Fourth International Symposium on Naturalistic Driving Research: Abstract for Review

Analysis of Mean Trip Speed of Motorcycle Riders

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Problem: Motorcyclist fatality rates are disproportionately high when compared to those of automobile occupants. The fatality rate for motorcyclists in 2011 was 24.94 fatalities per 100 million miles traveled, whereas the fatality rate for car drivers was 0.8 fatalities per 100 million miles traveled. While passenger vehicle and large truck fatality rates have steadily declined since the mid 1970's, motorcycle fatality rates have not experienced the same steady decline (National Highway Traffic Safety Administration, 2011).

Studies of mean trip speeds have been shown to vary by vehicle type, both by type of passenger vehicle, as well as between passenger vehicles and heavy trucks. Deviation from average traffic speeds has been shown to increase the likelihood of a crash. (Jun, Guensler, & Ogle, 2011; Solomon, 1964) However, the scope of these studies was limited to either accident reports or observations at fixed test areas. These studies provide a snapshot of speed behaviors of drivers, but to gain a more complete knowledge of driver speed behavior, continuous observation of drivers or riders within the complete driving environments must be obtained. To this end, large scale naturalistic driving studies have become a useful methodology (Dingus et al., 2006). The MSF 100 Motorcyclists Naturalistic Study is the first large scale naturalistic motorcycle study, with data from 100 riders, on their own motorcycles, collected generally for a year of riding from each participant. This paper presents basic descriptive statistics about the speed distributions of the MSF100 riders, as well as statistical comparisons between categories of motorcycle type and gender.

Method

Rider inputs from 100 instrumented motorcycles were recorded over a period of two to 24 months in a naturalistic riding study. Participants were recruited in four geographic areas: Irvine California, Orlando Florida, Blacksburg Virginia and Phoenix Arizona. Each participant's motorcycle was equipped with a data acquisition system (DAS) which included sensors to measure speed, position, acceleration, rotational velocity, engine rpm, brake light and turn signals, as well as individual front and rear brake activation. The total group of instrumented motorcycles included 41 cruisers, 21 sport bikes, and 38 touring motorcycles. Due to inoperable GPS units on two of the motorcycles, the number of motorcycles used in this analysis numbered: 41 cruisers, 20 sport bikes, and 37 touring motorcycles for a total of 98 motorcycles. The gender distribution of the participants was 76 males and 22 females. The distribution of motorcycle type by gender can be seen in Figure 1. Rider age at the start of participation ranged from 21 to 79 years old. These participants rode a variety of motorcycles, however there were no sport bike riders in the two oldest age groups (61-70 and 71-80). The number of touring motorcycles

per age group increased with the age of the participant. Additionally, there were no females in the two oldest age groups, 61-70 and 71-80.

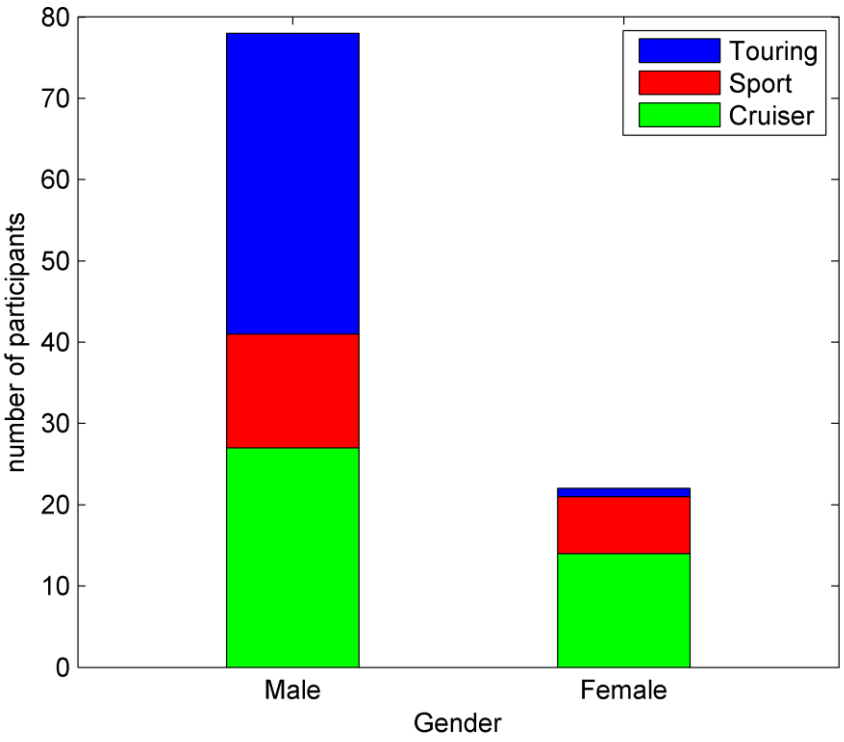

Figure 1: Distribution of participants by gender and motorcycle type

A 3X2 between subjects experimental design was used, with three levels of Motorcycle Type (Cruiser, Sport, and Touring) and Gender as between-subjects factors with Speed as the dependent variable. A "trip" was defined as the time between key on to key off where the motorcycle had moved over 0.1 miles. Each trip was given a unique identification number. When assembling a data set for analysis, each trip's record was quality checked to ensure that the data collected were reasonable and present. Data were excluded if a trip did not pass the basic quality checks. These included checks on missing GPS epochs, zero mean speeds, or empty data sets. The resulting data set included 29,267 trips.

Results

The range of mean speeds for the 29,267 trips was 0.01 mph (0.02 kph) to 85.1 mph (136.9 kph). The mean speed in the sample was 31.2 mph (50.2 kph), and the median 29.4 mph (47.3 kph). The distribution of average trip speeds can be seen in Figure 2. While this distribution appears to be bimodal, the bimodality coefficient (b = 0.45) of the distribution showed that the distribution was unimodal (SAS Institute Inc, 2012). Based on this, subsequent statistical tests on the distribution were carried out without concern that would stem from performing statistical tests on a non-unimodal distribution. The statistical analysis using the General Linear Model found that there was no significant difference between mean trip speeds by Motorcycle Type, Gender or Gender X Motorcycle Type.

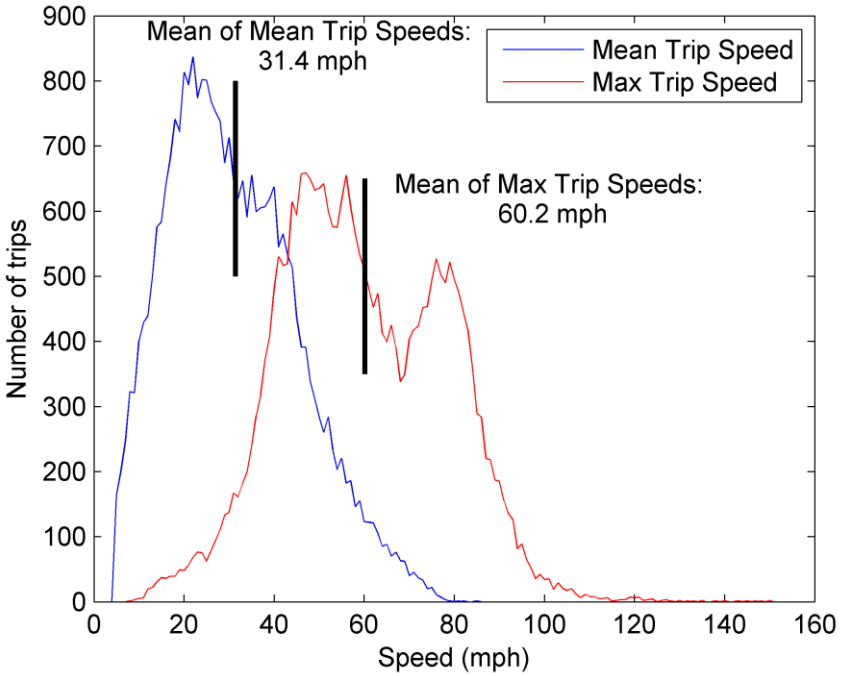

Figure 2: Distributions of mean and maximum trip speeds with a bin size of one mph

When examining the maximum trip speed, the mean of the maximum trip speeds was 60.2 mph (96.8 kph) and the median of the maximum trip speed distribution was found to be 58.3 mph (93.8 kph). The range of maximum trip speeds was 8.7 mph (14.1 kph) to 150.2 mph (241.4 kph). Four participants were recorded riding at speeds in excess of 140 mph, some of them multiple times. In an attempt to determine if the distribution was bimodal, the Bimodality Coefficient was found to be (b = 0.09), and thus is classified as unimodal. An analysis using the General Linear Model was performed with Maximum Trip Speed as the dependent variable and Motorcycle Type, Gender, and Motorcycle Type X Gender as the independent variables. The analysis shows no statistical difference between Motorcycle Type, Gender, or Gender X Motorcycle Type. The distribution of maximum speeds can be seen in Figure 2. Additionally the means of maximum trip speeds by motorcycle type can be seen in Table 1.

Table 1: Means of Mean and Max Trip Speeds

	Mean Trip Speed		Maximum Trip Speed	
Motorcycle Type	Mean (mph)	SE (mph)	Mean (mph)	SE (mph)
Cruiser	28.58	2.92	56.09	4.29
Sport	33.09	4.12	68.43	6.05
Touring	35.01	1.97	60.14	2.89

Discussion

There was no statistical difference in the mean trip speeds observed, when compared by motorcycle type or gender. It may be the case that while the mean trip speeds of the three motorcycle types are the same, that the actual speed characteristics may still vary greatly. Due to the naturalistic nature of the riding data, the speed measurements were collected across different types of roads, as well as in urban and non-urban environments. Riders' speed selection, and thus mean trip speeds may vary significantly depending on the roadway environment.

There is no statistically observable difference between comparison groups in terms of maximum speeds. This study begins to provide objective understanding of travel speeds, both means and maximums. It is anticipated that more targeted analysis will provide useful clarification around speed choices. Even though there were no observable differences in mean or maximum speed between motorcycle types or genders, there will likely be informative differences on some measure that remains to be quantified. Mean or maximum trip speed are only two of many possible measures for quantifying speed. For example, geospatial data combined with the naturalistic data will permit exploration of mean speed in specific riding contexts, such as on controlled and non-controlled access roads, urban versus non-urban riding, and speed relative to surrounding traffic. Previous work has used variation from average traffic speed as a metric for speed deviation (Solomon, 1964). This could be an interesting focus for future work in the field of motorcycle safety. Examining the nature of these variations is another possible approach to reveal differences that affect rider safety.

Summary

With a mean trip speed of 31.2 mph, motorcycle mean speeds in this sample were slightly higher than those of normal light passenger cars (29 mph or 46.7 kph), yet consistent with the pre-crash traveling speeds found in both MAIDS and the Hurt report (Association of European Motorcycle Manufacturers, 2004; Dingus et al., 2006; Hurt, Ouellet, & Thom, 1981). The extreme cases of maximum trip speed are higher than would be expected from passenger vehicles, however the means of the maximum speeds are not at levels which would be considered extreme, and are certainly well under posted interstate speed limits.

The study of motorcyclist speed selection offers insight into the different speeds at which groups of motorcyclists ride. While no statistical differences were found between the maximum or average speeds of groups of motorcyclists who rode different motorcycle types, basic descriptive statistics were found that offer a view into the speed behavior of motorcyclists. The results described motorcycle riding speeds from a wide array of riders belonging to various demographic groups and riding different kinds of motorcycles. The data set also contains a wide array of speed choices, from slow trips to trips with speeds well above any posted speed limit in North America. By describing this data set, a groundwork for future work into the exploration of motorcyclist speed behavior has been established.

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