning—Turned from through-only lane	Coefficient Significance	0.068 0.194	0.154 0.003	0.030 0.569	0.015 0.779	0.115 0.027	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Following	Coefficient Significance	0.057 0.270	0.029 0.580	0.052 0.314	0.087 0.094	0.037 0.482	0.018 0.727	0.032 0.543	0.026 0.621	0.013 0.805
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.052 0.313	0.035 0.502	0.063 0.223	0.031 0.549	0.091 0.078	0.022 0.673	0.038 0.462	0.031 0.549	0.016 0.765
Lateral vehicle control—No deviation	Coefficient Significance	0.040 0.441	0.052 0.315	0.031 0.552	0.029 0.582	0.149 0.004	0.058 0.264	0.031 0.553	0.029 0.582	0.041 0.430
Lateral vehicle control—Deviation in lane to right	Coefficient Significance	0.018 0.728	0.075 0.148	0.051 0.327	0.090 0.083	0.036 0.493	0.018 0.734	0.031 0.554	0.025 0.630	0.013 0.810
Lateral vehicle control—Deviation in lane to left	Coefficient Significance	0.051 0.327	0.027 0.599	0.050 0.340	0.024 0.639	0.035 0.505	0.017 0.741	0.030 0.564	0.094 0.071	0.012 0.815
Lateral vehicle control—Lane break to right	Coefficient Significance	0.013 0.808	0.029 0.577	0.037 0.472	0.039 0.459	0.060 0.250	0.027 0.601	0.085 0.104	0.039 0.459	0.019 0.712
Lateral vehicle control—Lane break to left	Coefficient Significance	0.049 0.348	0.017 0.750	0.015 0.779	0.044 0.399	0.195 0.000	0.031 0.552	0.006 0.905	0.044 0.399	0.022 0.675
Lateral vehicle control—Unknown	Coefficient Significance	0.147 0.004	0.011 0.838	0.267 0.000	0.010 0.855	0.014 0.795	0.007 0.898	0.012 0.823	0.010 0.855	0.005 0.928
Longitudinal vehicle control—Decelerating	Coefficient Significance	0.027 0.610	0.014 0.792	0.090 0.084	0.012 0.813	0.017 0.737	0.009 0.868	0.015 0.772	0.012 0.813	0.006 0.906
Longitudinal vehicle control—Anticipatory braking	Coefficient Significance	0.087 0.095	0.018 0.735	0.051 0.330	0.043 0.404	0.062 0.236	0.031 0.556	0.053 0.306	0.031 0.557	0.022 0.678
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient Significance	0.120 0.020	0.090 0.083	0.001 0.982	0.027 0.611	0.114 0.028	0.057 0.275	0.055 0.294	0.027 0.611	0.068 0.194
Longitudinal vehicle control—uncontrolled braking	Coefficient Significance	0.000 1.000	0.017 0.737	0.059 0.253	0.016 0.764	0.022 0.670	0.011 0.833	0.019 0.713	0.016 0.764	0.008 0.881
Longitudinal vehicle control—Skidding	Coefficient Significance	0.057 0.273	0.011 0.838	0.019 0.711	0.010 0.855	0.190 0.000	0.007 0.898	0.012 0.823	0.010 0.855	0.005 0.928
Longitudinal vehicle control—Accelerating	Coefficient Significance	0.198 0.000	0.077 0.139	0.064 0.216	0.046 0.377	0.145 0.005	0.112 0.030	0.149 0.004	0.068 0.189	0.034 0.513
Longitudinal vehicle control—Normal driving	Coefficient Significance	0.006 0.901	0.032 0.543	0.076 0.142	0.045 0.390	0.005 0.922	0.027 0.611	0.046 0.375	0.126 0.015	0.019 0.719
Longitudinal vehicle control—Unknown	Coefficient Significance	0.053 0.313	0.016 0.754	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Signal usage—Signal not required	Coefficient Significance	0.054 0.299	0.043 0.407	0.035 0.499	0.036 0.492	0.051 0.329	0.063 0.229	0.109 0.036	0.017 0.740	0.044 0.396
Signal usage—Incorrect signal	Coefficient Significance	0.040 0.447	0.012 0.813	0.022 0.668	0.011 0.833	0.016 0.764	0.008 0.882	0.013 0.796	0.011 0.833	0.005 0.916
Signal usage—Correct signal on in advance	Coefficient Significance	0.067 0.196	0.007 0.890	0.098 0.058	0.020 0.699	0.077 0.137	0.034 0.511	0.060 0.253	0.048 0.352	0.024 0.643
Signal usage—Correct signal not on in advance	Coefficient Significance	0.008 0.885	0.016 0.754	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.138 0.008	0.015 0.779	0.007 0.889
Signal usage—Signal not used	Coefficient Significance	0.104 0.044	0.009 0.869	0.010 0.854	0.005 0.928	0.037 0.472	0.134 0.010	0.132 0.011	0.067 0.199	0.095 0.068
Signal usage—Unknown	Coefficient Significance	0.032 0.537	0.048 0.356	0.064 0.217	0.032 0.544	0.045 0.388	0.030 0.561	0.008 0.873	0.043 0.409	0.021 0.681

Correlations between right turn maneuver and conflict types and lane change, same direction, forward, ramp, and pedestrian/bicyclist maneuvers and conflict types (N = 368).

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
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		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Right Turn Maneuver	Coefficient Significance	----								
Conflict 20	Coefficient Significance	0.297 0.000	----							
Conflict 21	Coefficient Significance	0.491 0.000	0.025 0.631	----						
Conflict 23	Coefficient Significance	0.267 0.000	0.012 0.813	0.022 0.668	----					
Conflict 24	Coefficient Significance	0.367 0.000	0.017 0.737	0.032 0.542	0.016 0.764	----				
Conflict 25	Coefficient Significance	0.192 0.000	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	----			
Conflict 26	Coefficient Significance	0.322 0.000	0.015 0.772	0.027 0.599	0.013 0.796	0.019 0.713	0.010 0.855	----		
Conflict 27	Coefficient Significance	0.267 0.000	0.012 0.813	0.022 0.668	0.011 0.833	0.016 0.764	0.008 0.882	0.013 0.796	----	
Conflict 28	Coefficient Significance	0.137 0.008	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	----
Lane Change Maneuver	Coefficient Significance	0.133 0.010	0.042 0.425	0.075 0.148	0.037 0.476	0.053 0.311	0.026 0.616	0.046 0.382	0.037 0.476	0.018 0.723
Conflict 30	Coefficient Significance	0.078 0.135	0.024 0.643	0.044 0.399	0.022 0.678	0.031 0.556	0.015 0.770	0.027 0.611	0.022 0.678	0.011 0.836
Conflict 31	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Conflict 33	Coefficient Significance	0.088 0.091	0.027 0.599	0.050 0.340	0.024 0.639	0.035 0.505	0.017 0.741	0.030 0.564	0.024 0.639	0.012 0.815
Conflict 34	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Conflict 35	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Conflict 38	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Same Direction Maneuver	Coefficient Significance	0.218 0.000	0.069 0.184	0.125 0.016	0.062 0.236	0.088 0.092	0.044 0.403	0.076 0.145	0.062 0.236	0.031 0.555
Conflict 40	Coefficient Significance	0.188 0.000	0.059 0.255	0.107 0.039	0.053 0.309	0.075 0.148	0.037 0.473	0.065 0.211	0.053 0.309	0.026 0.612
Conflict 41	Coefficient Significance	0.080 0.122	0.025 0.631	0.045 0.383	0.022 0.668	0.032 0.542	0.016 0.762	0.027 0.599	0.022 0.668	0.011 0.831
Conflict 42	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Conflict 43	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Conflict 44	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Forward Maneuver	Coefficient Significance	0.127 0.014	0.040 0.445	0.072 0.165	0.036 0.495	0.051 0.332	0.025 0.630	0.044 0.402	0.036 0.495	0.018 0.734
Conflict 50	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Conflict 51	Coefficient Significance	0.080 0.122	0.025 0.631	0.045 0.383	0.022 0.668	0.032 0.542	0.016 0.762	0.027 0.599	0.022 0.668	0.011 0.831
Conflict 52	Coefficient Significance	0.053 0.313	0.016 0.754	0.030 0.569	0.015 0.779	0.021 0.690	0.010 0.843	0.018 0.731	0.015 0.779	0.007 0.889
Conflict 53	Coefficient Significance	0.049 0.351	0.015 0.772	0.027 0.599	0.013 0.796	0.019 0.713	0.010 0.855	0.017 0.751	0.013 0.796	0.007 0.897
Conflict 54	Coefficient Significance	0.020 0.705	0.006 0.906	0.011 0.831	0.005 0.916	0.008 0.881	0.004 0.941	0.007 0.897	0.005 0.916	0.003 0.958
Conflict 56	Coefficient Significance	0.028 0.592	0.009 0.868	0.016 0.762	0.008 0.882	0.011 0.833	0.005 0.917	0.010 0.855	0.008 0.882	0.004 0.941
Conflict 57	Coefficient Significance	0.044 0.395	0.014 0.792	0.025 0.631	0.012 0.813	0.017 0.737	0.009 0.868	0.015 0.772	0.012 0.813	0.006 0.906

		Right Turn Maneuver	Conflict 20	Conflict 21	Conflict 23	Conflict 24	Conflict 25	Conflict 26	Conflict 27	Conflict 28
Enter Ramp Maneuver	Coefficient	0.063	0.020	0.036	0.018	0.025	0.012	0.022	0.018	0.009
	Significance	0.226	0.707	0.494	0.737	0.633	0.813	0.680	0.737	0.867
Conflict 60	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Conflict 61	Coefficient	0.034	0.011	0.019	0.010	0.014	0.007	0.012	0.010	0.005
	Significance	0.511	0.838	0.711	0.855	0.795	0.898	0.823	0.855	0.928
Conflict 62	Coefficient	0.049	0.015	0.027	0.013	0.019	0.010	0.017	0.013	0.007
	Significance	0.351	0.772	0.599	0.796	0.713	0.855	0.751	0.796	0.897
Ramp Proper Maneuver	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Conflict 71	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Exit Ramp Maneuver	Coefficient	0.129	0.040	0.073	0.036	0.051	0.025	0.044	0.036	0.018
	Significance	0.013	0.438	0.159	0.489	0.325	0.625	0.395	0.489	0.730
Conflict 80	Coefficient	0.075	0.023	0.042	0.021	0.030	0.015	0.026	0.021	0.010
	Significance	0.149	0.654	0.416	0.689	0.570	0.778	0.623	0.689	0.842
Conflict 83	Coefficient	0.102	0.032	0.057	0.028	0.040	0.020	0.035	0.028	0.014
	Significance	0.050	0.543	0.270	0.587	0.440	0.702	0.505	0.587	0.787
Pedestrian/Bicycle Maneuver	Coefficient	0.053	0.016	0.030	0.015	0.021	0.010	0.018	0.015	0.007
	Significance	0.313	0.754	0.569	0.779	0.690	0.843	0.731	0.779	0.889
Conflict 90	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958
Conflict 91	Coefficient	0.044	0.014	0.025	0.012	0.017	0.009	0.015	0.012	0.006
	Significance	0.395	0.792	0.631	0.813	0.737	0.868	0.772	0.813	0.906
Conflict 93	Coefficient	0.020	0.006	0.011	0.005	0.008	0.004	0.007	0.005	0.003
	Significance	0.705	0.906	0.831	0.916	0.881	0.941	0.897	0.916	0.958

13.4 Lane Change Contingency Correlation Tables

Correlations between lane change maneuver and conflict types and all site-related variables (N = 368).

		Lane Change Maneuver	Conflict 30	Conflict 31	Conflict 33	Conflict 34	Conflict 35	Conflict 38
Region—Rural	Coefficient	0.034	0.020	0.035	0.028	0.050	0.050	0.050
	Significance	0.517	0.696	0.500	0.589	0.339	0.339	0.339
Region—City	Coefficient	0.065	0.036	0.032	0.062	0.119	0.046	0.046
	Significance	0.213	0.495	0.535	0.233	0.022	0.380	0.380
Region—Metro	Coefficient	0.091	0.051	0.062	0.030	0.062	0.088	0.088
	Significance	0.081	0.323	0.230	0.564	0.237	0.089	0.089
Geometry—Roadway segment	Coefficient	0.088	0.092	0.015	0.023	0.115	0.022	0.022
	Significance	0.089	0.075	0.770	0.660	0.027	0.678	0.678
Geometry—Merge	Coefficient	0.075	0.008	0.030	0.092	0.043	0.043	0.043
	Significance	0.151	0.879	0.563	0.077	0.413	0.413	0.413
Geometry—T-intersection	Coefficient	0.037	0.090	0.023	0.035	0.032	0.167	0.068
	Significance	0.477	0.084	0.662	0.502	0.535	0.001	0.189
Geometry—4-legged intersection	Coefficient	0.044	0.011	0.028	0.007	0.040	0.040	0.040
	Significance	0.395	0.828	0.592	0.895	0.448	0.448	0.448
Geometry—Offset 4-legged intersection	Coefficient	0.078	0.045	0.011	0.051	0.016	0.016	0.016
	Significance	0.135	0.384	0.826	0.325	0.755	0.755	0.755
Geometry—Multi-legged intersection	Coefficient	0.018	0.044	0.092	0.046	0.042	0.042	0.042
	Significance	0.723	0.398	0.076	0.380	0.423	0.423	0.423
Geometry—All intersection types	Coefficient	0.119	0.060	0.037	0.098	0.105	0.052	0.027
	Significance	0.022	0.246	0.483	0.060	0.043	0.321	0.605
Road function—Group A	Coefficient	0.110	0.065	0.016	0.073	0.023	0.023	0.023
	Significance	0.033	0.215	0.753	0.160	0.656	0.656	0.656
Road function—Group B	Coefficient	0.133	0.068	0.035	0.081	0.050	0.109	0.109
	Significance	0.010	0.188	0.500	0.120	0.339	0.035	0.035
Road function—Group C	Coefficient	0.036	0.050	0.062	0.029	0.013	0.062	0.062
	Significance	0.487	0.334	0.233	0.581	0.802	0.234	0.234
Road function—Group D	Coefficient	0.105	0.089	0.023	0.067	0.069	0.032	0.032
	Significance	0.042	0.087	0.665	0.197	0.183	0.540	0.540
Road function—Group E	Coefficient	0.059	0.034	0.009	0.039	0.012	0.012	0.012
	Significance	0.256	0.509	0.867	0.454	0.813	0.813	0.813
Primary control—Yield sign	Coefficient	0.059	0.022	0.028	0.081	0.040	0.040	0.049
	Significance	0.254	0.677	0.592	0.117	0.448	0.448	0.345
Primary control—Stop sign	Coefficient	0.182	0.107	0.027	0.121	0.039	0.039	0.039
	Significance	0.000	0.039	0.601	0.019	0.458	0.458	0.458
Primary control—G, Y, R signal without turn arrows	Coefficient	0.013	0.053	0.023	0.032	0.068	0.032	0.032
	Significance	0.796	0.313	0.662	0.540	0.189	0.535	0.535
Primary control—G, Y, R signal with turn arrows	Coefficient	0.073	0.066	0.076	0.001	0.050	0.108	0.029
	Significance	0.158	0.207	0.142	0.984	0.333	0.038	0.579
Primary control—None	Coefficient	0.079	0.086	0.016	0.018	0.110	0.022	0.022
	Significance	0.129	0.099	0.761	0.735	0.034	0.667	0.667
Road edge—Paved full shoulder	Coefficient	0.096	0.045	0.021	0.095	0.030	0.030	0.075
	Significance	0.065	0.384	0.681	0.066	0.561	0.561	0.151
Road edge—Soft full shoulder	Coefficient	0.081	0.191	0.010	0.043	0.014	0.014	0.014
	Significance	0.121	0.000	0.854	0.411	0.795	0.795	0.795
Road edge—Paved partial shoulder	Coefficient	0.099	0.074	0.019	0.045	0.027	0.027	0.027
	Significance	0.055	0.156	0.719	0.387	0.611	0.611	0.611
Road edge—Soft partial shoulder	Coefficient	0.148	0.033	0.021	0.181	0.075	0.030	0.030
	Significance	0.004	0.528	0.681	0.000	0.151	0.561	0.561
Road edge—Curb (no shoulder)	Coefficient	0.003	0.013	0.046	0.018	0.010	0.065	0.010
	Significance	0.954	0.799	0.380	0.725	0.852	0.214	0.852
Markings—Good condition	Coefficient	0.067	0.143	0.044	0.030	0.062	0.088	0.013
	Significance	0.198	0.006	0.404	0.564	0.237	0.089	0.796
Markings—Fair condition	Coefficient	0.035	0.092	0.031	0.000	0.044	0.123	0.040
	Significance	0.497	0.077	0.549	0.997	0.396	0.018	0.447
Markings—Poor condition	Coefficient	0.047	0.084	0.021	0.044	0.030	0.030	0.030
	Significance	0.369	0.105	0.681	0.397	0.561	0.561	0.561
Markings—None	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Median—Depressed	Coefficient	0.024	0.019	0.029	0.099	0.041	0.041	0.041
	Significance	0.642	0.717	0.575	0.056	0.427	0.427	0.427
Median—Flush	Coefficient	0.081	0.191	0.010	0.043	0.014	0.014	0.014
	Significance	0.121	0.000	0.854	0.411	0.795	0.795	0.795
Median—Raised	Coefficient	0.115	0.091	0.086	0.080	0.038	0.045	0.045
	Significance	0.026	0.078	0.099	0.125	0.460	0.390	0.390
Median—None	Coefficient	0.151	0.134	0.048	0.140	0.006	0.080	0.080
	Significance	0.003	0.010	0.356	0.007	0.908	0.124	0.124
Barrier—Permanent	Coefficient	0.143	0.044	0.069	0.129	0.056	0.097	0.021
	Significance	0.005	0.399	0.186	0.013	0.283	0.061	0.689
Barrier—None	Coefficient	0.143	0.044	0.069	0.129	0.056	0.097	0.021
	Significance	0.005	0.399	0.186	0.013	0.283	0.061	0.689
Sidewalk—Along all roadways	Coefficient	0.057	0.010	0.025	0.081	0.061	0.035	0.035
	Significance	0.276	0.854	0.637	0.121	0.243	0.503	0.503
Sidewalk—Along most roadways	Coefficient	0.132	0.102	0.034	0.122	0.048	0.114	0.034
	Significance	0.011	0.049	0.519	0.018	0.361	0.028	0.520
Sidewalk—Along few roadways	Coefficient	0.148	0.120	0.159	0.091	0.024	0.024	0.024
	Significance	0.004	0.021	0.002	0.078	0.646	0.646	0.646
Sidewalk—None	Coefficient	0.011	0.016	0.045	0.004	0.011	0.064	0.011
	Significance	0.840	0.766	0.385	0.940	0.840	0.219	0.840

		Lane Change Maneuver	Conflict 30	Conflict 31	Conflict 33	Conflict 34	Conflict 35	Conflict 38
Obstruction—Vegetation	Coefficient	0.055	0.114	0.029	0.014	0.041	0.132	0.046
	Significance	0.294	0.028	0.577	0.785	0.430	0.011	0.379
Obstruction—Advertisement signs	Coefficient	0.065	0.038	0.010	0.043	0.014	0.014	0.014
	Significance	0.212	0.468	0.854	0.411	0.795	0.795	0.795
Obstruction—Other	Coefficient	0.081	0.191	0.010	0.043	0.014	0.014	0.014
	Significance	0.121	0.000	0.854	0.411	0.795	0.795	0.795
Obstruction—None	Coefficient	0.044	0.046	0.034	0.046	0.049	0.112	0.032
	Significance	0.393	0.381	0.510	0.374	0.351	0.031	0.540
Posted speed limit	Coefficient	0.242	0.150	0.067	0.282	0.145	0.094	0.088
	Significance	0.000	0.131	0.895	0.000	0.160	0.652	0.719

Correlations between lane change maneuver and conflict types and all traffic-related variables (N = 368).

		Lane Change Maneuver	Conflict 30	Conflict 31	Conflict 33	Conflict 34	Conflict 35	Conflict 38
Hour event occurred	Coefficient	0.199	0.185	0.137	0.162	0.109	0.148	0.174
	Significance	0.236	0.364	0.856	0.622	0.974	0.764	0.491
Relation—Pre-intersection	Coefficient	0.030	0.003	0.014	0.016	0.020	0.020	0.020
	Significance	0.562	0.951	0.782	0.753	0.696	0.696	0.696
Relation—Within intersection	Coefficient	0.058	0.040	0.052	0.060	0.073	0.074	0.000
	Significance	0.262	0.442	0.314	0.249	0.158	0.154	0.994
Relation—Post-intersection	Coefficient	0.013	0.028	0.018	0.003	0.093	0.026	0.026
	Significance	0.808	0.593	0.727	0.961	0.075	0.620	0.620
Relation—Driveway, alley access, etc.	Coefficient	0.103	0.060	0.015	0.068	0.022	0.022	0.022
	Significance	0.047	0.247	0.770	0.190	0.678	0.678	0.678
Relation—Exiting ramp	Coefficient	0.033	0.023	0.011	0.050	0.016	0.016	0.016
	Significance	0.525	0.653	0.831	0.340	0.762	0.762	0.762
Relation—Entering ramp	Coefficient	0.017	0.063	0.016	0.059	0.023	0.023	0.023
	Significance	0.740	0.222	0.757	0.260	0.662	0.662	0.662
Relation—Roadway	Coefficient	0.245	0.182	0.019	0.146	0.089	0.027	0.089
	Significance	0.000	0.000	0.719	0.005	0.085	0.611	0.085
Lanes—None, illegal action	Coefficient	0.075	0.044	0.011	0.050	0.016	0.016	0.016
	Significance	0.148	0.399	0.831	0.340	0.762	0.762	0.762
Lanes—1	Coefficient	0.291	0.182	0.068	0.200	0.097	0.056	0.097
	Significance	0.000	0.000	0.188	0.000	0.062	0.280	0.062
Lanes—2	Coefficient	0.317	0.134	0.090	0.279	0.127	0.043	0.043
	Significance	0.000	0.010	0.083	0.000	0.014	0.413	0.413
Lanes—3	Coefficient	0.071	0.156	0.014	0.064	0.020	0.020	0.123
	Significance	0.174	0.002	0.782	0.217	0.696	0.696	0.017
Lanes—4	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Weather—Sunny	Coefficient	0.049	0.048	0.094	0.016	0.046	0.041	0.041
	Significance	0.344	0.352	0.070	0.755	0.372	0.434	0.434
Weather—Partly cloudy	Coefficient	0.016	0.050	0.022	0.070	0.070	0.032	0.032
	Significance	0.766	0.335	0.668	0.180	0.176	0.544	0.544
Weather—Cloudy/Overcast	Coefficient	0.057	0.142	0.176	0.068	0.022	0.022	0.022
	Significance	0.277	0.006	0.001	0.190	0.678	0.678	0.678
Visibility—Unlimited	Coefficient	0.046	0.027	0.007	0.030	0.010	0.010	0.010
	Significance	0.382	0.611	0.897	0.564	0.855	0.855	0.855
Visibility—Glare	Coefficient	0.032	0.019	0.005	0.021	0.007	0.007	0.007
	Significance	0.538	0.720	0.928	0.685	0.898	0.898	0.898
Visibility—Fog	Coefficient	0.032	0.019	0.005	0.021	0.007	0.007	0.007
	Significance	0.538	0.720	0.928	0.685	0.898	0.898	0.898
Debris on roadway—Clear/None	Coefficient	0.146	0.011	0.003	0.218	0.004	0.004	0.004
	Significance	0.005	0.836	0.958	0.000	0.941	0.941	0.941
Debris on Roadway—Sand	Coefficient	0.146	0.011	0.003	0.218	0.004	0.004	0.004
	Significance	0.005	0.836	0.958	0.000	0.941	0.941	0.941
Level of Service A	Coefficient	0.043	0.014	0.024	0.023	0.063	0.034	0.063
	Significance	0.414	0.785	0.646	0.665	0.222	0.515	0.222
Level of Service B	Coefficient	0.021	0.010	0.028	0.024	0.039	0.039	0.039
	Significance	0.682	0.848	0.595	0.642	0.451	0.451	0.451
Level of Service C	Coefficient	0.034	0.029	0.056	0.117	0.006	0.080	0.006
	Significance	0.519	0.571	0.280	0.024	0.914	0.126	0.914
Level of Service D	Coefficient	0.020	0.038	0.020	0.094	0.028	0.028	0.028
	Significance	0.705	0.469	0.702	0.069	0.587	0.587	0.587
Level of Service E	Coefficient	0.023	0.027	0.007	0.067	0.010	0.010	0.010
	Significance	0.665	0.611	0.897	0.199	0.855	0.855	0.855
Number of vehicles in event	Coefficient	0.121	0.116	0.040	0.121	0.146	0.379	0.052
	Significance	0.794	0.833	1.000	0.788	0.531	0.000	0.999
General traffic congestion	Coefficient	0.040	0.070	0.026	0.038	0.037	0.037	0.037
	Significance	0.438	0.181	0.618	0.467	0.481	0.481	0.481
Event obstacle—Other obstacle	Coefficient	0.026	0.015	0.004	0.017	0.005	0.005	0.005
	Significance	0.616	0.770	0.941	0.741	0.917	0.917	0.917
Event obstacle—Pedestrian	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Event obstacle—Bicyclist	Coefficient	0.032	0.019	0.005	0.021	0.007	0.007	0.007
	Significance	0.538	0.720	0.928	0.685	0.898	0.898	0.898
Event obstacle—Other vehicle(s)	Coefficient	0.030	0.035	0.021	0.024	0.076	0.030	0.076
	Significance	0.566	0.505	0.685	0.643	0.144	0.565	0.144
Good surface condition	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941

		Lane Change Maneuver	Conflict 30	Conflict 31	Conflict 33	Conflict 34	Conflict 35	Conflict 38
Rough surface condition	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Markings conditions—Lane lines	Coefficient	0.091	0.015	0.004	0.148	0.005	0.005	0.005
	Significance	0.080	0.770	0.941	0.004	0.917	0.917	0.917
Markings conditions—Median delineation	Coefficient	0.026	0.015	0.004	0.017	0.005	0.005	0.005
	Significance	0.616	0.770	0.941	0.741	0.917	0.917	0.917
Markings conditions—Other type of marking	Coefficient	0.146	0.011	0.003	0.218	0.004	0.004	0.004
	Significance	0.005	0.836	0.958	0.000	0.941	0.941	0.941
Missing regulatory sign(s)	Coefficient	0.000	0.033	0.008	0.037	0.012	0.012	0.222
	Significance	0.998	0.531	0.874	0.479	0.822	0.822	0.000
Missing warning sign(s)	Coefficient	0.039	0.036	0.009	0.103	0.013	0.013	0.013
	Significance	0.451	0.488	0.860	0.048	0.803	0.803	0.803
Missing directional or guide sign(s)	Coefficient	0.040	0.080	0.012	0.004	0.017	0.017	0.017
	Significance	0.445	0.122	0.820	0.938	0.748	0.748	0.748
No pedestrian signal	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Limitations to sight distance—Other traffic	Coefficient	0.082	0.048	0.012	0.054	0.017	0.017	0.017
	Significance	0.113	0.356	0.815	0.296	0.741	0.741	0.741
Limitations to sight distance—Geometry	Coefficient	0.048	0.063	0.167	0.028	0.023	0.023	0.023
	Significance	0.357	0.222	0.001	0.586	0.662	0.662	0.662
Limitations to sight distance—Signage	Coefficient	0.026	0.015	0.004	0.017	0.005	0.005	0.005
	Significance	0.616	0.770	0.941	0.741	0.917	0.917	0.917
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Limitations to sight distance—Vegetation	Coefficient	0.042	0.024	0.006	0.027	0.009	0.009	0.009
	Significance	0.425	0.643	0.906	0.599	0.868	0.868	0.868
Limitations to sight distance—Other	Coefficient	0.032	0.019	0.005	0.021	0.007	0.007	0.007
	Significance	0.538	0.720	0.928	0.685	0.898	0.898	0.898
Size of event vehicle	Coefficient	0.006	0.063	0.008	0.035	0.011	0.011	0.011
	Significance	0.902	0.223	0.881	0.505	0.833	0.833	0.833
Location of event	Coefficient	0.459	0.397	0.208	0.466	0.328	0.219	0.184
	Significance	0.000	0.000	0.977	0.000	0.045	0.949	0.997

Correlations between lane change maneuver and conflict types and all driver performance-related variables (N = 368).

		Lane Change Maneuver	Conflict 30	Conflict 31	Conflict 33	Conflict 34	Conflict 35	Conflict 38
Pulled into traffic or Proceeded without clearance	Coefficient	0.145	0.098	0.060	0.119	0.011	0.064	0.011
	Significance	0.005	0.058	0.248	0.021	0.840	0.219	0.840
Entered intersection on red light	Coefficient	0.037	0.022	0.005	0.024	0.008	0.008	0.008
	Significance	0.476	0.678	0.916	0.639	0.882	0.882	0.882
Inadequate reaction speed	Coefficient	0.085	0.067	0.017	0.034	0.024	0.024	0.024
	Significance	0.102	0.200	0.745	0.517	0.646	0.646	0.646
Failure to respond to primary control	Coefficient	0.107	0.062	0.016	0.071	0.022	0.022	0.022
	Significance	0.039	0.203	0.761	0.175	0.667	0.667	0.667
Failure to yield right-of-way to pedestrian	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Failure to respond to active emergency vehicle	Coefficient	0.026	0.015	0.004	0.017	0.005	0.005	0.005
	Significance	0.616	0.770	0.941	0.741	0.917	0.917	0.917
Lateral vehicle control—Close to center line or road edge marking	Coefficient	0.064	0.019	0.005	0.115	0.007	0.007	0.007
	Significance	0.220	0.720	0.928	0.027	0.898	0.898	0.898
Lateral vehicle control—Lane change	Coefficient	0.347	0.251	0.030	0.252	0.043	0.126	0.042
	Significance	0.000	0.000	0.560	0.000	0.410	0.015	0.420
Lateral vehicle control—Deviation in lane in both directions	Coefficient	0.011	0.036	0.009	0.031	0.013	0.013	0.013
	Significance	0.826	0.488	0.860	0.550	0.803	0.803	0.803
Lateral vehicle control—Ran off road	Coefficient	0.033	0.024	0.006	0.078	0.009	0.009	0.009
	Significance	0.526	0.643	0.906	0.131	0.868	0.868	0.868
Vehicle turn control—Under compensate	Coefficient	0.056	0.033	0.008	0.037	0.012	0.012	0.012
	Significance	0.282	0.531	0.874	0.479	0.822	0.822	0.822
Vehicle turn control—Over compensate	Coefficient	0.056	0.033	0.008	0.037	0.012	0.012	0.012
	Significance	0.282	0.531	0.874	0.479	0.822	0.822	0.822
Backing-up	Coefficient	0.068	0.039	0.010	0.045	0.014	0.014	0.014
	Significance	0.194	0.449	0.848	0.392	0.786	0.786	0.786
Vehicle turn control—U-turn	Coefficient	0.053	0.031	0.008	0.035	0.011	0.011	0.011
	Significance	0.311	0.556	0.881	0.505	0.833	0.833	0.833
Vehicle turn control—Turned into incorrect lane	Coefficient	0.112	0.066	0.017	0.074	0.024	0.024	0.024
	Significance	0.030	0.207	0.749	0.153	0.651	0.651	0.651
Vehicle turn control—Proceeded forward from a turn lane	Coefficient	0.091	0.015	0.004	0.148	0.005	0.005	0.005
	Significance	0.080	0.770	0.941	0.004	0.917	0.917	0.917
Defensive maneuver	Coefficient	0.040	0.016	0.018	0.042	0.026	0.026	0.026
	Significance	0.438	0.754	0.727	0.420	0.620	0.620	0.620
Avoiding—Obstruction in roadway	Coefficient	0.157	0.027	0.007	0.162	0.272	0.010	0.010
	Significance	0.002	0.611	0.897	0.002	0.000	0.855	0.855
No room to respond to an active emergency vehicle	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Gesturing—Sounding horn	Coefficient	0.014	0.029	0.007	0.032	0.010	0.010	0.252
	Significance	0.790	0.582	0.889	0.533	0.843	0.843	0.000
Avoiding—Another vehicle	Coefficient	0.014	0.029	0.007	0.057	0.010	0.010	0.010
	Significance	0.790	0.582	0.889	0.271	0.843	0.843	0.843
Violation stopping—Ran red light or stop sign	Coefficient	0.087	0.051	0.013	0.057	0.018	0.018	0.018
	Significance	0.095	0.331	0.805	0.271	0.727	0.727	0.727

Violation stopping—Rolling stop	Coefficient Significance	0.033 0.525	0.044 0.399	0.238 0.000	0.050 0.340	0.016 0.762	0.016 0.762	0.016 0.762
Failure to yield right-of-way—General	Coefficient Significance	0.101 0.052	0.097 0.061	0.059 0.254	0.056 0.283	0.010 0.852	0.010 0.852	0.065 0.214
Failure to yield right-of-way—Right turn on red light	Coefficient Significance	0.033 0.525	0.044 0.399	0.238 0.000	0.050 0.340	0.016 0.762	0.016 0.762	0.016 0.762
Violation turning—Illegal U-turn	Coefficient Significance	0.049 0.344	0.029 0.582	0.007 0.880	0.032 0.533	0.010 0.843	0.010 0.843	0.010 0.843
Entered intersection on an amber light	Coefficient Significance	0.042 0.425	0.024 0.643	0.006 0.906	0.027 0.599	0.009 0.868	0.009 0.868	0.009 0.868
Violations passing—Passing in a no passing zone	Coefficient Significance	0.018 0.723	0.011 0.836	0.003 0.958	0.012 0.815	0.004 0.941	0.004 0.941	0.004 0.941
Following closely	Coefficient Significance	0.090 0.084	0.081 0.117	0.021 0.691	0.021 0.689	0.029 0.574	0.029 0.574	0.029 0.574
Force another vehicle out of lane	Coefficient Significance	0.014 0.790	0.072 0.168	0.007 0.889	0.032 0.533	0.010 0.843	0.010 0.843	0.010 0.843
Speed of event vehicle	Coefficient Significance	0.101 0.051	0.063 0.229	0.025 0.634	0.079 0.128	0.035 0.500	0.035 0.500	0.060 0.249
Observed difficulties navigating—Intersection angle	Coefficient Significance	0.053 0.311	0.052 0.319	0.013 0.801	0.007 0.893	0.019 0.721	0.019 0.721	0.019 0.721
Observed difficulties navigating—Intersection width	Coefficient Significance	0.062 0.233	0.036 0.488	0.009 0.860	0.041 0.432	0.013 0.803	0.013 0.803	0.013 0.803
Observed difficulties navigating—Intersection grade	Coefficient Significance	0.042 0.425	0.024 0.643	0.006 0.906	0.027 0.599	0.009 0.868	0.009 0.868	0.009 0.868
Observed difficulties navigating—Ramp	Coefficient Significance	0.060 0.245	0.053 0.313	0.119 0.022	0.035 0.502	0.032 0.535	0.032 0.535	0.032 0.535
Observed difficulties navigating—Roadway	Coefficient Significance	0.023 0.665	0.027 0.611	0.007 0.897	0.030 0.564	0.010 0.855	0.272 0.000	0.010 0.855
Observed difficulties navigating—Alignment/ Curve	Coefficient Significance	0.062 0.233	0.036 0.488	0.009 0.860	0.041 0.432	0.013 0.803	0.013 0.803	0.013 0.803
Observed difficulties navigating—Alignment/ Undulation	Coefficient Significance	0.049 0.344	0.029 0.582	0.007 0.889	0.032 0.533	0.010 0.843	0.010 0.843	0.010 0.843
Observed difficulties navigating—Grade	Coefficient Significance	0.065 0.212	0.038 0.468	0.010 0.854	0.043 0.411	0.014 0.795	0.014 0.795	0.014 0.795
Violations turning—Illegal left turn	Coefficient Significance	0.080 0.123	0.047 0.370	0.012 0.820	0.053 0.310	0.017 0.748	0.017 0.748	0.017 0.748
Violations turning—Illegal right turn	Coefficient Significance	0.006 0.902	0.031 0.556	0.330 0.000	0.035 0.505	0.011 0.833	0.011 0.833	0.011 0.833
Violations turning—Wrong way on one-way	Coefficient Significance	0.042 0.425	0.024 0.643	0.006 0.906	0.027 0.599	0.009 0.868	0.009 0.868	0.009 0.868
Violations passing—Driving on shoulder	Coefficient Significance	0.049 0.344	0.029 0.582	0.007 0.889	0.032 0.533	0.010 0.843	0.010 0.843	0.010 0.843
Avoiding active emergency vehicle	Coefficient Significance	0.018 0.723	0.011 0.836	0.003 0.958	0.012 0.815	0.004 0.941	0.004 0.941	0.004 0.941
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.078 0.131	0.063 0.222	0.016 0.757	0.028 0.586	0.023 0.662	0.023 0.662	0.023 0.662
Creeping into intersection	Coefficient Significance	0.044 0.403	0.048 0.356	0.012 0.815	0.054 0.296	0.148 0.004	0.017 0.741	0.017 0.741
Vehicle control while turning—Turned from through-only lane	Coefficient Significance	0.014 0.790	0.029 0.582	0.007 0.889	0.057 0.271	0.010 0.843	0.010 0.843	0.010 0.843
Following	Coefficient Significance	0.087 0.095	0.051 0.331	0.013 0.805	0.057 0.271	0.018 0.727	0.018 0.727	0.018 0.727
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.115 0.027	0.089 0.087	0.016 0.765	0.065 0.212	0.112 0.030	0.022 0.673	0.022 0.673
Lateral vehicle control—No deviation	Coefficient Significance	0.058 0.262	0.035 0.497	0.041 0.430	0.043 0.405	0.018 0.733	0.093 0.072	0.058 0.264
Lateral vehicle control—Deviation in lane to right	Coefficient Significance	0.047 0.369	0.049 0.343	0.013 0.810	0.002 0.973	0.018 0.734	0.018 0.734	0.018 0.734
Lateral vehicle control—Deviation in lane to left	Coefficient Significance	0.082 0.113	0.048 0.356	0.012 0.815	0.054 0.296	0.017 0.741	0.017 0.741	0.017 0.741
Lateral vehicle control—Lane break to right	Coefficient Significance	0.108 0.036	0.175 0.001	0.019 0.712	0.028 0.597	0.027 0.601	0.027 0.601	0.027 0.601
Lateral vehicle control—Lane break to left	Coefficient Significance	0.069 0.182	0.048 0.358	0.022 0.675	0.074 0.153	0.072 0.163	0.174 0.001	0.031 0.552
Lateral vehicle control—Unknown	Coefficient Significance	0.032 0.538	0.019 0.720	0.005 0.928	0.021 0.685	0.007 0.898	0.007 0.898	0.007 0.898
Longitudinal vehicle control—Decelerating	Coefficient Significance	0.033 0.526	0.024 0.643	0.006 0.906	0.027 0.599	0.009 0.868	0.297 0.000	0.009 0.868
Longitudinal vehicle control—Anticipatory braking	Coefficient Significance	0.073 0.158	0.047 0.371	0.022 0.678	0.027 0.600	0.031 0.556	0.031 0.556	0.031 0.556
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient Significance	0.094 0.071	0.045 0.388	0.040 0.441	0.078 0.134	0.096 0.066	0.057 0.275	0.057 0.275
Longitudinal vehicle control—uncontrolled braking	Coefficient Significance	0.124 0.017	0.063 0.223	0.008 0.881	0.132 0.010	0.011 0.833	0.011 0.833	0.011 0.833
Longitudinal vehicle control—Skidding	Coefficient Significance	0.064 0.220	0.019 0.720	0.005 0.928	0.005 0.027	0.007 0.898	0.007 0.898	0.007 0.898
Longitudinal vehicle control—Accelerating	Coefficient Significance	0.005 0.926	0.075 0.147	0.080 0.125	0.045 0.387	0.048 0.354	0.048 0.354	0.048 0.354
Longitudinal vehicle control—Normal driving	Coefficient Significance	0.143 0.006	0.012 0.811	0.019 0.719	0.146 0.005	0.027 0.611	0.027 0.611	0.202 0.000
Longitudinal vehicle control—Unknown	Coefficient Significance	0.014 0.790	0.029 0.582	0.007 0.889	0.032 0.533	0.010 0.843	0.252 0.000	0.010 0.843
Signal usage—Signal not required	Coefficient Significance	0.107 0.039	0.091 0.080	0.044 0.396	0.073 0.159	0.063 0.229	0.012 0.815	0.087 0.095
Signal usage—Incorrect signal	Coefficient Significance	0.037 0.476	0.022 0.678	0.005 0.916	0.024 0.639	0.008 0.882	0.008 0.882	0.008 0.882
Signal usage—Correct signal on in advance	Coefficient Significance	0.028 0.590	0.013 0.809	0.024 0.643	0.044 0.402	0.034 0.511	0.063 0.229	0.034 0.511
Signal usage—Correct signal not on in advance	Coefficient Significance	0.049 0.344	0.029 0.582	0.007 0.889	0.032 0.533	0.010 0.843	0.010 0.843	0.010 0.843

Signal usage—Signal not used	Coefficient	0.072	0.082	0.029	0.047	0.047	0.040	0.040
	Significance	0.165	0.113	0.583	0.368	0.365	0.437	0.437
Signal usage—Unknown	Coefficient	0.124	0.033	0.126	0.113	0.075	0.030	0.030
	Significance	0.016	0.528	0.015	0.029	0.151	0.561	0.561

Correlations between lane change maneuver and conflict types and same direction, forward, ramp, and pedestrian/bicyclist maneuvers and conflict types (N = 368).

		Lane Change Maneuver	Conflict 30	Conflict 31	Conflict 33	Conflict 34	Conflict 35	Conflict 38
Lane Change Maneuver	Coefficient	----						
	Significance							
Conflict 30	Coefficient	0.503	----					
	Significance	0.000						
Conflict 31	Coefficient	0.146	0.011	----				
	Significance	0.005	0.836					
Conflict 33	Coefficient	0.550	0.048	0.012	----			
	Significance	0.000	0.356	0.815				
Conflict 34	Coefficient	0.204	0.015	0.004	0.017	----		
	Significance	0.000	0.770	0.941	0.741			
Conflict 35	Coefficient	0.204	0.015	0.004	0.017	0.005	----	
	Significance	0.000	0.770	0.941	0.741	0.917		
Conflict 38	Coefficient	0.204	0.015	0.004	0.017	0.005	0.005	----
	Significance	0.000	0.770	0.941	0.741	0.917	0.917	
Same Direction Maneuver	Coefficient	0.204	0.121	0.031	0.136	0.044	0.044	0.044
	Significance	0.000	0.020	0.555	0.008	0.403	0.403	0.403
Conflict40	Coefficient	0.176	0.104	0.026	0.117	0.037	0.037	0.037
	Significance	0.001	0.045	0.612	0.024	0.473	0.473	0.473
Conflict41	Coefficient	0.075	0.044	0.011	0.050	0.016	0.016	0.016
	Significance	0.148	0.399	0.831	0.340	0.762	0.762	0.762
Conflict 42	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Conflict43	Coefficient	0.026	0.015	0.004	0.017	0.005	0.005	0.005
	Significance	0.616	0.770	0.941	0.741	0.917	0.917	0.917
Conflict44	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Forward Maneuver	Coefficient	0.119	0.070	0.018	0.079	0.025	0.025	0.025
	Significance	0.021	0.180	0.734	0.129	0.630	0.630	0.630
Conflict50	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Conflict51	Coefficient	0.075	0.044	0.011	0.050	0.016	0.016	0.016
	Significance	0.148	0.399	0.831	0.340	0.762	0.762	0.762
Conflict52	Coefficient	0.049	0.029	0.007	0.032	0.010	0.010	0.010
	Significance	0.344	0.582	0.889	0.533	0.843	0.843	0.843
Conflict53	Coefficient	0.046	0.027	0.007	0.030	0.010	0.010	0.010
	Significance	0.382	0.611	0.897	0.564	0.855	0.855	0.855
Conflict54	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Conflict56	Coefficient	0.026	0.015	0.004	0.017	0.005	0.005	0.005
	Significance	0.616	0.770	0.941	0.741	0.917	0.917	0.917
Conflict57	Coefficient	0.042	0.024	0.006	0.027	0.009	0.009	0.009
	Significance	0.425	0.643	0.906	0.599	0.868	0.868	0.868
Enter Ramp Maneuver	Coefficient	0.059	0.034	0.009	0.039	0.012	0.012	0.012
	Significance	0.256	0.509	0.867	0.454	0.813	0.813	0.813
Conflict60	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Conflict61	Coefficient	0.032	0.019	0.005	0.021	0.007	0.007	0.007
	Significance	0.538	0.720	0.928	0.685	0.898	0.898	0.898
Conflict62	Coefficient	0.046	0.027	0.007	0.030	0.010	0.010	0.010
	Significance	0.382	0.611	0.897	0.564	0.855	0.855	0.855
Ramp Proper Maneuver	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Conflict71	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Exit Ramp Maneuver	Coefficient	0.121	0.071	0.018	0.080	0.025	0.025	0.025
	Significance	0.019	0.173	0.730	0.123	0.625	0.625	0.625
Conflict80	Coefficient	0.070	0.041	0.010	0.046	0.015	0.015	0.015
	Significance	0.177	0.432	0.842	0.373	0.778	0.778	0.778
Conflict83	Coefficient	0.095	0.056	0.014	0.063	0.020	0.020	0.020
	Significance	0.067	0.286	0.787	0.227	0.702	0.702	0.702
Pedestrian/Bicycle Maneuver	Coefficient	0.049	0.029	0.007	0.032	0.010	0.010	0.010
	Significance	0.344	0.582	0.889	0.533	0.843	0.843	0.843
Conflict90	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941
Conflict91	Coefficient	0.042	0.024	0.006	0.027	0.009	0.009	0.009
	Significance	0.425	0.643	0.906	0.599	0.868	0.868	0.868
Conflict93	Coefficient	0.018	0.011	0.003	0.012	0.004	0.004	0.004
	Significance	0.723	0.836	0.958	0.815	0.941	0.941	0.941

13.5 Same Direction Contingency Correlation Tables

Correlations between same direction maneuver and conflict types and site-related variables (N = 368).

		Same Direction Maneuver	Conflict 40	Conflict 41	Conflict 42	Conflict 43	Conflict 44
Region—Rural	Coefficient	0.089	0.079	0.029	0.035	0.030	0.035
	Significance	0.086	0.129	0.581	0.500	0.566	0.500
Region—City	Coefficient	0.060	0.057	0.017	0.032	0.046	0.032
	Significance	0.249	0.273	0.747	0.535	0.380	0.535
Region—Metro	Coefficient	0.138	0.126	0.012	0.062	0.013	0.062
	Significance	0.008	0.015	0.821	0.230	0.796	0.230
Geometry—Roadway segment	Coefficient	0.277	0.311	0.013	0.015	0.022	0.015
	Significance	0.000	0.000	0.805	0.770	0.678	0.770
Geometry—Merge	Coefficient	0.068	0.012	0.092	0.030	0.043	0.030
	Significance	0.191	0.823	0.077	0.563	0.413	0.563
Geometry—T-intersection	Coefficient	0.030	0.036	0.016	0.023	0.032	0.023
	Significance	0.566	0.486	0.762	0.662	0.535	0.662
Geometry—4-legged intersection	Coefficient	0.136	0.171	0.046	0.028	0.049	0.028
	Significance	0.009	0.001	0.378	0.592	0.345	0.592
Geometry—Offset 4-legged intersection	Coefficient	0.070	0.079	0.017	0.011	0.016	0.011
	Significance	0.175	0.129	0.751	0.826	0.755	0.826
Geometry—Multi-legged intersection	Coefficient	0.029	0.018	0.035	0.092	0.045	0.092
	Significance	0.573	0.731	0.500	0.076	0.393	0.076
Geometry—All intersection types	Coefficient	0.102	0.174	0.092	0.037	0.052	0.037
	Significance	0.049	0.001	0.076	0.483	0.321	0.483
Road function—Group A	Coefficient	0.098	0.064	0.067	0.016	0.023	0.016
	Significance	0.060	0.217	0.199	0.753	0.656	0.753
Road function—Group B	Coefficient	0.137	0.194	0.057	0.035	0.050	0.035
	Significance	0.008	0.000	0.270	0.500	0.339	0.500
Road function—Group C	Coefficient	0.016	0.054	0.011	0.062	0.088	0.062
	Significance	0.764	0.296	0.839	0.233	0.091	0.233
Road function—Group D	Coefficient	0.084	0.125	0.090	0.023	0.032	0.023
	Significance	0.104	0.015	0.082	0.665	0.540	0.665
Road function—Group E	Coefficient	0.016	0.002	0.046	0.009	0.012	0.009
	Significance	0.759	0.976	0.374	0.867	0.813	0.867
Primary control—Yield sign	Coefficient	0.077	0.028	0.082	0.028	0.040	0.028
	Significance	0.139	0.594	0.115	0.592	0.448	0.592
Primary control—Stop sign	Coefficient	0.126	0.148	0.018	0.027	0.051	0.027
	Significance	0.015	0.004	0.725	0.601	0.324	0.601
Primary control—G,Y,R signal without turn arrows	Coefficient	0.030	0.018	0.016	0.119	0.032	0.023
	Significance	0.566	0.731	0.762	0.022	0.535	0.662
Primary control—G, Y, R signal with turn arrows	Coefficient	0.003	0.041	0.055	0.036	0.029	0.076
	Significance	0.958	0.429	0.294	0.494	0.579	0.142
Primary control—None	Coefficient	0.259	0.294	0.017	0.016	0.022	0.016
	Significance	0.000	0.000	0.749	0.761	0.667	0.761
Road edge—Paved full shoulder	Coefficient	0.065	0.015	0.087	0.021	0.030	0.021
	Significance	0.212	0.768	0.093	0.681	0.561	0.681
Road edge—Soft full shoulder	Coefficient	0.202	0.242	0.039	0.010	0.014	0.010
	Significance	0.000	0.000	0.453	0.854	0.795	0.854
Road edge—Paved partial shoulder	Coefficient	0.100	0.094	0.049	0.019	0.027	0.019
	Significance	0.053	0.071	0.345	0.719	0.611	0.719
Road edge—Soft partial shoulder	Coefficient	0.065	0.035	0.049	0.021	0.030	0.021
	Significance	0.212	0.507	0.342	0.681	0.561	0.681
Road edge—Curb (no shoulder)	Coefficient	0.046	0.113	0.079	0.046	0.065	0.046
	Significance	0.375	0.028	0.127	0.380	0.214	0.380
Markings—Good condition	Coefficient	0.013	0.024	0.066	0.062	0.013	0.044
	Significance	0.805	0.641	0.206	0.230	0.796	0.404
Markings—Fair condition	Coefficient	0.042	0.034	0.024	0.087	0.044	0.031
	Significance	0.424	0.512	0.650	0.094	0.396	0.549
Markings—Poor condition	Coefficient	0.030	0.073	0.064	0.021	0.075	0.021
	Significance	0.568	0.161	0.217	0.681	0.151	0.681
Markings—None	Coefficient	0.031	0.026	0.011	0.003	0.004	0.003
	Significance	0.555	0.612	0.831	0.958	0.941	0.958
Median—Depressed	Coefficient	0.010	0.017	0.026	0.029	0.041	0.029
	Significance	0.841	0.747	0.621	0.575	0.427	0.575
Median—Flush	Coefficient	0.202	0.242	0.039	0.010	0.014	0.010
	Significance	0.000	0.000	0.453	0.854	0.795	0.854
Median—Raised	Coefficient	0.008	0.048	0.021	0.086	0.038	0.086
	Significance	0.881	0.354	0.688	0.099	0.460	0.099
Median—None	Coefficient	0.058	0.060	0.017	0.048	0.006	0.048
	Significance	0.269	0.249	0.738	0.356	0.908	0.356
Barrier—Permanent	Coefficient	0.044	0.010	0.005	0.069	0.097	0.069
	Significance	0.399	0.853	0.926	0.186	0.061	0.186
Barrier—None	Coefficient	0.044	0.010	0.005	0.069	0.097	0.069
	Significance	0.399	0.853	0.926	0.186	0.061	0.186
Sidewalk—Along all roadways	Coefficient	0.059	0.041	0.038	0.110	0.035	0.025
	Significance	0.253	0.432	0.472	0.034	0.503	0.637
Sidewalk—Along most roadways	Coefficient	0.066	0.059	0.020	0.034	0.034	0.034
	Significance	0.202	0.254	0.696	0.519	0.520	0.519
Sidewalk—Along few roadways	Coefficient	0.022	0.049	0.024	0.017	0.101	0.159
	Significance	0.674	0.347	0.649	0.745	0.050	0.002
Sidewalk—None	Coefficient	0.028	0.052	0.004	0.045	0.064	0.045
	Significance	0.595	0.321	0.946	0.385	0.219	0.385

		Same Direction Maneuver	Conflict 40	Conflict 41	Conflict 42	Conflict 43	Conflict 44
Obstruction—Vegetation	Coefficient Significance	0.037 0.476	0.020 0.699	0.038 0.464	0.093 0.072	0.041 0.430	0.029 0.577
Obstruction—Advertisement signs	Coefficient Significance	0.073 0.159	0.055 0.292	0.039 0.453	0.010 0.854	0.014 0.795	0.010 0.854
Obstruction—Other	Coefficient Significance	0.202 0.000	0.242 0.000	0.039 0.453	0.010 0.854	0.014 0.795	0.010 0.854
Obstruction—None	Coefficient Significance	0.086 0.100	0.093 .072	0.005 0.923	0.079 0.128	0.049 0.351	0.034 0.510
Posted speed limit	Coefficient Significance	0.152 0.122	0.148 0.142	0.126 0.314	0.176 0.039	0.088 0.719	0.067 0.895

Correlations between same direction maneuver and conflict types and traffic-related variables (N = 368).

		Same Direction Maneuver	Conflict 40	Conflict 41	Conflict 42	Conflict 43	Conflict 44
Hour event occurred	Coefficient Significance	0.204 0.195	0.202 0.206	0.210 0.150	0.124 0.930	0.165 0.588	0.499 0.000
Relation—Pre-intersection	Coefficient Significance	0.285 0.000	0.247 0.000	0.045 0.386	0.014 0.782	0.123 0.017	0.186 0.000
Relation—Within intersection	Coefficient Significance	0.266 0.000	0.264 0.000	0.025 0.625	0.052 0.319	0.000 0.994	0.052 0.319
Relation—Post-intersection	Coefficient Significance	0.073 0.160	0.104 0.044	0.074 0.153	0.148 0.004	0.026 0.620	0.018 0.727
Relation—Driveway, alley access, etc.	Coefficient Significance	0.081 0.120	0.023 0.662	0.228 0.000	0.015 0.770	0.022 0.678	0.015 0.770
Relation—Exiting ramp	Coefficient Significance	0.034 0.509	0.009 0.869	0.045 0.383	0.011 0.831	0.016 0.762	0.011 0.831
Relation—Entering ramp	Coefficient Significance	0.115 0.026	0.084 0.106	0.066 0.207	0.016 0.757	0.023 0.662	0.016 0.757
Relation—Roadway	Coefficient Significance	0.176 0.001	0.216 0.000	0.035 0.507	0.019 0.719	0.027 0.611	0.019 0.719
Lanes—None, illegal action	Coefficient Significance	0.034 0.509	0.075 0.151	0.020 0.703	0.238 0.000	0.016 0.762	0.011 0.831
Lanes—1	Coefficient Significance	0.167 0.001	0.185 0.000	0.024 0.645	0.068 0.188	0.056 0.280	0.068 0.188
Lanes—2	Coefficient Significance	0.089 0.086	0.112 0.030	0.031 0.555	0.030 0.563	0.043 0.413	0.090 0.083
Lanes—3	Coefficient Significance	0.174 0.001	0.199 0.000	0.007 0.896	0.014 0.782	0.020 0.696	0.014 0.782
Lanes—4	Coefficient Significance	0.088 0.090	0.103 0.048	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Weather—Sunny	Coefficient Significance	0.003 0.955	0.008 0.872	0.055 0.293	0.029 0.580	0.133 0.010	0.094 0.070
Weather—Partly cloudy	Coefficient Significance	0.012 0.814	0.007 0.891	0.054 0.296	0.022 0.668	0.032 0.544	0.121 0.019
Weather—Cloudy/Overcast	Coefficient Significance	0.012 0.820	0.023 0.662	0.013 0.805	0.015 0.770	0.245 0.000	0.015 0.770
Visibility—Unlimited	Coefficient Significance	0.027 0.606	0.012 0.820	0.027 0.599	0.007 0.897	0.010 0.855	0.007 0.897
Visibility—Glare	Coefficient Significance	0.053 0.305	0.046 0.379	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Visibility—Fog	Coefficient Significance	0.016 0.765	0.029 0.576	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Debris on roadway—Clear/None	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Debris on Roadway—Sand	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Level of Service A	Coefficient Significance	0.009 0.870	0.036 0.485	0.043 0.412	0.024 0.646	0.063 0.222	0.024 0.646
Level of Service B	Coefficient Significance	0.014 0.794	0.024 0.641	0.081 0.120	0.028 0.595	0.039 0.451	0.098 0.059
Level of Service C	Coefficient Significance	0.064 0.222	0.018 0.725	0.096 0.064	0.056 0.280	0.006 0.914	0.048 0.353
Level of Service D	Coefficient Significance	0.040 0.446	0.009 0.870	0.081 0.118	0.020 0.702	0.028 0.587	0.020 0.702
Level of Service E	Coefficient Significance	0.076 0.145	0.065 0.211	0.027 0.599	0.007 0.897	0.010 0.855	0.007 0.897
Number of vehicles in event	Coefficient Significance	0.185 0.160	0.157 0.415	0.102 0.918	0.040 1.000	0.579 0.000	0.096 0.947
General traffic congestion	Coefficient Significance	0.106 0.041	0.049 0.350	0.105 0.042	0.026 0.618	0.037 0.481	0.026 0.618
Event obstacle—Other obstacle	Coefficient Significance	0.044 0.403	0.037 0.473	0.016 0.762	0.004 0.941	0.005 0.917	0.004 0.941
Event obstacle—Pedestrian	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Event obstacle—Bicyclist	Coefficient Significance	0.016 0.765	0.029 0.576	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Event obstacle—Other vehicle(s)	Coefficient Significance	0.025 0.626	0.050 0.334	0.028 0.588	0.021 0.685	0.076 0.144	0.021 0.685

		Same Direction Maneuver	Conflict 40	Conflict 41	Conflict 42	Conflict 43	Conflict 44
Good surface condition	Coefficient Significance	0.088 0.090	0.103 0.048	0.011 0.831	0.003 0.968	0.004 0.941	0.003 0.958
Rough surface condition	Coefficient Significance	0.088 0.090	0.103 0.048	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Markings conditions—Lane lines	Coefficient Significance	0.044 0.403	0.037 0.473	0.016 0.762	0.004 0.941	0.005 0.917	0.004 0.941
Markings conditions—Median delineation	Coefficient Significance	0.124 0.016	0.145 0.005	0.016 0.762	0.004 0.941	0.005 0.917	0.004 0.941
Markings conditions—Other type of marking	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Missing regulatory sign(s)	Coefficient Significance	0.093 0.073	0.080 0.124	0.034 0.517	0.008 0.874	0.012 0.822	0.008 0.874
Missing warning sign(s)	Coefficient Significance	0.103 0.047	0.088 0.088	0.037 0.473	0.009 0.860	0.013 0.803	0.009 0.860
Missing directional or guide sign(s)	Coefficient Significance	0.039 0.455	0.021 0.688	0.013 0.797	0.012 0.820	0.153 0.003	0.224 0.000
No pedestrian signal	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Limitations to sight distance—Other traffic	Coefficient Significance	0.025 0.626	0.004 0.940	0.050 0.340	0.012 0.815	0.017 0.741	0.012 0.815
Limitations to sight distance—Geometry	Coefficient Significance	0.158 0.002	0.131 0.011	0.066 0.207	0.016 0.757	0.023 0.662	0.016 0.757
Limitations to sight distance—Signage	Coefficient Significance	0.044 0.403	0.037 0.473	0.016 0.762	0.004 0.941	0.005 0.917	0.004 0.941
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Limitations to sight distance—Vegetation	Coefficient Significance	0.069 0.184	0.059 0.255	0.025 0.631	0.006 0.906	0.009 0.868	0.006 0.906
Limitations to sight distance—Other	Coefficient Significance	0.016 0.765	0.029 0.576	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Size of event vehicle	Coefficient Significance	0.003 0.958	0.029 0.576	0.032 0.542	0.008 0.881	0.011 0.833	0.330 0.000
Location of event	Coefficient Significance	0.369 0.002	0.406 0.000	0.225 0.924	0.176 0.999	0.233 0.887	0.208 0.977

Correlations between same direction maneuver and conflict types and driver performance-related variables (N = 368).

		Same Direction Maneuver	Conflict 40	Conflict 41	Conflict 42	Conflict 43	Conflict 44
Pulled into traffic or Proceeded without clearance	Coefficient Significance	0.428 0.000	0.370 0.000	0.182 0.000	0.045 0.385	0.064 0.219	0.045 0.385
Entered intersection on red light	Coefficient Significance	0.002 0.970	0.012 0.818	0.022 0.668	0.005 0.916	0.008 0.882	0.005 0.916
Inadequate reaction speed	Coefficient Significance	0.125 0.015	0.111 0.032	0.067 0.198	0.017 0.745	0.024 0.646	0.017 0.745
Failure to respond to primary control	Coefficient Significance	0.067 0.198	0.128 0.013	0.079 0.128	0.016 0.761	0.022 0.667	0.170 0.001
Failure to respond to an active emergency vehicle	Coefficient Significance	0.124 0.016	0.054 0.297	0.163 0.002	0.004 0.941	0.005 0.917	0.004 0.941
Failure to yield right-of-way to pedestrian	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Lateral vehicle control—Close to center line or road edge marking	Coefficient Significance	0.053 0.305	0.046 0.379	0.019 0.0711	0.005 0.928	0.007 0.898	0.005 0.928
Lateral vehicle control—Lane change	Coefficient Significance	0.142 0.006	0.123 0.018	0.093 0.073	0.030 0.560	0.042 0.420	0.089 0.085
Lateral vehicle control—Deviation in lane in both directions	Coefficient Significance	0.042 0.417	0.030 0.565	0.041 0.434	0.009 0.860	0.013 0.803	0.009 0.860
Lateral vehicle control—Ran off road	Coefficient Significance	0.016 0.765	0.001 0.983	0.025 0.631	0.006 0.906	0.009 0.868	0.006 0.906
Vehicle turn control—Under compensate	Coefficient Significance	0.053 0.307	0.036 0.485	0.034 0.517	0.008 0.874	0.012 0.822	0.008 0.874
Vehicle turn control—Over compensate	Coefficient Significance	0.053 0.307	0.080 0.124	0.052 0.314	0.008 0.874	0.012 0.822	0.008 0.874
Backing-up	Coefficient Significance	0.055 0.289	0.060 0.248	0.041 0.434	0.263 0.000	0.360 0.000	0.263 0.000
Vehicle turn control—U-turn	Coefficient Significance	0.003 0.958	0.029 0.576	0.059 0.253	0.008 0.881	0.011 0.833	0.008 0.881
Vehicle turn control—Turned into incorrect lane	Coefficient Significance	0.081 0.120	0.114 0.028	0.070 0.179	0.017 0.749	0.024 0.651	0.017 0.749
Vehicle turn control—Proceeded forward from a turn lane	Coefficient Significance	0.041 0.433	0.054 0.297	0.016 0.762	0.004 0.941	0.005 0.917	0.004 0.941
Defensive maneuver	Coefficient Significance	0.026 0.612	0.047 0.371	0.054 0.300	0.018 0.727	0.026 0.620	0.018 0.727
Avoiding—Obstruction in roadway	Coefficient Significance	0.027 0.606	0.012 0.820	0.027 0.599	0.007 0.897	0.010 0.855	0.007 0.897
No room to respond to an active emergency vehicle	Coefficient Significance	0.088 0.090	0.103 0.048	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Gesturing—Sounding horn	Coefficient Significance	0.099 0.056	0.077 0.136	0.068 0.193	0.007 0.889	0.010 0.843	0.007 0.889

Avoiding—Another vehicle	Coefficient Significance	0.009 0.866	0.028 0.587	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Violation stopping—Ran red light or stop sign	Coefficient Significance	0.091 0.079	0.095 0.067	0.005 0.924	0.013 0.805	0.018 0.727	0.013 0.805
Violation stopping—Rolling stop	Coefficient Significance	0.065 0.213	0.075 0.151	0.045 0.383	0.011 0.831	0.016 0.762	0.238 0.000
Failure to yield right-of-way—General	Coefficient Significance	0.280 0.000	0.245 0.000	0.106 0.041	0.059 0.254	0.065 0.214	0.046 0.380
Failure to yield right-of-way—Right turn on red light	Coefficient Significance	0.026 0.612	0.009 0.869	0.020 0.703	0.011 0.831	0.016 0.762	0.238 0.000
Violation turning—Illegal U-turn	Coefficient Significance	0.009 0.866	0.021 0.686	0.068 0.193	0.007 0.889	0.010 0.843	0.007 0.889
Entered intersection on an amber light	Coefficient Significance	0.038 0.466	0.001 0.983	0.090 0.084	0.006 0.906	0.009 0.868	0.006 0.906
Violations passing—Passing in a no passing zone	Coefficient Significance	0.088 0.090	0.103 0.048	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Following closely	Coefficient Significance	0.441 0.000	0.410 0.000	0.184 0.000	0.021 0.691	0.029 0.574	0.021 0.691
Force another vehicle out of lane	Coefficient Significance	0.054 0.298	0.077 0.136	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Speed of event vehicle	Coefficient Significance	0.180 0.000	0.174 0.001	0.070 0.178	0.025 0.634	0.035 0.500	0.025 0.634
Observed difficulties navigating—Intersection angle	Coefficient Significance	0.096 0.065	0.070 0.175	0.054 0.302	0.013 0.801	0.019 0.721	0.013 0.801
Observed difficulties navigating—Intersection width	Coefficient Significance	0.006 0.911	0.010 0.854	0.041 0.434	0.009 0.860	0.013 0.803	0.009 0.860
Observed difficulties navigating—Intersection grade	Coefficient Significance	0.038 0.466	0.057 0.273	0.025 0.631	0.006 0.906	0.009 0.868	0.006 0.906
Observed difficulties navigating—Ramp	Coefficient Significance	0.071 0.170	0.037 0.475	0.057 0.276	0.023 0.662	0.032 0.535	0.023 0.662
Observed difficulties navigating—Roadway	Coefficient Significance	0.071 0.172	0.094 0.069	0.027 0.599	0.007 0.897	0.010 0.855	0.007 0.897
Observed difficulties navigating—Alignment/Curve	Coefficient Significance	0.031 0.557	0.049 0.345	0.037 0.473	0.009 0.860	0.013 0.803	0.285 0.000
Observed difficulties navigating—Alignment/Undulation	Coefficient Significance	0.009 0.866	0.028 0.587	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Observed difficulties navigating—Grade	Coefficient Significance	0.003 0.948	0.021 0.686	0.039 0.453	0.010 0.854	0.014 0.795	0.010 0.810
Violations turning—Illegal left turn	Coefficient Significance	0.019 0.721	0.021 0.688	0.013 0.797	0.012 0.820	0.017 0.748	0.012 0.820
Violations turning—Illegal right turn	Coefficient Significance	0.003 0.958	0.017 0.743	0.032 0.542	0.008 0.881	0.011 0.833	0.008 0.881
Violations turning—Wrong way on one-way	Coefficient Significance	0.069 0.184	0.059 0.255	0.025 0.631	0.006 0.906	0.009 0.868	0.006 0.906
Violations passing—Driving on shoulder	Coefficient Significance	0.009 0.866	0.028 0.587	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Avoiding active emergency vehicle	Coefficient Significance	0.088 0.090	0.103 0.048	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.137 0.008	0.108 0.038	0.066 0.207	0.016 0.757	0.023 0.662	0.016 0.757
Creeping into intersection	Coefficient Significance	0.109 0.036	0.087 0.093	0.050 0.340	0.012 0.815	0.017 0.741	0.012 0.815
Vehicle control while turning—Turned from through-only lane	Coefficient Significance	0.054 0.298	0.028 0.587	0.068 0.193	0.007 0.889	0.010 0.843	0.007 0.889
Following	Coefficient Significance	0.095 0.066	0.079 0.129	0.062 0.231	0.013 0.805	0.018 0.727	0.013 0.805
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.062 0.232	0.052 0.317	0.015 0.776	0.016 0.765	0.022 0.673	0.016 0.765
Lateral vehicle control—No deviation	Coefficient Significance	0.107 0.040	0.107 0.039	0.004 0.945	0.066 0.204	0.058 0.264	0.041 0.430
Lateral vehicle control—Deviation in lane to right	Coefficient Significance	0.050 0.334	0.027 0.598	0.008 0.883	0.213 0.000	0.018 0.734	0.013 0.810
Lateral vehicle control—Deviation in lane to left	Coefficient Significance	0.053 0.305	0.057 0.274	0.010 0.841	0.012 0.815	0.017 0.741	0.012 0.815
Lateral vehicle control—Lane break to right	Coefficient Significance	0.139 0.007	0.123 0.017	0.037 0.472	0.019 0.712	0.027 0.601	0.019 0.712
Lateral vehicle control—Lane break to left	Coefficient Significance	0.003 0.947	0.004 0.939	0.023 0.663	0.022 0.675	0.031 0.552	0.022 0.675
Lateral vehicle control—Unknown	Coefficient Significance	0.053 0.305	0.046 0.379	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Longitudinal vehicle control—Decelerating	Coefficient Significance	0.016 0.765	0.059 0.255	0.090 0.084	0.006 0.906	0.009 0.868	0.006 0.906
Longitudinal vehicle control—Anticipatory braking	Coefficient Significance	0.054 0.303	0.057 0.273	0.013 0.802	0.022 0.678	0.074 0.157	0.022 0.678
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient Significance	0.185 0.000	0.153 0.003	0.111 0.033	0.068 0.194	0.057 0.275	0.040 0.441
Longitudinal vehicle control—uncontrolled braking	Coefficient Significance	0.040 0.445	0.017 0.743	0.032 0.542	0.008 0.881	0.236 0.000	0.008 0.881
Longitudinal vehicle control—Skidding	Coefficient Significance	0.016 0.765	0.029 0.576	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Longitudinal vehicle control—Accelerating	Coefficient Significance	0.166 0.001	0.109 0.036	0.109 0.035	0.034 0.513	0.048 0.354	0.034 0.513
Longitudinal vehicle control—Normal driving	Coefficient Significance	0.132 0.010	0.158 0.002	0.007 0.889	0.019 0.719	0.027 0.611	0.144 0.005
Longitudinal vehicle control—Unknown	Coefficient Significance	0.037 0.482	0.021 0.686	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Signal usage—Signal not required	Coefficient Significance	0.235 0.000	0.259 0.000	0.019 0.718	0.061 0.238	0.012 0.815	0.044 0.396

Signal usage—Incorrect signal	Coefficient Significance	0.002 0.970	0.0120 0.818	0.022 0.668	0.005 0.916	0.008 0.882	0.005 0.916
Signal usage—Correct signal on in advance	Coefficient Significance	0.142 0.006	0.161 0.002	0.006 0.907	0.024 0.643	0.034 0.511	0.112 0.031
Signal usage—Correct signal not on in advance	Coefficient Significance	0.037 0.482	0.070 0.177	0.068 0.193	0.007 0.889	0.010 0.843	0.007 0.889
Signal usage—Signal not used	Coefficient Significance	0.159 0.002	0.148 0.004	0.022 0.673	0.029 0.583	0.040 0.437	0.029 0.583
Signal usage—Unknown	Coefficient Significance	0.023 0.655	0.004 0.942	0.026 0.613	0.021 0.681	0.075 0.151	0.021 0.681

Correlations between same direction maneuver and conflict types and forward, remp, and pedestrian/bicyclist maneuvers and conflict types (N = 368).

		Same Direction Maneuver	Conflict 40	Conflict 41	Conflict 42	Conflict 43	Conflict 44
Same Direction Maneuver	Coefficient Significance	----					
Conflict 40	Coefficient Significance	0.651 0.000	----				
Conflict 41	Coefficient Significance	0.340 0.000	0.107 0.039	----			
Conflict 42	Coefficient Significance	0.088 0.090	0.026 0.612	0.011 0.831	----		
Conflict 43	Coefficient Significance	0.124 0.016	0.037 0.473	0.016 0.762	0.004 0.941	----	
Conflict 44	Coefficient Significance	0.088 0.090	0.026 0.612	0.011 0.831	0.003 0.968	0.004 0.941	----
Forward Maneuver	Coefficient Significance	0.196 0.000	0.169 0.001	0.072 0.165	0.018 0.734	0.025 0.630	0.018 0.734
Conflict 50	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Conflict 51	Coefficient Significance	0.125 0.016	0.107 0.039	0.045 0.383	0.011 0.831	0.016 0.762	0.011 0.831
Conflict 52	Coefficient Significance	0.082 0.115	0.070 0.177	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Conflict 53	Coefficient Significance	0.076 0.145	0.065 0.211	0.027 0.599	0.007 0.897	0.010 0.855	0.007 0.897
Conflict 54	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Conflict 56	Coefficient Significance	0.044 0.403	0.037 0.473	0.016 0.762	0.004 0.941	0.005 0.917	0.004 0.941
Conflict 57	Coefficient Significance	0.069 0.184	0.059 0.255	0.025 0.631	0.006 0.906	0.009 0.868	0.006 0.906
Enter Ramp Maneuver	Coefficient Significance	0.098 0.059	0.084 0.105	0.036 0.494	0.009 0.867	0.012 0.813	0.009 0.867
Conflict 60	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Conflict 61	Coefficient Significance	0.053 0.305	0.046 0.379	0.019 0.711	0.005 0.928	0.007 0.898	0.005 0.928
Conflict 62	Coefficient Significance	0.076 0.145	0.065 0.211	0.027 0.599	0.007 0.897	0.010 0.855	0.007 0.897
Ramp Proper Maneuver	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Conflict 71	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Exit Ramp Maneuver	Coefficient Significance	0.199 0.000	0.172 0.001	0.073 0.159	0.018 0.730	0.025 0.625	0.018 0.730
Conflict 80	Coefficient Significance	0.117 0.024	0.100 0.054	0.042 0.416	0.010 0.842	0.015 0.778	0.010 0.842
Conflict 83	Coefficient Significance	0.157 0.002	0.135 0.009	0.057 0.270	0.014 0.787	0.020 0.702	0.014 0.787
Pedestrian/Bicycle Maneuver	Coefficient Significance	0.082 0.115	0.070 0.177	0.030 0.569	0.007 0.889	0.010 0.843	0.007 0.889
Conflict 90	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958
Conflict 91	Coefficient Significance	0.069 0.184	0.059 0.255	0.025 0.631	0.006 0.906	0.009 0.868	0.006 0.906
Conflict 93	Coefficient Significance	0.031 0.555	0.026 0.612	0.011 0.831	0.003 0.958	0.004 0.941	0.003 0.958

13.6 Forward Contingency Correlation Tables

Correlations between forward maneuver and conflict types and site-related variables (N = 368).

	Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
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		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Region—Rural	Coefficient Significance	0.191 0.000	0.077 0.137	0.142 0.006	0.120 0.021	0.098 0.059	0.077 0.137	0.030 0.566	0.079 0.129
Region—City	Coefficient Significance	0.090 0.083	0.032 0.535	0.043 0.413	0.003 0.959	0.079 0.126	0.032 0.535	0.037 0.480	0.072 0.163
Region—Metro	Coefficient Significance	0.101 0.051	0.044 0.404	0.096 0.064	0.115 0.026	0.020 0.699	0.044 0.404	0.062 0.237	0.139 0.007
Geometry—Roadway segment	Coefficient Significance	0.066 0.205	0.015 0.770	0.062 0.232	0.041 0.435	0.038 0.470	0.015 0.770	0.115 0.027	0.034 0.510
Geometry—Merge	Coefficient Significance	0.192 0.000	0.030 0.563	0.122 0.018	0.080 0.123	0.074 0.154	0.030 0.563	0.043 0.413	0.068 0.194
Geometry—T-intersection	Coefficient Significance	0.002 0.966	0.023 0.662	0.016 0.762	0.048 0.361	0.056 0.281	0.023 0.662	0.032 0.535	0.013 0.808
Geometry—4-legged intersection	Coefficient Significance	0.076 0.146	0.028 0.592	0.109 0.035	0.116 0.025	0.069 0.186	0.028 0.592	0.049 0.345	0.063 0.228
Geometry—Offset 4-legged intersection	Coefficient Significance	0.295 0.000	0.011 0.826	0.261 0.000	0.064 0.219	0.268 0.000	0.011 0.826	0.016 0.755	0.026 0.620
Geometry—Multi-legged intersection	Coefficient Significance	0.017 0.746	0.092 0.076	0.089 0.087	0.078 0.131	0.077 0.137	0.092 0.076	0.042 0.423	0.151 0.003
Geometry—All intersection types	Coefficient Significance	0.213 0.000	0.037 0.483	0.148 0.004	0.097 0.062	0.090 0.084	0.037 0.483	0.027 0.605	0.082 0.115
Road function—Group A	Coefficient Significance	0.106 0.041	0.016 0.753	0.067 0.199	0.044 0.402	0.040 0.438	0.016 0.753	0.023 0.656	0.037 0.480
Road function—Group B	Coefficient Significance	0.150 0.004	0.035 0.500	0.086 0.098	0.051 0.328	0.086 0.096	0.035 0.500	0.050 0.339	0.028 0.585
Road function—Group C	Coefficient Significance	0.031 0.555	0.062 0.233	0.070 0.176	0.076 0.143	0.021 0.689	0.062 0.233	0.013 0.802	0.092 0.077
Road function—Group D	Coefficient Significance	0.304 0.000	0.023 0.665	0.264 0.000	0.208 0.000	0.177 0.001	0.023 0.665	0.032 0.540	0.051 0.330
Road function—Group E	Coefficient Significance	0.002 0.973	0.009 0.867	0.036 0.494	0.023 0.655	0.022 0.680	0.009 0.867	0.210 0.000	0.020 0.707
Primary control—Yield sign	Coefficient Significance	0.179 0.000	0.028 0.592	0.113 0.029	0.074 0.153	0.069 0.186	0.028 0.592	0.040 0.448	0.063 0.228
Primary control—Stop sign	Coefficient Significance	0.307 0.000	0.027 0.601	0.268 0.000	0.257 0.000	0.089 0.086	0.027 0.601	0.051 0.324	0.061 0.239
Primary control—G,Y,R signal without turn arrows	Coefficient Significance	0.071 0.175	0.119 0.022	0.093 0.074	0.061 0.243	0.118 0.022	0.119 0.022	0.032 0.535	0.200 0.000
Primary control—G, Y, R signal with turn arrows	Coefficient Significance	0.135 0.009	0.036 0.494	0.031 0.551	0.095 0.068	0.088 0.092	0.036 0.494	0.050 0.333	0.030 0.569
Primary control—None	Coefficient Significance	0.071 0.175	0.016 0.761	0.065 0.215	0.042 0.418	0.039 0.454	0.016 0.761	0.110 0.034	0.036 0.495
Road edge—Paved full shoulder	Coefficient Significance	0.138 0.008	0.021 0.681	0.087 0.093	0.057 0.273	0.053 0.311	0.021 0.681	0.030 0.561	0.048 0.356
Road edge—Soft full shoulder	Coefficient Significance	0.062 0.232	0.010 0.854	0.039 0.453	0.026 0.624	0.024 0.650	0.010 0.854	0.014 0.795	0.022 0.679
Road edge—Paved partial shoulder	Coefficient Significance	0.093 0.072	0.019 0.719	0.035 0.507	0.050 0.338	0.046 0.375	0.019 0.719	0.027 0.611	0.042 0.419
Road edge—Soft partial shoulder	Coefficient Significance	0.164 0.001	0.021 0.681	0.139 0.007	0.056 0.281	0.129 0.012	0.021 0.681	0.075 0.151	0.048 0.356
Road edge—Curb (no shoulder)	Coefficient Significance	0.063 0.224	0.046 0.380	0.001 0.982	0.042 0.422	0.017 0.745	0.046 0.380	0.010 0.852	0.102 0.048
Markings—Good condition	Coefficient Significance	0.044 0.402	0.062 0.230	0.042 0.416	0.076 0.146	0.023 0.653	0.062 0.230	0.088 0.089	0.139 0.007
Markings—Fair condition	Coefficient Significance	0.040 0.441	0.087 0.094	0.097 0.062	0.083 0.110	0.069 0.185	0.087 0.094	0.040 0.447	0.193 0.000
Markings—Poor condition	Coefficient Significance	0.012 0.818	0.021 0.681	0.064 0.217	0.000 0.993	0.053 0.311	0.021 0.681	0.030 0.561	0.048 0.356
Markings—None	Coefficient Significance	0.152 0.003	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.577 0.000	0.006 0.906
Median—Depressed	Coefficient Significance	0.167 0.001	0.029 0.575	0.088 0.090	0.078 0.134	0.072 0.166	0.029 0.575	0.041 0.427	0.066 0.207
Median—Flush	Coefficient Significance	0.062 0.232	0.010 0.854	0.039 0.453	0.026 0.624	0.024 0.650	0.010 0.854	0.014 0.795	0.022 0.679
Median—Raised	Coefficient Significance	0.025 0.637	0.032 0.544	0.069 0.184	0.084 0.105	0.019 0.720	0.032 0.544	0.038 0.460	0.139 0.007
Median—None	Coefficient Significance	0.186 0.000	0.057 0.277	0.149 0.004	0.149 0.004	0.054 0.304	0.057 0.277	0.006 0.908	0.061 0.242
Barrier—Permanent	Coefficient Significance	0.071 0.172	0.039 0.449	0.105 0.042	0.064 0.219	0.008 0.874	0.039 0.449	0.056 0.283	0.153 0.003
Barrier—None	Coefficient Significance	0.071 0.172	0.039 0.449	0.105 0.042	0.064 0.219	0.008 0.874	0.039 0.449	0.056 0.283	0.153 0.003
Sidewalk—Along all roadways	Coefficient Significance	0.021 0.683	0.025 0.637	0.100 0.054	0.066 0.208	0.050 0.333	0.025 0.637	0.035 0.503	0.185 0.000
Sidewalk—Along most roadways	Coefficient Significance	0.226 0.000	0.081 0.120	0.153 0.003	0.128 0.014	0.105 0.043	0.081 0.120	0.034 0.520	0.024 0.644
Sidewalk—Along few roadways	Coefficient Significance	0.049 0.346	0.017 0.745	0.022 0.677	0.045 0.386	0.042 0.423	0.017 0.745	0.024 0.646	0.038 0.465
Sidewalk—None	Coefficient Significance	0.166 0.001	0.045 0.385	0.077 0.138	0.040 0.438	0.111 0.032	0.045 0.385	0.011 0.840	0.101 0.051
Obstruction—Vegetation	Coefficient Significance	0.166 0.001	0.029 0.577	0.069 0.182	0.031 0.556	0.178 0.001	0.029 0.577	0.041 0.430	0.206 0.000
Obstruction—Advertisement signs	Coefficient Significance	0.038 0.463	0.010 0.854	0.036 0.491	0.086 0.097	0.024 0.650	0.010 0.854	0.014 0.795	0.022 0.679
Obstruction—Other	Coefficient Significance	0.062 0.232	0.010 0.854	0.039 0.453	0.026 0.624	0.024 0.650	0.010 0.854	0.015 0.795	0.022 0.679
Obstruction—None	Coefficient Significance	0.145 0.005	0.034 0.510	0.063 0.226	0.005 0.926	0.148 0.004	0.034 0.510	0.049 0.351	0.176 0.001
Posted speed limit	Coefficient Significance	0.342 0.000	0.176 0.039	0.259 0.000	0.228 0.001	0.201 0.009	0.176 0.039	0.088 0.719	0.301 0.000

Correlations between forward maneuver and conflict types and traffic-related variables (N = 368).

		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Hour event occurred	Coefficient Significance	0.145 0.790	0.117 0.953	0.189 0.328	0.135 0.869	0.125 0.924	0.122 0.935	0.174 0.491	0.207 0.170
Relation--Pre-intersection	Coefficient Significance	0.024 0.647	0.014 0.782	0.059 0.259	0.038 0.461	0.035 0.496	0.186 0.000	0.020 0.696	0.059 0.256
Relation--Within intersection	Coefficient Significance	0.211 0.000	0.052 0.314	0.184 0.000	0.100 0.055	0.086 0.097	0.052 0.319	0.000 0.994	0.024 0.644
Relation--Post-intersection	Coefficient Significance	0.061 0.241	0.018 0.727	0.074 0.153	0.015 0.769	0.045 0.388	0.018 0.727	0.026 0.620	0.034 0.509
Relation--Driveway, alley access, etc.	Coefficient Significance	0.033 0.527	0.015 0.770	0.013 0.805	0.041 0.435	0.041 0.421	0.042 0.770	0.015 0.678	0.034 0.510
Relation--Exiting ramp	Coefficient Significance	0.072 0.165	0.011 0.831	0.045 0.383	0.030 0.569	0.027 0.599	0.011 0.831	0.016 0.762	0.025 0.631
Relation--Entering ramp	Coefficient Significance	0.104 0.045	0.016 0.757	0.066 0.207	0.043 0.410	0.040 0.446	0.016 0.757	0.023 0.662	0.036 0.487
Relation--Roadway	Coefficient Significance	0.093 0.072	0.019 0.719	0.076 0.142	0.050 0.338	0.046 0.375	0.019 0.719	0.089 0.085	0.042 0.419
Lanes--None, illegal action	Coefficient Significance	0.102 0.049	0.011 0.831	0.045 0.383	0.030 0.569	0.027 0.599	0.011 0.831	0.016 0.762	0.399 0.000
Lanes--1	Coefficient Significance	0.073 0.161	0.040 0.446	0.079 0.128	0.105 0.042	0.009 0.864	0.068 0.188	0.056 0.280	0.105 0.043
Lanes--2	Coefficient Significance	0.072 0.166	0.030 0.563	0.031 0.555	0.080 0.123	0.025 0.635	0.090 0.083	0.043 0.413	0.068 0.194
Lanes--3	Coefficient Significance	0.093 0.073	0.014 0.782	0.059 0.259	0.038 0.461	0.035 0.496	0.014 0.782	0.020 0.696	0.032 0.535
Lanes--4	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Weather--Sunny	Coefficient Significance	0.149 0.004	0.029 0.580	0.102 0.049	0.064 0.219	0.179 0.000	0.029 0.580	0.046 0.372	0.065 0.214
Weather--Partly cloudy	Coefficient Significance	0.077 0.140	0.022 0.668	0.092 0.075	0.005 0.929	0.063 0.223	0.022 0.668	0.070 0.176	0.050 0.335
Weather--Cloudy/Overcast	Coefficient Significance	0.132 0.011	0.015 0.770	0.037 0.483	0.106 0.040	0.197 0.000	0.015 0.770	0.022 0.678	0.034 0.510
Visibility--Unlimited	Coefficient Significance	0.097 0.062	0.007 0.897	0.078 0.136	0.018 0.731	0.151 0.003	0.007 0.897	0.010 0.855	0.015 0.772
Visibility--Glare	Coefficient Significance	0.031 0.555	0.005 0.928	0.019 0.711	0.013 0.809	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Visibility--Fog	Coefficient Significance	0.166 0.001	0.005 0.928	0.128 0.013	0.013 0.809	0.221 0.000	0.005 0.928	0.007 0.898	0.011 0.838
Debris on roadway--Clear/None	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Debris on Roadway--Sand	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Level of Service A	Coefficient Significance	0.014 0.783	0.024 0.646	0.008 0.883	0.011 0.827	0.059 0.257	0.024 0.646	0.159 0.002	0.054 0.302
Level of Service B	Coefficient Significance	0.121 0.020	0.028 0.595	0.079 0.126	0.070 0.179	0.137 0.008	0.098 0.059	0.039 0.451	0.062 0.232
Level of Service C	Coefficient Significance	0.117 0.024	0.056 0.280	0.090 0.082	0.049 0.345	0.076 0.144	0.048 0.353	0.068 0.189	0.032 0.533
Level of Service D	Coefficient Significance	0.057 0.271	0.020 0.702	0.038 0.464	0.006 0.904	0.015 0.773	0.020 0.702	0.028 0.587	0.095 0.066
Level of Service E	Coefficient Significance	0.044 0.402	0.007 0.897	0.027 0.599	0.018 0.731	0.017 0.751	0.007 0.897	0.010 0.855	0.015 0.772
Number of vehicles in event	Coefficient Significance	0.182 0.182	0.040 1.000	0.101 0.922	0.105 0.902	0.060 0.998	0.213 0.042	0.056 0.999	0.443 0.000
General traffic congestion	Coefficient Significance	0.057 0.276	0.026 0.618	0.061 0.242	0.069 0.184	0.064 0.219	0.026 0.618	0.037 0.481	0.058 0.263
Event obstacle--Other obstacle	Coefficient Significance	0.096 0.064	0.004 0.941	0.163 0.002	0.010 0.843	0.010 0.855	0.004 0.941	0.005 0.917	0.009 0.868
Event obstacle--Pedestrian	Coefficient Significance	0.152 0.003	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.707 0.000	0.004 0.941	0.006 0.906
Event obstacle--Bicyclist	Coefficient Significance	0.031 0.555	0.005 0.928	0.019 0.711	0.013 0.809	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Event obstacle--Other vehicle(s)	Coefficient Significance	0.086 0.097	0.021 0.685	0.048 0.355	0.001 0.990	0.052 0.316	0.021 0.685	0.030 0.565	0.048 0.361
Good surface condition	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Rough surface condition	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Markings conditions--Lane lines	Coefficient Significance	0.025 0.630	0.004 0.941	0.016 0.762	0.010 0.843	0.010 0.855	0.004 0.941	0.005 0.917	0.009 0.868
Markings conditions--Median delineation	Coefficient Significance	0.025 0.630	0.004 0.941	0.016 0.762	0.010 0.843	0.010 0.855	0.004 0.941	0.005 0.917	0.009 0.868
Markings conditions--Other type of marking	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Missing regulatory sign(s)	Coefficient Significance	0.175 0.001	0.008 0.874	0.034 0.517	0.022 0.672	0.020 0.696	0.008 0.874	0.012 0.822	0.508 0.000
Missing warning sign(s)	Coefficient Significance	0.149 0.004	0.009 0.860	0.118 0.022	0.205 0.000	0.023 0.665	0.009 0.860	0.013 0.803	0.021 0.693
Missing directional or guide sign(s)	Coefficient Significance	0.169 0.001	0.012 0.820	0.048 0.354	0.061 0.245	0.029 0.575	0.012 0.820	0.017 0.748	0.460 0.000
No pedestrian signal	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906

		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Limitations to sight distance— Other traffic	Coefficient Significance	0.079 0.129	0.012 0.815	0.050 0.340	0.032 0.533	0.030 0.564	0.012 0.815	0.017 0.741	0.027 0.599
Limitations to sight distance— Geometry	Coefficient Significance	0.010 0.853	0.016 0.757	0.019 0.723	0.043 0.410	0.036 0.485	0.016 0.757	0.108 0.038	0.036 0.487
Limitations to sight distance— Signage	Coefficient Significance	0.096 0.064	0.004 0.941	0.016 0.762	0.010 0.843	0.010 0.272	0.004 0.000	0.005 0.941	0.009 0.868
Limitations to sight distance— Pedestrian/Bicyclist	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Limitations to sight distance— Vegetation	Coefficient Significance	0.037 0.474	0.006 0.906	0.090 0.084	0.016 0.754	0.015 0.772	0.006 0.906	0.009 0.868	0.014 0.792
Limitations to sight distance— Other	Coefficient Significance	0.031 0.555	0.005 0.928	0.019 0.711	0.013 0.809	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Location of event	Coefficient Significance	0.511 0.000	0.208 0.977	0.430 0.000	0.315 0.095	0.394 0.000	0.208 0.977	0.632 0.000	0.307 0.145

Correlations between forward maneuver and conflict types and driver performance-related variables (N = 368).

		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Pulled into traffic or Proceeded without clearance	Coefficient Significance	0.066 0.202	0.060 0.248	0.111 0.033	0.000 0.997	0.018 0.724	0.045 0.385	0.064 0.219	0.007 0.894
Entered intersection on red light	Coefficient Significance	0.217 0.000	0.005 0.916	0.341 0.000	0.015 0.779	0.013 0.796	0.005 0.916	0.008 0.882	0.012 0.813
Inadequate reaction speed	Coefficient Significance	0.049 0.346	0.017 0.745	0.069 0.185	0.045 0.386	0.042 0.423	0.017 0.745	0.222 0.000	0.038 0.465
Failure to respond to primary control	Coefficient Significance	0.026 0.622	0.170 0.001	0.079 0.128	0.042 0.418	0.039 0.454	0.016 0.761	0.022 0.667	0.036 0.495
Failure to respond to an active emergency vehicle	Coefficient Significance	0.025 0.630	0.004 0.941	0.016 0.762	0.010 0.843	0.010 0.855	0.004 0.941	0.005 0.917	0.009 0.868
Failure to yield right-of-way to pedestrian	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Lateral vehicle control—Close to center line or road edge marking	Coefficient Significance	0.031 0.555	0.005 0.928	0.019 0.711	0.013 0.809	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Lateral vehicle control—Lane change	Coefficient Significance	0.114 0.027	0.030 0.560	0.093 0.073	0.081 0.120	0.025 0.625	0.030 0.560	0.042 0.420	0.014 0.785
Lateral vehicle control— Deviation in lane in both directions	Coefficient Significance	0.007 0.891	0.009 0.860	0.037 0.473	0.024 0.639	0.023 0.665	0.009 0.860	0.200 0.000	0.021 0.693
Lateral vehicle control—Ran off road	Coefficient Significance	0.037 0.474	0.006 0.906	0.025 0.631	0.016 0.754	0.015 0.772	0.006 0.906	0.297 0.000	0.014 0.792
Vehicle turn control—Under compensate	Coefficient Significance	0.062 0.235	0.008 0.874	0.034 0.517	0.022 0.672	0.020 0.696	0.008 0.874	0.423 0.000	0.019 0.721
Vehicle turn control—Over compensate	Coefficient Significance	0.054 0.303	0.008 0.874	0.034 0.517	0.022 0.672	0.020 0.696	0.008 0.874	0.012 0.822	0.019 0.721
Backing-up	Coefficient Significance	0.174 0.001	0.010 0.848	0.241 0.000	0.081 0.120	0.025 0.636	0.010 0.848	0.014 0.786	0.022 0.667
Vehicle turn control—U-turn	Coefficient Significance	0.051 0.332	0.008 0.881	0.032 0.542	0.021 0.690	0.019 0.713	0.008 0.881	0.011 0.833	0.017 0.737
Vehicle turn control—Turned into incorrect lane	Coefficient Significance	0.077 0.137	0.161 0.002	0.068 0.192	0.044 0.394	0.041 0.431	0.017 0.749	0.024 0.651	0.037 0.473
Vehicle turn control—Proceeded forward from a turn lane	Coefficient Significance	0.025 0.630	0.004 0.941	0.016 0.762	0.010 0.843	0.010 0.855	0.004 0.941	0.005 0.917	0.009 0.868
Defensive maneuver	Coefficient Significance	0.061 0.241	0.018 0.727	0.074 0.153	0.079 0.129	0.045 0.388	0.018 0.727	0.026 0.620	0.041 0.432
Avoiding—Obstruction in roadway	Coefficient Significance	0.027 0.607	0.007 0.897	0.078 0.136	0.018 0.731	0.017 0.751	0.007 0.897	0.010 0.855	0.015 0.772
No room to respond to an active emergency vehicle	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Gesturing—Sounding horn	Coefficient Significance	0.047 0.365	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Avoiding—Another vehicle	Coefficient Significance	0.047 0.365	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Violation stopping—Ran red light or stop sign	Coefficient Significance	0.070 0.176	0.208 0.000	0.062 0.231	0.034 0.511	0.061 0.243	0.013 0.805	0.018 0.727	0.029 0.580
Violation stopping—Rolling stop	Coefficient Significance	0.029 0.584	0.011 0.831	0.020 0.703	0.030 0.569	0.027 0.599	0.011 0.831	0.016 0.762	0.025 0.631
Failure to yield right-of-way— General	Coefficient Significance	0.219 0.000	0.059 0.254	0.134 0.009	0.078 0.132	0.145 0.005	0.046 0.380	0.065 0.214	0.133 0.010
Failure to yield right-of-way— Right turn on red light	Coefficient Significance	0.072 0.165	0.011 0.831	0.045 0.383	0.030 0.569	0.027 0.599	0.011 0.831	0.016 0.762	0.025 0.631
Violation turning—Illegal U-turn	Coefficient Significance	0.047 0.365	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Entered intersection on an amber light	Coefficient Significance	0.037 0.474	0.006 0.906	0.025 0.631	0.016 0.754	0.168 0.001	0.006 0.906	0.009 0.868	0.014 0.792
Violations passing—Passing in a no passing zone	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Following closely	Coefficient Significance	0.133 0.010	0.021 0.691	0.084 0.105	0.055 0.289	0.051 0.327	0.021 0.691	0.029 0.574	0.046 0.372
Force another vehicle out of lane	Coefficient Significance	0.047 0.365	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Speed of event vehicle	Coefficient Significance	0.115 0.027	0.025 0.634	0.033 0.529	0.066 0.203	0.061 0.240	0.025 0.634	0.035 0.500	0.056 0.284
Observed difficulties navigating— Intersection angle	Coefficient Significance	0.102 0.049	0.013 0.801	0.059 0.261	0.035 0.501	0.232 0.000	0.013 0.801	0.019 0.721	0.030 0.570

		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Observed difficulties navigating— Intersection width	Coefficient Significance	0.007 0.891	0.009 0.860	0.041 0.434	0.024 0.639	0.023 0.665	0.009 0.860	0.013 0.803	0.021 0.693
Observed difficulties navigating— Intersection grade	Coefficient Significance	0.114 0.028	0.006 0.906	0.201 0.000	0.016 0.754	0.015 0.772	0.006 0.906	0.009 0.868	0.014 0.792
Observed difficulties navigating— Ramp	Coefficient Significance	0.147 0.004	0.023 0.662	0.093 0.074	0.061 0.243	0.056 0.281	0.023 0.662	0.032 0.535	0.051 0.325
Observed difficulties navigating— Roadway	Coefficient Significance	0.097 0.062	0.007 0.897	0.027 0.599	0.018 0.731	0.017 0.751	0.007 0.897	0.272 0.000	0.168 0.001
Observed difficulties navigating— Alignment/Curve	Coefficient Significance	0.097 0.061	0.009 0.860	0.118 0.022	0.024 0.639	0.023 0.665	0.009 0.860	0.200 0.000	0.021 0.693
Observed difficulties navigating— Alignment/ Undulation	Coefficient Significance	0.018 0.728	0.007 0.889	0.068 0.193	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Observed difficulties navigating— Grade	Coefficient Significance	0.088 0.089	0.010 0.854	0.110 0.033	0.026 0.624	0.024 0.650	0.010 0.854	0.191 0.000	0.022 0.679
Violations turning—Illegal left turn	Coefficient Significance	0.077 0.140	0.012 0.820	0.048 0.354	0.032 0.545	0.029 0.575	0.012 0.820	0.017 0.748	0.027 0.610
Violations turning—Illegal right turn	Coefficient Significance	0.051 0.332	0.008 0.881	0.032 0.542	0.021 0.690	0.019 0.713	0.008 0.881	0.011 0.833	0.017 0.737
Violations turning—Wrong way on one-way	Coefficient Significance	0.260 0.000	0.006 0.906	0.025 0.631	0.016 0.754	0.015 0.772	0.006 0.906	0.009 0.868	0.623 0.000
Violations passing—Driving on shoulder	Coefficient Significance	0.018 0.728	0.007 0.889	0.030 0.569	0.019 0.710	0.138 0.008	0.007 0.889	0.010 0.843	0.016 0.754
Avoiding active emergency vehicle	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Size of event vehicle	Coefficient Significance	0.051 0.332	0.008 0.881	0.032 0.542	0.021 0.690	0.019 0.713	0.008 0.881	0.011 0.833	0.017 0.737
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.147 0.004	0.167 0.001	0.122 0.018	0.028 0.596	0.040 0.446	0.016 0.757	0.023 0.662	0.129 0.012
Creeping into intersection	Coefficient Significance	0.042 0.422	0.012 0.815	0.071 0.175	0.032 0.533	0.030 0.564	0.012 0.815	0.017 0.741	0.078 0.131
Vehicle control while turning— Turned from through-only lane	Coefficient Significance	0.047 0.365	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Following	Coefficient Significance	0.045 0.388	0.013 0.805	0.005 0.924	0.034 0.511	0.032 0.543	0.013 0.805	0.018 0.727	0.029 0.580
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.029 0.572	0.016 0.765	0.015 0.776	0.041 0.426	0.038 0.462	0.016 0.765	0.241 0.000	0.051 0.330
Lateral vehicle control—No deviation	Coefficient Significance	0.173 0.001	0.041 0.430	0.139 0.007	0.069 0.187	0.101 0.052	0.041 0.430	0.093 0.072	0.044 0.396
Lateral vehicle control— Deviation in lane to right	Coefficient Significance	0.081 0.119	0.013 0.810	0.051 0.327	0.033 0.522	0.031 0.554	0.013 0.810	0.018 0.734	0.028 0.589
Lateral vehicle control— Deviation in lane to left	Coefficient Significance	0.079 0.129	0.012 0.815	0.050 0.340	0.032 0.533	0.030 0.564	0.012 0.815	0.017 0.741	0.027 0.599
Lateral vehicle control—Lane break to right	Coefficient Significance	0.070 0.179	0.019 0.712	0.037 0.472	0.051 0.325	0.047 0.363	0.019 0.712	0.086 0.096	0.043 0.407
Lateral vehicle control—Lane break to left	Coefficient Significance	0.092 0.077	0.022 0.675	0.089 0.086	0.058 0.263	0.054 0.301	0.022 0.675	0.072 0.163	0.017 0.750
Lateral vehicle control— Unknown	Coefficient Significance	0.068 0.189	0.005 0.928	0.019 0.711	0.204 0.000	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Longitudinal vehicle control— Decelerating	Coefficient Significance	0.040 0.445	0.006 0.906	0.025 0.631	0.016 0.754	0.015 0.772	0.006 0.906	0.009 0.868	0.014 0.792
Longitudinal vehicle control— Anticipatory braking	Coefficient Significance	0.160 0.002	0.022 0.678	0.136 0.008	0.058 0.268	0.068 0.193	0.022 0.678	0.031 0.556	0.212 0.000
Longitudinal vehicle control— Unanticipated controlled braking	Coefficient Significance	0.076 0.142	0.040 0.441	0.054 0.301	0.016 0.756	0.010 0.842	0.068 0.194	0.057 0.275	0.090 0.083
Longitudinal vehicle control— uncontrolled braking	Coefficient Significance	0.051 0.332	0.008 0.881	0.032 0.542	0.021 0.690	0.019 0.713	0.008 0.881	0.011 0.833	0.017 0.737
Longitudinal vehicle control— Skidding	Coefficient Significance	0.031 0.555	0.005 0.928	0.019 0.711	0.013 0.809	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Longitudinal vehicle control— Accelerating	Coefficient Significance	0.026 0.611	0.080 0.125	0.023 0.662	0.039 0.449	0.010 0.853	0.034 0.513	0.048 0.354	0.076 0.142
Longitudinal vehicle control— Normal driving	Coefficient Significance	0.019 0.721	0.019 0.719	0.007 0.889	0.013 0.809	0.046 0.375	0.019 0.719	0.202 0.000	0.042 0.419
Longitudinal vehicle control— Unknown	Coefficient Significance	0.018 0.728	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.154 0.003
Signal usage—Signal not required	Coefficient Significance	0.127 0.014	0.061 0.238	0.115 0.026	0.083 0.109	0.021 0.683	0.061 0.238	0.087 0.095	0.099 0.056
Signal usage—Incorrect signal	Coefficient Significance	0.135 0.009	0.005 0.916	0.106 0.042	0.175 0.001	0.013 0.796	0.005 0.916	0.008 0.882	0.012 0.813
Signal usage—Correct signal on in advance	Coefficient Significance	0.110 0.034	0.024 0.643	0.064 0.221	0.064 0.216	0.003 0.949	0.024 0.643	0.034 0.511	0.054 0.297
Signal usage—Correct signal not on in advance	Coefficient Significance	0.018 0.728	0.007 0.889	0.068 0.193	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Signal usage—Signal not used	Coefficient Significance	0.026 0.619	0.029 0.583	0.054 0.304	0.029 0.576	0.031 0.549	0.029 0.583	0.040 0.437	0.209 0.000
Signal usage—Unknown	Coefficient Significance	0.138 0.008	0.021 0.681	0.087 0.093	0.057 0.273	0.053 0.311	0.021 0.681	0.030 0.561	0.048 0.356

Correlations between forward maneuver and conflict types and ramp and pedestrian/bicyclist maneuvers and conflict types (N = 368).

		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Forward Maneuver	Coefficient Significance	----							

		Forward Maneuver	Conflict 50	Conflict 51	Conflict 52	Conflict 53	Conflict 54	Conflict 56	Conflict 57
Conflict 50	Coefficient Significance	0.152 0.003	----						
Conflict 51	Coefficient Significance	0.532 0.000	0.011 0.831	----					
Conflict 52	Coefficient Significance	0.380 0.000	0.007 0.889	0.030 0.569	----				
Conflict 53	Coefficient Significance	0.355 0.000	0.007 0.897	0.027 0.599	0.018 0.731	----			
Conflict 54	Coefficient Significance	0.152 0.003	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	----		
Conflict 56	Coefficient Significance	0.213 0.000	0.004 0.941	0.016 0.762	0.010 0.843	0.010 0.855	0.004 0.941	----	
Conflict 57	Coefficient Significance	0.327 0.000	0.006 0.906	0.025 0.631	0.016 0.754	0.015 0.772	0.006 0.906	0.009 0.868	----
Enter Ramp Maneuver	Coefficient Significance	0.057 0.277	0.003 0.958	0.036 0.494	0.023 0.655	0.022 0.680	0.009 0.867	0.012 0.813	0.020 0.707
Conflict 60	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Conflict 61	Coefficient Significance	0.031 0.555	0.005 0.928	0.019 0.711	0.013 0.809	0.012 0.823	0.005 0.928	0.007 0.898	0.011 0.838
Conflict 62	Coefficient Significance	0.044 0.402	0.007 0.897	0.027 0.599	0.018 0.731	0.017 0.751	0.007 0.897	0.010 0.855	0.015 0.772
Ramp Proper Maneuver	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Conflict 71	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Exit Ramp Maneuver	Coefficient Significance	0.116 0.025	0.018 0.730	0.073 0.159	0.048 0.358	0.044 0.395	0.018 0.730	0.025 0.625	0.040 0.438
Conflict 80	Coefficient Significance	0.067 0.195	0.010 0.842	0.042 0.416	0.028 0.595	0.026 0.623	0.010 0.842	0.015 0.778	0.023 0.654
Conflict 83	Coefficient Significance	0.091 0.079	0.014 0.787	0.057 0.270	0.038 0.471	0.035 0.505	0.014 0.787	0.020 0.702	0.032 0.543
Pedestrian/Bicycle Maneuver	Coefficient Significance	0.047 0.365	0.007 0.889	0.030 0.569	0.019 0.710	0.018 0.731	0.007 0.889	0.010 0.843	0.016 0.754
Conflict 90	Coefficient Significance	0.018 0.734	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906
Conflict 91	Coefficient Significance	0.040 0.445	0.006 0.906	0.025 0.631	0.016 0.754	0.015 0.772	0.006 0.906	0.009 0.868	0.014 0.792
Conflict 93	Coefficient Significance	0.018 0.445	0.003 0.958	0.011 0.831	0.007 0.889	0.007 0.897	0.003 0.958	0.004 0.941	0.006 0.906

13.7 Ramp Contingency Correlation Tables

Correlations between ramp maneuver and conflict types and site-related variables (N = 368).

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Region—Rural	Coefficient	0.112	0.035	0.061	0.086	0.035	0.035	0.172	0.103	0.134
	Significance	0.031	0.500	0.241	0.096	0.500	0.500	0.001	0.047	0.009
Region—City	Coefficient	0.120	0.032	0.011	0.158	0.084	0.084	0.304	0.278	0.168
	Significance	0.021	0.535	0.827	0.002	0.106	0.106	0.000	0.000	0.001
Region—Metro	Coefficient	0.004	0.062	0.047	0.064	0.044	0.044	0.125	0.164	0.028
	Significance	0.946	0.230	0.365	0.221	0.404	0.404	0.016	0.001	0.596
Geometry—Roadway segment	Coefficient	0.049	0.015	0.027	0.038	0.015	0.015	0.100	0.058	0.079
	Significance	0.348	0.770	0.611	0.470	0.770	0.770	0.053	0.265	0.130
Geometry—Merge	Coefficient	0.243	0.090	0.155	0.171	0.090	0.09	0.499	0.326	0.405
	Significance	0.000	0.083	0.003	0.001	0.083	0.083	0.000	0.000	0.000
Geometry—T-intersection	Coefficient	0.073	0.023	0.040	0.056	0.023	0.023	0.149	0.087	0.117
	Significance	0.161	0.662	0.447	0.281	0.662	0.662	0.004	0.096	0.024
Geometry—4-legged intersection	Coefficient	0.049	0.028	0.048	0.017	0.028	0.028	0.161	0.106	0.118
	Significance	0.344	0.592	0.352	0.730	0.592	0.592	0.002	0.041	0.023
Geometry—Offset 4-legged intersection	Coefficient	0.037	0.011	0.020	0.028	0.011	0.011	0.076	0.044	0.059
	Significance	0.480	0.826	0.702	0.587	0.826	0.826	0.146	0.401	0.254
Geometry—Multi-legged intersection	Coefficient	0.094	0.029	0.051	0.073	0.029	0.029	0.191	0.112	0.151
	Significance	0.070	0.572	0.326	0.163	0.572	0.572	0.000	0.031	0.003
Geometry—All intersection types	Coefficient	0.199	0.074	0.128	0.137	0.074	0.074	0.428	0.273	0.341
	Significance	0.000	0.153	0.013	0.008	0.153	0.153	0.000	0.000	0.000
Road function—Group A	Coefficient	0.233	0.016	0.077	0.252	0.016	0.016	0.535	0.471	0.346
	Significance	0.000	0.753	0.138	0.000	0.753	0.753	0.000	0.000	0.000
Road function—Group B	Coefficient	0.032	0.077	0.069	0.040	0.035	0.035	0.004	0.103	0.074
	Significance	0.545	0.137	0.184	0.437	0.500	0.500	0.945	0.047	0.154
Road function—Group C	Coefficient	0.106	0.044	0.076	0.064	0.062	0.062	0.229	0.137	0.180
	Significance	0.042	0.401	0.145	0.217	0.233	0.233	0.000	0.008	0.000
Road function—Group D	Coefficient	0.072	0.023	0.039	0.056	0.023	0.023	0.147	0.086	0.116
	Significance	0.166	0.665	0.452	0.285	0.665	0.665	0.004	0.099	0.025
Road function—Group E	Coefficient	0.028	0.009	0.015	0.022	0.009	0.009	0.057	0.033	0.045
	Significance	0.592	0.867	0.771	0.680	0.867	0.867	0.270	0.524	0.387
Primary control—Yield sign	Coefficient	0.226	0.097	0.096	0.186	0.028	0.028	0.501	0.320	0.412
	Significance	0.000	0.061	0.064	0.000	0.592	0.592	0.000	0.000	0.000
Primary control—Stop sign	Coefficient	0.087	0.027	0.047	0.067	0.027	0.027	0.177	0.103	0.140
	Significance	0.094	0.601	0.363	0.197	0.601	0.601	0.001	0.046	0.007
Primary control—G, Y, R signal without turn arrows	Coefficient	0.073	0.023	0.040	0.056	0.119	0.119	0.102	0.048	0.088
	Significance	0.161	0.662	0.447	0.281	0.022	0.022	0.050	0.355	0.089
Primary control—G, Y, R signal with turn arrows	Coefficient	0.078	0.036	0.062	0.042	0.036	0.036	0.211	0.135	0.159
	Significance	0.133	0.494	0.235	0.422	0.494	0.494	0.000	0.009	0.002
Primary control—None	Coefficient	0.009	0.016	0.081	0.039	0.016	0.016	0.104	0.060	0.082
	Significance	0.856	0.761	0.119	0.454	0.761	0.761	0.045	0.247	0.116
Road edge—Paved full shoulder	Coefficient	0.298	0.126	0.134	0.245	0.021	0.021	0.567	0.375	0.472
	Significance	0.000	0.015	0.010	0.000	0.681	0.681	0.000	0.000	0.000
Road edge—Soft full shoulder	Coefficient	0.031	0.010	0.017	0.024	0.010	0.010	0.063	0.036	0.050
	Significance	0.556	0.854	0.749	0.650	0.854	0.854	0.225	0.484	0.342
Road edge—Paved partial shoulder	Coefficient	0.060	0.019	0.033	0.046	0.019	0.019	0.068	0.027	0.063
	Significance	0.250	0.719	0.532	0.375	0.719	0.719	0.192	0.608	0.227
Road edge—Soft partial shoulder	Coefficient	0.068	0.021	0.037	0.053	0.126	0.126	0.066	0.041	0.049
	Significance	0.188	0.681	0.476	0.311	0.015	0.015	0.207	0.430	0.345
Road edge—Curb (no shoulder)	Coefficient	0.122	0.059	0.042	0.103	0.059	0.059	0.351	0.221	0.275
	Significance	0.018	0.254	0.416	0.047	0.254	0.254	0.000	0.000	0.000
Markings—Good condition	Coefficient	0.138	0.044	0.075	0.107	0.044	0.044	0.276	0.164	0.220
	Significance	0.007	0.404	0.147	0.039	0.404	0.404	0.000	0.001	0.000

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Markings—Fair condition	Coefficient	0.099	0.031	0.054	0.077	0.031	0.031	0.202	0.118	0.159
	Significance	0.055	0.549	0.298	0.140	0.549	0.549	0.000	0.022	0.002
Markings—Poor condition	Coefficient	0.068	0.021	0.037	0.053	0.021	0.021	0.14	0.081	0.110
	Significance	0.188	0.681	0.476	0.311	0.681	0.681	0.007	0.118	0.034
Markings—None	Coefficient	0.009	0.003	0.005	0.007	0.003	0.003	0.018	0.010	0.014
	Significance	0.867	0.958	0.928	0.897	0.958	0.958	0.730	0.842	0.787
Median—Depressed	Coefficient	0.102	0.029	0.020	0.128	0.029	0.029	0.344	0.306	0.199
	Significance	0.050	0.575	0.701	0.013	0.575	0.575	0.000	0.000	0.000
Median—Flush	Coefficient	0.031	0.010	0.017	0.024	0.010	0.010	0.063	0.036	0.050
	Significance	0.556	0.854	0.749	0.650	0.854	0.854	0.225	0.484	0.342
Median—Raised	Coefficient	0.026	0.032	0.013	0.03	0.086	0.086	0.148	0.088	0.114
	Significance	0.618	0.544	0.801	0.569	0.099	0.099	0.004	0.089	0.027
Median—None	Coefficient	0.053	0.057	0.023	0.075	0.048	0.048	0.156	0.180	0.054
	Significance	0.306	0.277	0.660	0.147	0.356	0.356	0.002	0.000	0.302
Barrier—Permanent	Coefficient	0.125	0.039	0.068	0.097	0.039	0.039	0.235	0.149	0.179
	Significance	0.015	0.449	0.188	0.062	0.449	0.449	0.000	0.004	0.000
Barrier—None	Coefficient	0.125	0.039	0.068	0.097	0.039	0.039	0.235	0.149	0.179
	Significance	0.015	0.449	0.188	0.062	0.449	0.449	0.000	0.004	0.000
Sidewalk—Along all roadways	Coefficient	0.036	0.025	0.043	0.005	0.025	0.025	0.138	0.093	0.099
	Significance	0.495	0.637	0.412	0.921	0.637	0.637	0.007	0.072	0.057
Sidewalk—Along most roadways	Coefficient	0.107	0.034	0.058	0.083	0.034	0.034	0.217	0.127	0.171
	Significance	0.039	0.519	0.262	0.111	0.519	0.519	0.000	0.014	0.001
Sidewalk—Along few roadways	Coefficient	0.003	0.017	0.073	0.042	0.017	0.017	0.111	0.064	0.087
	Significance	0.957	0.745	0.158	0.423	0.745	0.745	0.032	0.216	0.093
Sidewalk—None	Coefficient	0.124	0.060	0.043	0.104	0.060	0.060	0.354	0.223	0.278
	Significance	0.016	0.248	0.404	0.044	0.248	0.248	0.000	0.000	0.000
Obstruction—Vegetation	Coefficient	0.054	0.029	0.021	0.071	0.029	0.029	0.188	0.110	0.149
	Significance	0.303	0.577	0.692	0.169	0.577	0.577	0.000	0.034	0.004
Obstruction—Advertisement signs	Coefficient	0.031	0.010	0.017	0.024	0.010	0.010	0.063	0.036	0.050
	Significance	0.556	0.854	0.749	0.650	0.854	0.854	0.225	0.484	0.342
Obstruction—Other	Coefficient	0.031	0.010	0.017	0.024	0.010	0.010	0.063	0.036	0.050
	Significance	0.556	0.854	0.749	0.650	0.854	0.854	0.225	0.484	0.342
Obstruction—None	Coefficient	0.073	0.034	0.006	0.084	0.034	0.034	0.221	0.130	0.175
	Significance	0.159	0.510	0.904	0.105	0.510	0.510	0.000	0.012	0.001
Posted speed limit	Coefficient	0.304	0.128	0.140	0.249	0.176	0.176	0.574	0.381	0.478
	Significance	0.000	0.297	0.194	0.000	0.039	0.039	0.000	0.000	0.000

Correlations between ramp maneuver and conflict types and traffic-related variables (N = 368).

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Hour event occurred	Coefficient	0.124	0.137	0.116	0.133	0.139	0.139	0.257	0.188	0.240
	Significance	0.927	0.856	0.958	0.882	0.844	0.844	0.011	0.338	0.033
Relation—Pre-intersection	Coefficient	0.046	0.014	0.025	0.035	0.186	0.186	0.095	0.055	0.074
	Significance	0.377	0.782	0.632	0.496	0.000	0.000	0.069	0.293	0.153
Relation—Within intersection	Coefficient	0.132	0.052	0.09	0.085	0.052	0.052	0.309	0.167	0.259
	Significance	0.011	0.319	0.084	0.102	0.319	0.319	0.000	0.001	0.000
Relation—Post-intersection	Coefficient	0.058	0.018	0.032	0.045	0.018	0.018	0.007	0.024	0.010
	Significance	0.263	0.727	0.544	0.388	0.727	0.727	0.896	0.648	0.851
Relation—Driveway, alley access, etc.	Coefficient	0.049	0.015	0.027	0.038	0.015	0.015	0.100	0.058	0.079
	Significance	0.348	0.770	0.611	0.470	0.770	0.770	0.053	0.265	0.130
Relation—Exiting ramp	Coefficient	0.474	0.011	0.391	0.366	0.011	0.011	0.099	0.042	0.152
	Significance	0.000	0.831	0.000	0.000	0.831	0.831	0.056	0.416	0.003
Relation—Entering ramp	Coefficient	0.052	0.016	0.028	0.040	0.016	0.016	0.578	0.442	0.441
	Significance	0.322	0.757	0.591	0.446	0.757	0.757	0.000	0.000	0.000
Relation—Roadway	Coefficient	0.045	0.144	0.033	0.021	0.019	0.019	0.013	0.027	0.005
	Significance	0.387	0.005	0.532	0.683	0.719	0.719	0.810	0.608	0.924

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Lanes—None, illegal action	Coefficient Significance	0.036 0.494	0.011 0.831	0.019 0.711	0.027 0.599	0.011 0.831	0.011 0.831	0.073 0.159	0.042 0.416	0.057 0.270
Lanes—1	Coefficient Significance	0.058 0.267	0.068 0.188	0.069 0.186	0.053 0.305	0.068 0.188	0.068 0.188	0.133 0.010	0.092 0.076	0.093 0.073
Lanes—2	Coefficient Significance	0.096 0.064	0.030 0.563	0.052 0.315	0.074 0.154	0.090 0.083	0.090 0.083	0.136 0.008	0.082 0.116	0.105 0.042
Lanes—3	Coefficient Significance	0.084 0.106	0.186 0.000	0.025 0.632	0.048 0.355	0.014 0.782	0.014 0.782	0.043 0.411	0.001 0.991	0.052 0.319
Lanes—4	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Weather—Sunny	Coefficient Significance	0.092 0.077	0.029 0.580	0.050 0.337	0.071 0.173	0.029 0.580	0.029 0.580	0.106 0.041	0.009 0.861	0.123 0.018
Weather—Partly cloudy	Coefficient Significance	0.071 0.170	0.022 0.668	0.039 0.457	0.055 0.290	0.022 0.668	0.022 0.668	0.122 0.018	0.046 0.379	0.115 0.027
Weather—Cloudy/Overcast	Coefficient Significance	0.049 0.348	0.015 0.770	0.027 0.611	0.038 0.470	0.015 0.770	0.015 0.770	0.002 0.963	0.047 0.364	0.039 0.456
Visibility—Unlimited	Coefficient Significance	0.022 0.680	0.007 0.897	0.012 0.823	0.017 0.751	0.007 0.897	0.007 0.897	0.044 0.395	0.026 0.623	0.035 0.505
Visibility—Glare	Coefficient Significance	0.015 0.771	0.005 0.928	0.008 0.875	0.012 0.823	0.005 0.928	0.005 0.928	0.031 0.549	0.018 0.729	0.024 0.639
Visibility—Fog	Coefficient Significance	0.015 0.771	0.005 0.928	0.008 0.875	0.012 0.823	0.005 0.928	0.005 0.928	0.031 0.549	0.018 0.729	0.024 0.639
Debris on roadway— Clear/None	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Debris on Roadway—Sand	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Level of Service A	Coefficient Significance	0.076 0.141	0.024 0.646	0.042 0.425	0.059 0.257	0.024 0.646	0.024 0.646	0.088 0.091	0.016 0.755	0.095 0.067
Level of Service B	Coefficient Significance	0.048 0.353	0.028 0.595	0.025 0.635	0.068 0.190	0.098 0.059	0.098 0.059	0.030 0.563	0.066 0.207	0.013 0.802
Level of Service C	Coefficient Significance	0.046 0.375	0.056 0.280	0.023 0.654	0.053 0.311	0.048 0.353	0.048 0.353	0.017 0.738	0.042 0.423	0.053 0.308
Level of Service D	Coefficient Significance	0.086 0.098	0.020 0.702	0.056 0.284	0.079 0.128	0.020 0.702	0.020 0.702	0.001 0.992	0.009 0.863	0.006 0.905
Level of Service E	Coefficient Significance	0.022 0.680	0.007 0.897	0.012 0.823	0.017 0.751	0.007 0.897	0.007 0.897	0.095 0.068	0.026 0.623	0.135 0.009
Number of vehicles in event	Coefficient Significance	0.182 0.178	0.040 1.000	0.039 1.000	0.239 0.008	0.040 1.000	0.040 1.000	0.138 0.625	0.048 1.000	0.154 0.443
General traffic congestion	Coefficient Significance	0.041 0.429	0.026 0.618	0.031 0.556	0.064 0.219	0.026 0.618	0.026 0.618	0.222 0.000	0.114 0.028	0.187 0.000
Event obstacle—Other obstacle	Coefficient Significance	0.012 0.813	0.004 0.941	0.007 0.898	0.010 0.855	0.004 0.941	0.004 0.941	0.025 0.625	0.015 0.778	0.020 0.702
Event obstacle—Pedestrian	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Event obstacle—Bicyclist	Coefficient Significance	0.015 0.771	0.005 0.928	0.008 0.875	0.012 0.823	0.005 0.928	0.005 0.928	0.031 0.549	0.018 0.729	0.024 0.639
Event obstacle—Other vehicle(s)	Coefficient Significance	0.020 0.704	0.021 0.685	0.037 0.480	0.009 0.857	0.021 0.685	0.0210 0.685	0.013 0.804	0.001 0.986	0.017 0.751
Good surface condition	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Rough surface condition	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Markings conditions—Lane lines	Coefficient Significance	0.012 0.813	0.004 0.941	0.007 0.898	0.010 0.855	0.004 0.941	0.577 0.000	0.025 0.625	0.015 0.778	0.020 0.702
Markings conditions—Median delineation	Coefficient Significance	0.012 0.813	0.004 0.941	0.007 0.898	0.010 0.855	0.004 0.941	0.004 0.941	0.025 0.625	0.015 0.778	0.020 0.702
Markings conditions—Other type of marking	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Missing regulatory sign(s)	Coefficient Significance	0.026 0.612	0.008 0.874	0.014 0.783	0.020 0.696	0.008 0.874	0.008 0.874	0.060 0.251	0.031 0.546	0.097 0.063

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Missing warning sign(s)	Coefficient	0.029	0.009	0.016	0.023	0.009	0.009	0.060	0.035	0.047
	Significance	0.574	0.860	0.760	0.665	0.860	0.860	0.246	0.503	0.363
Missing directional or guide sign(s)	Coefficient	0.038	0.012	0.021	0.029	0.012	0.012	0.078	0.045	0.061
	Significance	0.467	0.820	0.693	0.575	0.820	0.820	0.134	0.387	0.240
No pedestrian signal	Coefficient	0.009	0.003	0.005	0.007	0.003	0.003	0.018	0.010	0.014
	Significance	0.867	0.958	0.928	0.897	0.958	0.958	0.730	0.842	0.787
Limitations to sight distance—Other traffic	Coefficient	0.039	0.012	0.021	0.030	0.012	0.012	0.040	0.018	0.063
	Significance	0.454	0.815	0.685	0.564	0.815	0.815	0.438	0.733	0.227
Limitations to sight distance—Geometry	Coefficient	0.052	0.016	0.028	0.040	0.016	0.016	0.173	0.187	0.070
	Significance	0.322	0.757	0.591	0.446	0.757	0.757	0.001	0.000	0.179
Limitations to sight distance—Signage	Coefficient	0.012	0.004	0.007	0.010	0.004	0.004	0.025	0.015	0.020
	Significance	0.813	0.941	0.898	0.855	0.941	0.941	0.625	0.778	0.702
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient	0.009	0.003	0.005	0.007	0.003	0.003	0.018	0.010	0.014
	Significance	0.867	0.958	0.928	0.897	0.958	0.958	0.730	0.842	0.787
Limitations to sight distance—Vegetation	Coefficient	0.020	0.006	0.011	0.015	0.006	0.006	0.040	0.023	0.032
	Significance	0.707	0.906	0.838	0.772	0.906	0.906	0.438	0.654	0.543
Limitations to sight distance—Other	Coefficient	0.015	0.005	0.008	0.012	0.005	0.005	0.031	0.018	0.024
	Significance	0.771	0.928	0.875	0.823	0.928	0.928	0.549	0.729	0.639
Size of event vehicle	Coefficient	0.025	0.008	0.014	0.019	0.008	0.008	0.009	0.068	0.040
	Significance	0.633	0.881	0.795	0.713	0.881	0.881	0.860	0.194	0.440
Location of event	Coefficient	0.375	0.218	0.398	0.296	0.330	0.330	0.594	0.485	0.492
	Significance	0.001	0.951	0.000	0.232	0.038	0.038	0.000	0.000	0.000

Correlations between ramp maneuver and conflict types and driver performance-related variables (N = 368).

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Pulled into traffic or Proceeded without clearance	Coefficient	0.010	0.045	0.078	0.062	0.045	0.045	0.022	0.086	0.093
	Significance	0.849	0.385	0.131	0.236	0.385	0.385	0.668	0.097	0.074
Entered intersection on red light	Coefficient	0.018	0.005	0.010	0.013	0.005	0.005	0.036	0.021	0.028
	Significance	0.737	0.916	0.855	0.796	0.916	0.916	0.489	0.689	0.587
Inadequate reaction speed	Coefficient	0.003	0.017	0.073	0.042	0.017	0.017	0.039	0.032	0.023
	Significance	0.957	0.745	0.158	0.423	0.745	0.745	0.456	0.535	0.660
Failure to respond to primary control	Coefficient	0.009	0.016	0.027	0.038	0.016	0.016	0.104	0.060	0.082
	Significance	0.856	0.761	0.598	0.464	0.761	0.761	0.045	0.247	0.116
Failure to respond to an active emergency vehicle	Coefficient	0.012	0.004	0.007	0.010	0.004	0.004	0.025	0.015	0.020
	Significance	0.813	0.941	0.898	0.855	0.941	0.941	0.625	0.778	0.702
Failure to yield right-of-way to pedestrian	Coefficient	0.009	0.003	0.005	0.007	0.003	0.003	0.018	0.010	0.014
	Significance	0.867	0.958	0.928	0.897	0.958	0.958	0.730	0.842	0.787
Lateral vehicle control—Close to center line or road edge marking	Coefficient	0.015	0.005	0.008	0.012	0.005	0.005	0.031	0.018	0.024
	Significance	0.771	0.928	0.875	0.823	0.928	0.928	0.549	0.729	0.639
Lateral vehicle control—Lane change	Coefficient	0.095	0.030	0.017	0.122	0.089	0.089	0.144	0.018	0.188
	Significance	0.068	0.560	0.747	0.019	0.085	0.085	0.005	0.736	0.000
Lateral vehicle control—Deviation in lane in both directions	Coefficient	0.029	0.009	0.016	0.023	0.009	0.009	0.009	0.035	0.016
	Significance	0.574	0.860	0.760	0.665	0.860	0.860	0.869	0.503	0.759
Lateral vehicle control—Ran off road	Coefficient	0.020	0.006	0.011	0.015	0.006	0.006	0.040	0.023	0.032
	Significance	0.707	0.906	0.838	0.772	0.906	0.906	0.438	0.654	0.543
Vehicle turn control—Under compensate	Coefficient	0.081	0.008	0.178	0.020	0.008	0.008	0.003	0.031	0.027
	Significance	0.117	0.874	0.001	0.696	0.874	0.874	0.960	0.546	0.602
Vehicle turn control—Over compensate	Coefficient	0.026	0.008	0.014	0.020	0.008	0.008	0.054	0.031	0.043
	Significance	0.612	0.874	0.783	0.696	0.874	0.874	0.296	0.546	0.412
Backing-up	Coefficient	0.032	0.010	0.017	0.025	0.010	0.010	0.066	0.038	0.052
	Significance	0.540	0.848	0.739	0.636	0.848	0.848	0.206	0.465	0.322
Vehicle turn control—U-turn	Coefficient	0.025	0.008	0.014	0.019	0.008	0.008	0.051	0.030	0.040
	Significance	0.633	0.881	0.795	0.713	0.881	0.881	0.325	0.570	0.440

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Vehicle turn control—Turned into incorrect lane	Coefficient Significance	0.053 0.306	0.017 0.749	0.029 0.579	0.041 0.431	0.017 0.749	0.017 0.749	0.109 0.035	0.063 0.224	0.086 0.098
Vehicle turn control—Proceeded forward from a turn lane	Coefficient Significance	0.012 0.813	0.004 0.941	0.007 0.898	0.010 0.855	0.004 0.941	0.004 0.941	0.025 0.625	0.015 0.778	0.020 0.702
Defensive maneuver	Coefficient Significance	0.005 0.929	0.148 0.004	0.032 0.544	0.045 0.388	0.018 0.727	0.018 0.727	0.063 0.223	0.069 0.183	0.025 0.633
Avoiding—Obstruction in roadway	Coefficient Significance	0.022 0.680	0.007 0.897	0.012 .823	0.017 0.751	0.007 0.897	0.007 0.897	0.044 0.395	0.026 0.623	0.035 0.505
No room to respond to an active emergency vehicle	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Gesturing—Sounding horn	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.017 0.749	0.076 0.143	0.038 0.471
Avoiding—Another vehicle	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.017 0.749	0.076 0.143	0.038 0.471
Violation stopping—Ran red light or stop sign	Coefficient Significance	0.041 0.430	0.013 0.805	0.022 0.669	0.032 0.543	0.013 0.805	0.013 0.805	0.084 0.104	0.049 0.348	0.066 0.203
Violation stopping—Rolling stop	Coefficient Significance	0.036 0.494	0.011 0.831	0.019 0.711	0.027 0.599	0.011 0.831	0.011 0.831	0.073 0.159	0.042 0.416	0.057 0.270
Failure to yield right-of-way--General	Coefficient Significance	0.045 0.383	0.046 0.380	0.079 0.127	0.017 0.745	0.046 0.380	0.046 0.380	0.105 0.042	0.060 0.251	0.084 0.106
Failure to yield right-of-way--Right turn on red light	Coefficient Significance	0.036 0.494	0.011 0.831	0.019 0.711	0.027 0.599	0.011 0.831	0.011 0.831	0.030 0.563	0.027 0.601	0.057 0.270
Violation turning—Illegal U-turn	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.048 0.358	0.028 0.595	0.038 0.471
Entered intersection on an amber light	Coefficient Significance	0.020 0.707	0.006 0.906	0.011 0.838	0.015 0.772	0.006 0.906	0.006 0.906	0.040 0.438	0.023 0.654	0.032 0.543
Violations passing—Passing in a no passing zone	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Following closely	Coefficient Significance	0.017 0.737	0.021 0.691	0.052 0.316	0.051 0.327	0.021 0.691	0.021 0.691	0.018 0.729	0.127 0.014	0.075 0.147
Force another vehicle out of lane	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.081 0.119	0.177 0.001	0.038 0.471
Speed of event vehicle	Coefficient Significance	0.036 0.484	0.025 0.634	0.035 0.506	0.061 0.240	0.025 0.634	0.025 0.634	0.153 0.003	0.052 0.321	0.148 0.004
Observed difficulties navigating—Intersection angle	Coefficient Significance	0.042 0.419	0.013 0.801	0.023 0.661	0.032 0.533	0.013 0.801	0.013 0.801	0.050 0.342	0.010 0.851	0.068 0.192
Observed difficulties navigating—Intersection width	Coefficient Significance	0.029 0.574	0.009 0.860	0.016 0.760	0.023 0.665	0.009 0.860	0.009 0.860	0.060 0.246	0.035 0.503	0.047 0.363
Observed difficulties navigating—Intersection grade	Coefficient Significance	0.020 0.707	0.006 0.906	0.011 0.838	0.015 0.772	0.006 0.906	0.006 0.906	0.040 0.438	0.023 0.654	0.032 0.543
Observed difficulties navigating—Ramp	Coefficient Significance	0.196 0.000	0.023 0.662	0.040 0.447	0.283 0.000	0.119 0.022	0.119 0.022	0.429 0.000	0.288 0.000	0.333 0.000
Observed difficulties navigating—Roadway	Coefficient Significance	0.022 0.680	0.007 0.897	0.012 0.823	0.017 0.751	0.007 0.897	0.007 0.897	0.044 0.395	0.026 0.623	0.035 0.505
Observed difficulties navigating—Alignment/Curve	Coefficient Significance	0.029 0.574	0.009 0.860	0.016 0.760	0.023 0.665	0.009 0.860	0.009 0.860	0.145 0.005	0.131 0.011	0.079 0.128
Observed difficulties navigating—Alignment/Undulation	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.048 0.358	0.028 0.595	0.038 0.471
Observed difficulties navigating—Grade	Coefficient Significance	0.031 0.556	0.010 0.854	0.017 0.749	0.024 0.650	0.010 0.854	0.010 0.854	0.063 0.225	0.036 0.484	0.050 0.342
Violations turning—Illegal left turn	Coefficient Significance	0.038 0.467	0.012 0.820	0.021 0.693	0.029 0.575	0.012 0.820	0.012 0.820	0.037 0.476	0.021 0.690	0.061 0.240
Violations turning—Illegal right turn	Coefficient Significance	0.089 0.085	0.008 0.881	0.014 0.795	0.127 0.014	0.008 0.881	0.008 0.881	0.051 0.325	0.030 0.570	0.040 0.440
Violations turning—Wrong way on one-way	Coefficient Significance	0.020 0.707	0.006 0.906	0.011 0.838	0.015 0.772	0.006 0.906	0.006 0.906	0.040 0.438	0.023 0.654	0.032 0.543

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Violations passing—Driving on shoulder	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.048 0.358	0.028 0.595	0.038 0.471
Avoiding active emergency vehicle	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.01 0.842	0.014 0.787
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.052 0.322	0.016 0.757	0.028 0.591	0.040 0.446	0.016 0.757	0.016 0.757	0.106 0.042	0.061 0.239	0.083 0.110
Creeping into intersection	Coefficient Significance	0.039 0.454	0.012 0.815	0.021 0.685	0.030 0.564	0.012 0.815	0.012 0.815	0.001 0.992	0.082 0.116	0.063 0.227
Vehicle control while turning—Turned from through-only lane	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.048 0.358	0.028 0.595	0.038 0.471
Following	Coefficient Significance	0.041 0.430	0.013 0.805	0.022 0.669	0.032 0.543	0.013 0.805	0.013 0.805	0.105 0.043	0.192 0.000	0.020 0.703
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.011 0.829	0.016 0.765	0.027 0.604	0.040 0.442	0.016 0.765	0.016 0.765	0.122 0.018	0.096 0.064	0.077 0.137
Lateral vehicle control—No deviation	Coefficient Significance	0.142 0.006	0.066 0.204	0.053 0.310	0.118 0.022	0.066 0.204	0.066 0.204	0.091 0.078	0.048 0.359	0.076 0.145
Lateral vehicle control—Deviation in lane to right	Coefficient Significance	0.040 0.442	0.013 0.810	0.022 0.677	0.031 0.554	0.013 0.810	0.013 0.810	0.034 0.511	0.139 0.007	0.065 0.214
Lateral vehicle control—Deviation in lane to left	Coefficient Significance	0.037 0.483	0.012 0.815	0.115 0.027	0.03 0.564	0.012 0.815	0.012 0.815	0.039 0.450	0.046 0.373	0.083 0.110
Lateral vehicle control—Lane break to right	Coefficient Significance	0.240 0.000	0.140 0.007	0.060 0.252	0.212 0.000	0.019 0.712	0.019 0.712	0.072 0.165	0.014 0.784	0.099 0.056
Lateral vehicle control—Lane break to left	Coefficient Significance	0.023 0.657	0.022 0.675	0.038 0.466	0.006 0.905	0.124 0.017	0.124 0.017	0.151 0.003	0.004 0.944	0.186 0.000
Lateral vehicle control—Unknown	Coefficient Significance	0.015 0.771	0.005 0.928	0.008 0.875	0.012 0.823	0.005 0.928	0.005 0.928	0.031 0.549	0.018 0.729	0.024 0.639
Longitudinal vehicle control—Decelerating	Coefficient Significance	0.02 0.707	0.006 0.906	0.011 0.838	0.015 0.772	0.006 0.906	0.006 0.906	0.036 0.492	0.023 0.654	0.061 0.237
Longitudinal vehicle control—Anticipatory braking	Coefficient Significance	0.069 0.184	0.022 0.678	0.038 0.471	0.053 0.306	0.125 0.016	0.125 0.016	0.007 0.894	0.078 0.134	0.051 0.329
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient Significance	0.113 0.030	0.068 0.194	0.007 0.889	0.122 0.018	0.040 0.441	0.04 0.441	0.064 0.218	0.006 0.905	0.074 0.156
Longitudinal vehicle control—uncontrolled braking	Coefficient Significance	0.025 0.633	0.008 0.881	0.014 0.795	0.019 0.713	0.008 0.881	0.008 0.881	0.051 0.325	0.030 0.570	0.040 0.440
Longitudinal vehicle control—Skidding	Coefficient Significance	0.015 0.771	0.005 0.928	0.008 0.875	0.012 0.823	0.005 0.928	0.005 0.928	0.031 0.549	0.018 0.729	0.024 0.639
Longitudinal vehicle control—Accelerating	Coefficient Significance	0.072 0.164	0.034 0.513	0.007 0.896	0.084 0.107	0.034 0.513	0.034 0.513	0.064 0.216	0.025 0.627	0.060 0.253
Longitudinal vehicle control—Normal driving	Coefficient Significance	0.045 0.387	0.019 0.719	0.062 0.231	0.021 0.683	0.019 0.719	0.019 0.719	0.015 0.770	0.071 0.171	0.073 0.162
Longitudinal vehicle control—Unknown	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.017 0.749	0.028 0.595	0.041 0.426
Signal usage—Signal not required	Coefficient Significance	0.107 0.038	0.044 0.396	0.077 0.140	0.066 0.207	0.061 0.238	0.061 0.238	0.077 0.138	0.053 0.305	0.054 0.301
Signal usage—Incorrect signal	Coefficient Significance	0.018 0.737	0.005 0.916	0.010 0.855	0.013 0.796	0.005 0.916	0.005 0.916	0.049 0.347	0.115 0.026	0.028 0.587
Signal usage—Correct signal on in advance	Coefficient Significance	0.224 0.000	0.112 0.031	0.192 0.000	0.109 0.036	0.024 0.643	0.024 0.643	0.118 0.023	0.094 0.071	0.073 0.160
Signal usage—Correct signal not on in advance	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.081 0.119	0.028 0.595	0.120 0.021
Signal usage—Signal not used	Coefficient Significance	0.052 0.319	0.029 0.583	0.050 0.341	0.020 0.706	0.029 0.583	0.029 0.583	0.042 0.423	0.026 0.620	0.031 0.547
Signal usage—Unknown	Coefficient Significance	0.021 0.688	0.021 0.681	0.037 0.476	0.008 0.873	0.021 0.681	0.021 0.681	0.115 0.026	0.081 0.118	0.080 0.125

Correlations between ramp maneuver and conflict types and pedestrian/bicyclist maneuver and conflict types (N = 368).

		Enter Ramp Maneuver	Conflict 60	Conflict 61	Conflict 62	Ramp Proper Maneuver	Conflict 71	Exit Ramp Maneuver	Conflict 80	Conflict 83
Enter Ramp Maneuver	Coefficient Significance	----								
Conflict 60	Coefficient Significance	0.298 0.000	----							
Conflict 61	Coefficient Significance	0.477 0.000	0.005 0.928	----						
Conflict 62	Coefficient Significance	0.610 0.000	0.007 0.897	0.012 0.823	----					
Ramp Proper Maneuver	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	----				
Conflict 71	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.707 0.000	----			
Exit Ramp Maneuver	Coefficient Significance	0.057 0.270	0.018 0.730	0.031 0.549	0.044 0.395	0.018 0.730	0.018 0.730	----		
Conflict 80	Coefficient Significance	0.033 0.524	0.010 0.842	0.018 0.729	0.026 0.623	0.010 0.842	0.010 0.842	0.500 0.000	----	
Conflict 83	Coefficient Significance	0.045 0.387	0.014 0.787	0.024 0.639	0.035 0.505	0.014 0.787	0.014 0.787	0.617 0.000	0.054 0.303	----
Pedestrian/Bicycle Maneuver	Coefficient Significance	0.023 0.655	0.007 0.889	0.013 0.809	0.018 0.731	0.007 0.889	0.007 0.889	0.048 0.358	0.028 0.595	0.038 0.471
Conflict90(event)	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787
Conflict91(event)	Coefficient Significance	0.020 0.707	0.006 0.906	0.011 0.838	0.015 0.772	0.006 0.906	0.006 0.906	0.040 0.438	0.023 0.654	0.032 0.543
Conflict93(event)	Coefficient Significance	0.009 0.867	0.003 0.958	0.005 0.928	0.007 0.897	0.003 0.958	0.003 0.958	0.018 0.730	0.010 0.842	0.014 0.787

13.8 Pedestrian/Bicycle Contingency Correlation Tables

Correlations between pedestrian and bicycle maneuver and conflict types and site-related variables (N = 368).

		Pedestrian/ Bicycle/ Maneuver	Conflict 90	Conflict 91	Conflict 93
Region—Rural	Coefficient	0.051	0.035	0.028	0.035
	Significance	0.328	0.500	0.585	0.500
Region—City	Coefficient	0.086	0.032	0.072	0.032
	Significance	0.098	0.535	0.163	0.535
Region—Metro	Coefficient	0.125	0.062	0.093	0.062
	Significance	0.015	0.230	0.074	0.230
Geometry—Roadway segment	Coefficient	0.041	0.015	0.034	0.015
	Significance	0.435	0.770	0.510	0.770
Geometry—Merge	Coefficient	0.080	0.030	0.068	0.030
	Significance	0.123	0.563	0.194	0.563
Geometry—T-intersection	Coefficient	0.048	0.023	0.076	0.023
	Significance	0.361	0.662	0.141	0.662
Geometry—4-legged intersection	Coefficient	0.027	0.028	0.006	0.028
	Significance	0.608	0.592	0.902	0.592
Geometry—Offset 4-legged intersection	Coefficient	0.031	0.011	0.026	0.011
	Significance	0.557	0.826	0.620	0.826
Geometry—Multi-legged intersection	Coefficient	0.107	0.092	0.043	0.092
	Significance	0.040	0.076	0.406	0.076
Geometry—All intersection types	Coefficient	0.097	0.037	0.082	0.037
	Significance	0.062	0.483	0.115	0.483
Road function—Group A	Coefficient	0.044	0.016	0.037	0.016
	Significance	0.402	0.753	0.480	0.753
Road function—Group B	Coefficient	0.008	0.035	0.022	0.035
	Significance	0.877	0.500	0.671	0.500
Road function—Group C	Coefficient	0.085	0.062	0.045	0.062
	Significance	0.102	0.233	0.393	0.233
Road function—Group D	Coefficient	0.060	0.023	0.051	0.023
	Significance	0.248	0.665	0.330	0.665
Road function—Group E	Coefficient	0.023	0.009	0.020	0.009
	Significance	0.655	0.867	0.707	0.867
Primary control—Yield sign	Coefficient	0.074	0.028	0.063	0.028
	Significance	0.153	0.592	0.228	0.592
Primary control—Stop sign	Coefficient	0.073	0.027	0.061	0.027
	Significance	0.163	0.601	0.239	0.601
Primary control—G,Y,R signal without turn arrows	Coefficient	0.154	0.119	0.076	0.119
	Significance	0.003	0.022	0.141	0.022
Primary control—G, Y, R signal with turn arrows	Coefficient	0.033	0.036	0.071	0.036
	Significance	0.526	0.494	0.173	0.494
Primary control—None	Coefficient	0.042	0.016	0.036	0.016
	Significance	0.418	0.761	0.495	0.761
Road edge—Paved full shoulder	Coefficient	0.057	0.021	0.048	0.021
	Significance	0.273	0.681	0.356	0.681
Road edge—Soft full shoulder	Coefficient	0.026	0.010	0.022	0.010
	Significance	0.624	0.854	0.679	0.854
Road edge—Paved partial shoulder	Coefficient	0.050	0.019	0.042	0.019
	Significance	0.338	0.719	0.419	0.719
Road edge—Soft partial shoulder	Coefficient	0.057	0.021	0.048	0.021
	Significance	0.273	0.681	0.356	0.681
Road edge—Curb (no shoulder)	Coefficient	0.121	0.046	0.102	0.046
	Significance	0.019	0.380	0.048	0.380
Markings—Good condition	Coefficient	0.125	0.062	0.093	0.062
	Significance	0.015	0.230	0.074	0.230
Markings—Fair condition	Coefficient	0.184	0.087	0.141	0.087
	Significance	0.000	0.094	0.006	0.094
Markings—Poor condition	Coefficient	0.057	0.021	0.048	0.021
	Significance	0.273	0.681	0.356	0.681
Markings—None	Coefficient	0.007	0.003	0.006	0.003
	Significance	0.889	0.958	0.906	0.958
Median—Depressed	Coefficient	0.078	0.029	0.066	0.029
	Significance	0.134	0.575	0.207	0.575
Median—Flush	Coefficient	0.026	0.010	0.022	0.010
	Significance	0.624	0.854	0.679	0.854
Median—Raised	Coefficient	0.095	0.086	0.035	0.086
	Significance	0.069	0.099	0.506	0.099
Median—None	Coefficient	0.009	0.048	0.033	0.048
	Significance	0.869	0.356	0.525	0.356
Barrier—Permanent	Coefficient	0.141	0.069	0.106	0.069
	Significance	0.006	0.186	0.041	0.186
Barrier—None	Coefficient	0.141	0.069	0.106	0.069
	Significance	0.006	0.186	0.041	0.186
Sidewalk—Along all roadways	Coefficient	0.089	0.110	0.005	0.110
	Significance	0.088	0.034	0.917	0.034
Sidewalk—Along most roadways	Coefficient	0.085	0.034	0.129	0.034
	Significance	0.103	0.519	0.012	0.519
Sidewalk—Along few roadways	Coefficient	0.045	0.017	0.038	0.017
	Significance	0.386	0.745	0.465	0.745
Sidewalk—None	Coefficient	0.120	0.045	0.101	0.045
	Significance	0.021	0.385	0.051	0.385

		Pedestrian/ Bicycle Maneuver	Conflict 90	Conflict 91	Conflict 93
Obstruction—Vegetation	Coefficient Significance	0.155 0.003	0.093 0.072	0.10 0.054	0.093 0.072
Obstruction—Advertisement signs	Coefficient Significance	0.026 0.624	0.010 0.854	0.022 0.679	0.010 0.854
Obstruction—Other	Coefficient Significance	0.026 0.624	0.010 0.854	0.022 0.679	0.010 0.854
Obstruction—None	Coefficient Significance	0.124 0.016	0.079 0.128	0.076 0.143	0.079 0.128
Posted speed limit	Coefficient Significance	0.189 0.018	0.176 0.039	0.095 0.648	0.176 0.039

Correlations between pedestrian and bicycle maneuver and conflict types and traffic-related variables (N = 368).

		Pedestrian/ Bicycle Maneuver	Conflict 90	Conflict 91	Conflict 93
Hour event occurred	Coefficient Significance	0.291 0.001	0.122 0.935	0.329 0.000	0.117 0.953
Relation--Pre-intersection	Coefficient Significance	0.038 0.461	0.038 0.461	0.014 0.782	0.014 0.782
Relation—Within intersection	Coefficient Significance	0.139 0.007	0.139 0.007	0.052 0.314	0.052 0.314
Relation--Post-intersection	Coefficient Significance	0.049 0.351	0.049 0.351	0.018 0.727	0.018 0.727
Relation—Driveway, alley access, etc.	Coefficient Significance	0.041 0.435	0.041 0.435	0.015 0.770	0.015 0.770
Relation—Exiting ramp	Coefficient Significance	0.030 0.569	0.030 0.569	0.011 0.831	0.011 0.831
Relation—Entering ramp	Coefficient Significance	0.043 0.410	0.043 0.410	0.016 0.757	0.016 0.757
Relation—Roadway	Coefficient Significance	0.050 0.338	0.050 0.338	0.019 0.719	0.019 0.719
Lanes—None, illegal action	Coefficient Significance	0.068 0.193	0.068 0.193	0.011 0.831	0.011 0.831
Lanes—1	Coefficient Significance	0.018 0.732	0.018 0.732	0.040 0.446	0.040 0.446
Lanes—2	Coefficient Significance	0.011 0.826	0.011 0.826	0.030 0.563	0.030 0.563
Lanes—3	Coefficient Significance	0.038 0.461	0.038 0.461	0.014 0.782	0.014 0.782
Lanes—4	Coefficient Significance	0.007 0.889	0.007 0.889	0.003 0.958	0.003 0.958
Weather—Sunny	Coefficient Significance	0.017 0.743	0.017 0.743	0.094 0.070	0.094 0.070
Weather—Partly cloudy	Coefficient Significance	0.050 0.334	0.050 0.334	0.121 .0190	0.121 0.019
Weather—Cloudy/Overcast	Coefficient Significance	0.041 0.435	0.041 0.435	0.015 0.770	0.015 0.770
Visibility—Unlimited	Coefficient Significance	0.018 0.731	0.018 0.731	0.007 0.897	0.007 0.897
Visibility—Glare	Coefficient Significance	0.013 0.809	0.013 0.809	0.005 0.928	0.005 0.928
Visibility—Fog	Coefficient Significance	0.013 0.809	0.013 0.809	0.005 0.928	0.005 0.928
Debris on roadway—Clear/None	Coefficient Significance	0.007 0.889	0.007 0.889	0.003 0.958	0.003 0.958
Debris on Roadway—Sand	Coefficient Significance	0.007 0.889	0.007 0.889	0.003 0.958	0.003 0.958
Level of Service A	Coefficient Significance	0.064 0.220	0.064 0.220	0.024 0.646	0.024 0.646
Level of Service B	Coefficient Significance	0.022 0.672	0.022 0.672	0.028 0.595	0.028 0.595
Level of Service C	Coefficient Significance	0.031 0.557	0.031 0.557	0.056 0.280	0.056 0.280
Level of Service D	Coefficient Significance	0.006 0.904	0.006 0.904	0.020 0.702	0.020 0.702
Level of Service E	Coefficient Significance	0.018 0.731	0.007 0.897	0.015 0.772	0.007 0.897
Number of vehicles in event	Coefficient Significance	0.167 0.306	0.213 0.042	0.051 1.000	0.0406 0.000
General traffic congestion	Coefficient Significance	0.069 0.184	0.069 0.184	0.026 0.618	0.026 0.618
Event obstacle—Other obstacle	Coefficient Significance	0.010 0.843	0.010 0.843	0.004 0.941	0.004 0.941
Event obstacle—Pedestrian	Coefficient Significance	0.007 0.889	0.007 0.889	0.003 0.958	0.003 0.958
Event obstacle—Bicyclist	Coefficient Significance	0.013 0.809	0.013 0.809	0.005 0.928	0.005 0.928
Event obstacle—Other vehicle(s)	Coefficient Significance	0.056 0.279	0.056 0.279	0.021 0.685	0.021 0.685
Good surface condition	Coefficient Significance	0.007 0.889	0.003 0.958	0.006 0.906	0.003 0.958

		Pedestrian/ Bicycle Maneuver	Conflict 90	Conflict 91	Conflict 93
Rough surface condition	Coefficient Significance	0.007 0.889	0.003 0.958	0.006 0.906	0.003 0.958
Markings conditions—Lane lines	Coefficient Significance	0.010 0.843	0.004 0.941	0.009 0.868	0.004 0.941
Markings conditions—Median delineation	Coefficient Significance	0.010 0.843	0.004 0.941	0.009 0.868	0.004 0.941
Markings conditions—Other type of marking	Coefficient Significance	0.007 0.889	0.003 0.958	0.006 0.906	0.003 0.958
Missing regulatory sign(s)	Coefficient Significance	0.022 0.672	0.008 0.874	0.019 0.721	0.008 0.874
Missing warning sign(s)	Coefficient Significance	0.024 0.639	0.009 0.860	0.021 0.693	0.009 0.860
Missing directional or guide sign(s)	Coefficient Significance	0.032 0.545	0.012 0.820	0.027 0.610	0.012 0.820
No pedestrian signal	Coefficient Significance	0.351 0.000	0.003 0.958	0.406 0.000	0.003 0.958
Limitations to sight distance—Other traffic	Coefficient Significance	0.032 0.533	0.012 0.815	0.027 0.599	0.012 0.815
Limitations to sight distance—Geometry	Coefficient Significance	0.043 0.410	0.016 0.757	0.036 0.487	0.016 0.757
Limitations to sight distance—Signage	Coefficient Significance	0.010 0.843	0.004 0.941	0.009 0.868	0.004 0.941
Limitations to sight distance—Pedestrian/Bicyclist	Coefficient Significance	0.007 0.889	0.003 0.958	0.006 0.906	0.003 0.958
Limitations to sight distance—Vegetation	Coefficient Significance	0.016 0.754	0.006 0.906	0.014 0.792	0.006 0.906
Limitations to sight distance—Other	Coefficient Significance	0.013 0.809	0.005 0.928	0.011 0.838	0.005 0.928
Size of event vehicle	Coefficient Significance	0.115 0.027	0.008 0.881	0.142 0.006	0.008 0.881
Location of event	Coefficient Significance	0.261 0.627	0.176 0.999	0.236 0.862	0.176 0.999

Correlations between pedestrian and bicycle maneuver and conflict types and driver performance-related variables (N = 368).

		Pedestrian/ Bicycle Maneuver	Conflict 90	Conflict 91	Conflict 93
Pulled into traffic or Proceeded without clearance	Coefficient Significance	0.040 0.443	0.040 0.443	0.060 0.248	0.060 0.248
Entered intersection on red light	Coefficient Significance	0.015 0.779	0.015 0.779	0.005 0.916	0.005 0.916
Inadequate reaction speed	Coefficient Significance	0.045 0.386	0.045 0.386	0.017 0.745	0.017 0.745
Failure to respond to primary control	Coefficient Significance	0.170 0.001	0.170 0.001	0.016 0.761	0.016 0.761
Failure to respond to an active emergency vehicle	Coefficient Significance	0.010 0.843	0.010 0.843	0.004 0.941	0.004 0.941
Failure to yield right-of-way to pedestrian	Coefficient Significance	0.007 0.889	0.003 0.958	0.006 0.906	0.003 0.958
Lateral vehicle control—Close to center line or road edge marking	Coefficient Significance	0.013 0.809	0.005 0.928	0.011 0.838	0.005 0.928
Lateral vehicle control—Lane change	Coefficient Significance	0.081 0.120	0.081 0.120	0.030 0.560	0.030 0.560
Lateral vehicle control—Deviation in lane in both directions	Coefficient Significance	0.024 0.639	0.024 0.639	0.009 0.860	0.009 0.860
Lateral vehicle control—Ran off road	Coefficient Significance	0.016 0.754	0.016 0.754	0.006 0.906	0.006 0.906
Vehicle turn control—Under compensate	Coefficient Significance	0.022 0.672	0.022 0.672	0.008 0.874	0.008 0.874
Vehicle turn control—Over compensate	Coefficient Significance	0.022 0.672	0.022 0.672	0.008 0.874	0.008 0.874
Backing-up	Coefficient Significance	0.027 0.609	0.027 0.609	0.010 0.848	0.010 0.848
Vehicle turn control—U-turn	Coefficient Significance	0.021 0.690	0.021 0.690	0.008 0.881	0.008 0.881
Vehicle turn control—Turned into incorrect lane	Coefficient Significance	0.044 0.394	0.044 0.394	0.017 0.749	0.017 0.749
Vehicle turn control—Proceeded forward from a turn lane	Coefficient Significance	0.010 0.843	0.010 0.843	0.004 0.941	0.004 0.941
Defensive maneuver	Coefficient Significance	0.049 0.351	0.049 0.351	0.018 0.727	0.018 0.727
Avoiding—Obstruction in roadway	Coefficient Significance	0.018 0.731	0.018 0.731	0.007 0.897	0.007 0.897
No room to respond to an active emergency vehicle	Coefficient Significance	0.007 0.889	0.007 0.889	0.003 0.958	0.003 0.958
Gesturing—Sounding horn	Coefficient Significance	0.019 0.710	0.019 0.710	0.007 0.889	0.007 0.889
Avoiding—Another vehicle	Coefficient Significance	0.125 0.015	0.125 0.015	0.007 0.889	0.007 0.889
Violation stopping—Ran red light or stop sign	Coefficient Significance	0.218 0.000	0.218 0.000	0.208 0.000	0.208 0.000

		Pedestrian/ Bicycle/ Maneuver	Conflict 90	Conflict 91	Conflict 93
Violation stopping—Rolling stop	Coefficient Significance	0.068 0.193	0.068 0.193	0.011 0.831	0.011 0.831
Failure to yield right-of-way--General	Coefficient Significance	0.078 0.132	0.078 0.132	0.059 0.254	0.059 0.254
Failure to yield right-of-way—Right turn on red light	Coefficient Significance	0.030 0.569	0.030 0.569	0.011 0.831	0.011 0.831
Violation turning—Illegal U-turn	Coefficient Significance	0.019 0.710	0.019 0.710	0.007 0.889	0.007 0.889
Entered intersection on an amber light	Coefficient Significance	0.016 0.754	0.006 0.906	0.014 0.792	0.006 0.906
Violations passing—Passing in a no passing zone	Coefficient Significance	0.007 0.889	0.007 0.889	0.003 0.958	0.003 0.958
Following closely	Coefficient Significance	0.055 0.289	0.055 0.289	0.021 0.691	0.021 0.691
Force another vehicle out of lane	Coefficient Significance	0.019 0.710	0.019 0.710	0.007 0.889	0.007 0.889
Speed of event vehicle	Coefficient Significance	0.066 0.203	0.066 0.203	0.025 0.634	0.025 0.634
Observed difficulties navigating—Intersection angle	Coefficient Significance	0.035 0.501	0.035 0.501	0.013 0.801	0.013 0.801
Observed difficulties navigating—Intersection width	Coefficient Significance	0.024 0.639	0.024 0.639	0.009 0.860	0.009 0.860
Observed difficulties navigating—Intersection grade	Coefficient Significance	0.016 0.754	0.016 0.754	0.006 0.906	0.006 0.906
Observed difficulties navigating—Ramp	Coefficient Significance	0.061 0.243	0.061 0.243	0.023 0.662	0.023 0.662
Observed difficulties navigating—Roadway	Coefficient Significance	0.018 0.731	0.018 0.731	0.007 0.897	0.007 0.897
Observed difficulties navigating—Alignment/Curve	Coefficient Significance	0.024 0.639	0.024 0.639	0.009 0.860	0.009 0.860
Observed difficulties navigating—Alignment/ Undulation	Coefficient Significance	0.019 0.710	0.019 0.710	0.007 0.889	0.007 0.889
Observed difficulties navigating—Grade	Coefficient Significance	0.026 0.624	0.026 0.624	0.010 0.854	0.010 0.854
Violations turning—Illegal left turn	Coefficient Significance	0.032 0.545	0.012 0.820	0.027 0.610	0.012 0.820
Violations turning—Illegal right turn	Coefficient Significance	0.021 0.690	0.008 0.881	0.017 0.737	0.008 0.881
Violations turning—Wrong way on one-way	Coefficient Significance	0.154 0.003	0.006 0.906	0.014 0.792	0.406 0.000
Violations passing—Driving on shoulder	Coefficient Significance	0.019 0.710	0.007 0.889	0.016 0.754	0.007 0.889
Avoiding active emergency vehicle	Coefficient Significance	0.007 0.889	0.003 0.958	0.006 0.906	0.003 0.958
Violation stopping—Stopped beyond stop line	Coefficient Significance	0.043 0.410	0.016 0.757	0.036 0.487	0.016 0.757
Creeping into intersection	Coefficient Significance	0.032 0.533	0.012 0.815	0.027 0.599	0.012 0.815
Vehicle control while turning—Turned from through-only lane	Coefficient Significance	0.019 0.710	0.007 0.889	0.016 0.754	0.007 0.889
Following	Coefficient Significance	0.034 0.511	0.013 0.805	0.029 0.580	0.013 0.805
Lateral vehicle control—Lane break in both directions	Coefficient Significance	0.041 0.426	0.016 0.765	0.035 0.502	0.016 0.765
Lateral vehicle control—No deviation	Coefficient Significance	0.069 0.187	0.041 0.430	0.044 0.396	0.041 0.430
Lateral vehicle control—Deviation in lane to right	Coefficient Significance	0.033 0.522	0.013 0.810	0.028 0.589	0.013 0.810
Lateral vehicle control—Deviation in lane to left	Coefficient Significance	0.032 0.533	0.012 0.815	0.027 0.599	0.012 0.815
Lateral vehicle control—Lane break to right	Coefficient Significance	0.010 0.848	0.019 0.712	0.029 0.577	0.019 0.712
Lateral vehicle control—Lane break to left	Coefficient Significance	0.058 0.263	0.022 0.675	0.049 0.345	0.022 0.675
Lateral vehicle control—Unknown	Coefficient Significance	0.013 0.809	0.005 0.928	0.011 0.838	0.005 0.928
Longitudinal vehicle control—Decelerating	Coefficient Significance	0.016 0.754	0.006 0.906	0.014 0.792	0.006 0.906
Longitudinal vehicle control—Anticipatory braking	Coefficient Significance	0.055 0.294	0.022 0.678	0.084 0.107	0.022 0.678
Longitudinal vehicle control—Unanticipated controlled braking	Coefficient Significance	0.107 0.040	0.040 0.441	0.090 0.083	0.040 0.441
Longitudinal vehicle control—uncontrolled braking	Coefficient Significance	0.021 0.690	0.008 0.881	0.017 0.737	0.008 0.881
Longitudinal vehicle control—Skidding	Coefficient Significance	0.013 0.809	0.005 0.928	0.011 0.838	0.005 0.928
Longitudinal vehicle control—Accelerating	Coefficient Significance	0.047 0.362	0.080 0.125	0.076 0.142	0.034 0.513
Longitudinal vehicle control—Normal driving	Coefficient Significance	0.136 0.008	0.019 0.719	0.105 0.043	0.144 0.005
Longitudinal vehicle control—Unknown	Coefficient Significance	0.125 0.015	0.007 0.889	0.154 0.003	0.007 0.889
Signal usage—Signal not required	Coefficient Significance	0.123 0.018	0.061 0.238	0.090 0.082	0.061 0.238
Signal usage—Incorrect signal	Coefficient Significance	0.015 0.779	0.005 0.916	0.012 0.813	0.005 0.916
Signal usage—Correct signal on in advance	Coefficient Significance	0.064 0.216	0.024 0.643	0.054 0.297	0.024 0.643

		Pedestrian/ Bicycle/ Maneuver	Conflict 90	Conflict 91	Conflict 93
Signal usage—Correct signal not on in advance	Coefficient Significance	0.019 0.710	0.007 0.889	0.016 0.754	0.007 0.889
Signal usage—Signal not used	Coefficient Significance	0.029 0.576	0.029 0.583	0.009 0.869	0.029 0.583
Signal usage—Unknown	Coefficient Significance	0.057 0.273	0.021 0.681	0.048 0.356	0.021 0.681

Correlations between pedestrian and bicycle maneuver and conflict types (N = 368).

		Pedestrian/ Bicycle/ Maneuver	Conflict 90	Conflict 91	Conflict 93
Pedestrian/Bicycle Maneuver	Coefficient Significance	---			
Conflict 90	Coefficient Significance	0.351 0.000	---		
Conflict 91	Coefficient Significance	0.644 0.000	0.006 0.906	---	
Conflict 93	Coefficient Significance	0.351 0.000	0.003 0.958	0.006 0.906	---

14 Vita

Cheryl Kieliszewski is currently employed with International Business Machines, Inc. (IBM) working at the Almaden Research Center in San Jose, California as a Human Factors Scientist. Before coming to the Almaden Research Center, she was the Lead Human Factors Engineer, for IBM Storage Division (2000-2004) in Tucson, Arizona. Prior to IBM, Cheryl led research in the areas of human error, driver information processing of in-vehicle display information, and in-vehicle feature usability at the Virginia Tech Transportation Institute in Blacksburg, Virginia. She has also held adjunct faculty positions at North Dakota State University, Fargo, North Dakota and Radford University, Radford, Virginia.

Doctor of Philosophy December 2005
Virginia Polytechnic Institute and State University, Blacksburg, Virginia
Department of Industrial and Systems Engineering--Human Factors Option
Dissertation title: Twisted Metal: An Investigation into Observable Factors that Lead to Critical Traffic Events

Master of Science May 1996
Virginia Polytechnic Institute and State University, Blacksburg, Virginia
Department of Housing, Interior Design, and Resource Management
Thesis title: Relamping Hotel Guestrooms to Decrease Operating Costs

Bachelor of Science December 1989
University of Wisconsin - Stevens Point, Stevens Point, Wisconsin
Division of Fashion and Interior Design
Major: Interior Design