



Center for Transportation Research and Education

Motorcycle Conspicuity – What Factors Have the Greatest Impact

tech transfer summary

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RESEARCH PROJECT TITLE

Motorcycle Conspicuity – What Factors Have the Greatest Impact

SPONSORS

Iowa Department of Transportation
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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, and reliability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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This research investigated the impact of motorcycle headlight configurations, rider colors, and age of the drivers (participants) on motorcycle conspicuity in simulated urban and rural environments.

Problem Statement

The Iowa Motorcycle Operator Manual states that motorcycle crashes with other vehicles are frequently caused by the other motorist entering the rider's right-of-way. After these crashes, drivers often say they never saw the motorcycle.

Therefore, increasing the conspicuity of the motorcycle would help address this issue, resulting in fewer crashes (and injuries and damage).

Background Information

In 2009, the Iowa Department of Transportation (DOT) awarded a contract to the Center for Transportation Research and Education (CTRE) to study motorcycle conspicuity in Iowa using crash data analysis.

That project, completed as of September 2010, reviewed previous studies on motorcycle conspicuity with a focus on the effectiveness of proposed measures for enhancing motorcycle conspicuity, and examined the distribution of conspicuity-related factors in light and dark conditions in two-vehicle crashes that could potentially relate to collisions between motorcycles and other vehicles.



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Two of the six oncoming rider and headlight combinations



The three combinations for leading parked motorcycles used in the study

The limitations of examining motorcycle conspicuity by analysis of crash data were also discussed. More specifically, potential conspicuity-related factors, such as rider clothing, motorcycle color, helmet color, and motorcycle type, could not be collected from the crash database.

Driving simulator studies provide a promising avenue for the desired information to be collected in investigating motorcycle conspicuity. Driving simulators provide a safe, controlled environment in which to study situations that are hazardous in the real world. In addition, simulators enable the same situation to be presented to multiple participants, as well as multiple situations to a single participant.

Objective and Scope

The objectives of this project were to determine the following:

- Impact of modulating headlight and rider clothing and helmet color on motorcycle conspicuity in both urban and rural driving environments
- Differences in driver awareness of motorcyclists by age (younger versus older drivers)
- Differences in the conspicuity of motorcycles seen from the front (oncoming motorcycles) and from the rear (leading parked motorcycles)

Research Methodology

To achieve the research objectives, 36 participants completed three drives on a National Advanced Driving Simulator (NADS)-2 driving simulator.

During two of the drives, participants were presented with six oncoming motorcycles and three leading parked motorcycles, each with a different combination of rider color and headlight configuration. Each of the nine motorcycles was present in either the urban or rural driving environment.

Participants indicated when each motorcycle was first visible to them by pressing a button on the steering wheel of the driving simulator. The detection distances from the motorcycles to the participant vehicles were recorded. Participants were within one of two groups: younger drivers (25 to 55) or older drivers (65 and older).

For headlight configuration, the study compared daytime running lights (DRLs), high beam lamps, and modulating headlights. For rider color, the study compared bright yellow, blue denim, and black torso clothing and helmets. The analysis was conducted separately for oncoming and leading parked motorcycles.

The recorded detection distances for the oncoming and leading parked motorcycles from the participant vehicles were then used to analyze the simulator data. Motorcycles detected at greater distances by study participants were considered more conspicuous. However, note that the implications of the detection distances reported in this study are relative rather than absolute, given this study was conducted in a simulated environment.

This research then applied repeated measures analysis of variance to investigate the effect of headlight configurations and rider color on motorcycle conspicuity in urban and rural environments to younger and older driver (participant) groups.

Key Findings

Overall, the study results revealed that motorcycles with modulating headlights had longer detection distances than high beams or DRLs for both younger and older drivers in both urban and rural environments.

The results also indicated that motorcycle riders wearing bright yellow clothing and helmets were detected at the longest distance by both younger and older drivers in both rural and urban environments.

For Oncoming Motorcycles

- Motorcycles with modulating headlights were detected at the greatest distance and motorcycles with high beams were detected at a greater distance than motorcycles with DRLs by the study participants.
- No significant main effect of the participant age groups or the environment (rural versus urban) was found for detection distances.
- Participant ability to detect a motorcycle was significantly influenced by the headlight configurations when the motorcycles had black or bright yellow riders.
- Motorcycles with modulating headlights were detected at the greatest distance (compared to motorcycles with high beam and DRL) for both cases where the riders had black or bright yellow clothing and helmets.

For Leading Parked Motorcycles

- Motorcycles in urban environments were detected at a greater distance compared to those in rural environments.
- Motorcycles with bright yellow riders were detected at the greatest distance by study participants and motorcycles with blue denim riders were detected at a greater distance than those with riders depicted wearing black.



Simulated urban and rural driving environments

- Younger participants detected motorcycles with riders in bright colors (blue denim and bright yellow) at a greater distance than older driver participants in both urban and rural environments. Therefore, older drivers might have more difficulty than younger ones in detecting leading motorcycles.
- Both younger and older participant groups detected motorcycles with riders in bright colors (blue denim and bright yellow) at a greater distance in the urban environment than in the rural environment. On urban roads where the background surrounding motorcycles is more complex and multi-colored, bright outfits can increase motorcycle conspicuity compared to black outfits.

Recommendations

In view of the analysis results, the following recommendations are offered to the Iowa DOT for implementing motorcycle conspicuity-related campaigns and interventions:

- Motorcycle conspicuity can be increased with appropriate (bright) rider outfits that help distinguish them from the surrounding background
- Modulating motorcycle headlights can increase motorcycle conspicuity significantly, irrespective of the background environment
- Increased alertness and expectancy of drivers to the presence of motorcyclists can increase conspicuity (given motorcycles were detected at greater distances in an urban environment than a rural environment)
- Motorcycle awareness programs targeted specifically to older drivers can be considered given the study results