USE OF INSTRUMENTED MOTORCYCLE TO MEASURE THE EFFECTIVENESS OF MALAYSIAN RIDER TRAINING: A PILOT STUDY

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Summary: A pilot study used an instrumented motorcycle to evaluate riding performances of Malaysian learner riders graduating from rider training and licensing program. 105 participants were asked to ride the instrumented motorcycle along a predefined route (mean 8 KM) in a mixed traffic environment. Period of turn signal activation and deactivation, maneuvering speed and deceleration of participants at unsignalized T junctions were measured as riding performances. Significant differences between male and female riders in responding to oncoming vehicles at the junctions were observed. Significant effects of age were also found in period of turn signal activation and maneuvering speed. Implications for current rider training are discussed.

INTRODUCTION

Motorcyclists have been reported by many studies as the highest risk group in traffic due to their involvement in road crashes and the subsequent number of fatalities (e.g., Horswill and Helman, 2001; Clarke et al., 2004). In Malaysia, About 48% of vehicle populations are motorcycles with yearly average of 468,054 new motorcycles registered from 2005 to 2009 (RTD, 2011). In 2009, total motorcyclist fatalities were 4,067 or 60% of total recorded road fatalities (RMP, 2010). This figure represents an increase of 9% in fatalities from 2002 data.

Study by Pang concluded that motorcycle casualties on Malaysian roads are mainly young, novice riders with less than 3 years of riding license and mostly males (Pang et al., 2000). This trend continues until recently where 2008 accident data shows that young motorcyclists (aged 16-30) contribute to 48% of motorcyclist fatalities (RMP, 2010). Lack of experience and poor riding skills are two factors that are believed to be strongly related to crash involvement of young and novice riders (eg: Norghani et al., 1998). In addition, a study by Haworth found that risk-taking contributes to high fatality rate of moped riders (Haworth, et al., 2009).

One particular measure to enhance riding skills and risk avoidance is through graduated driver and rider license program. In 2001, a literature review by Christie suggests that increased supervision and graduated licensing for novice drivers can make a great impact on road safety (Christie, R., 2001). Graduated driver license (GDL) was found to be an effective measure in reducing rate of fatalities among young road users (eg: Ulmer et al., 1999, Foss et al., 2001; Shope et al., 2003; Dee, Grabowski & Morrisey, 2005).

In Malaysia, graduated rider licensing program is controlled by road transport department (RTD) which approves the rider license. In the current program, the practical session and test are conducted on a closed circuit inside the compound of driving institutes. The same circuit designed is used in all driving institutes in Malaysia. The design of the circuit was not intended to mimic the actual road but rather as a closed motorcycle training ground with elements of slalom, balancing bridge, roundabout and obstacles. In general, learner riders in Malaysia will not have the experience riding on actual road during the graduated licensing program. This pilot study investigated the readiness of learner riders to ride on the road by assessing their riding performance on actual road environment after completing the graduated licensing program.

METHOD

Participants and Setting

Total of 105 learner riders (62 males and 43 females) participated in the experiments with age ranged from 16-42 years old (mean 21.2; *SD* 5.8). The participants were recruited in six randomly selected driving institutes from the state of Malacca and Negeri Sembilan. The main criterion for participation was that the participants had completed all practical training. These participants were in their last stage of rider training before being tested for Probationary Rider License. Each participant was given a tour in a sedan car to familiarize with the experiment route. The familiarization of the route was emphasized so that participants could ride the motorcycle as natural as possible during the experiment. During each experiment run, participants were escorted by another motorcycle (engine displacement 100 cc) ridden by a licensed and experienced rider from the experimenter team for emergency assistance and other unexpected events. The escort motorcycle was positioned behind the participants at all time and the rider was told not to trail the participants too closely to avoid influencing their riding performances. Participants were given a safety helmet for their participation and were asked to fill in details about their age and gender.

Instrumented Motorcycle

A stock 2007 Honda Wave 100 cc (typical motorcycle used in Malaysia) was equipped with sensors, high resolution miniature (1/3”) bullet cameras, digital video recorder (DVR) and data acquisition system to measure and record riding performances and behaviors simultaneously and unobtrusively. A forward view camera captured image of the vehicle in front, markings on the road and road signs. Another camera was used to capture the rider’s face and hand position. A third camera was used to capture the images of following vehicles and area directly behind the motorcycle. The DVR system use a data overlay feature to stamp the recording time and date onto the recorded video continuously to an accuracy of 0.01s.

A data acquisition system (DAS) with 15 channels capable of capturing real time measures of riding performances was used to log data from sensors and electrical signal (analog) from the motorcycle. Motorcycle velocity (in kilometer per hour, km/h) was measured using a speed sensor mounted on the rear wheel. A brake pressure sensor and steering angle sensor were used to measure the braking and the degree of handle rotation. The DAS was also connected to specific electrical analog input (in volt, v) to measure turn signal activation and the pressing of brake pedal. Apart from cameras, all of the DAS and DVR system hardware were concealed inside the helmet compartment at the rear of the motorcycle.

Data Coding and Analysis

Video recording and sensor measurement were matched to extract the details of riding events (e.g., activating turn signal for certain time period when turning into a junction). All recordings of data were displayed and analyzed using a software capable of plotting the sensors output to 0.001s time frame. Interpretation and conclusion of riding performances were made by comparing the video footage to sensors data. The accuracy of the software has minimized the time needed to code the data compared to traditional instrumented vehicle experiment where video was coded manually. A right turn maneuver in one particular unsignalized T junction was chosen from each experiment run and the riding behaviors of participants during the event were analyzed.

The instrument successfully captured the data except for nine cases where video recordings and sensor outputs were not synchronized. Another two sets of data were not usable because only one channel of the video was captured. Synchronization glitch and loss of video output were suspected to be caused by loose power connection due to extreme vibration sustained by motorcycle during each ride. Also, due to unsatisfactory image captures of the participants' facial expression, analyses of the participants glance were not carried out as originally planned. In some cases, the participants' faces were totally blurred out especially during afternoon session. In total, 94 usable sample data were coded and analyzed. Four observations (0.04% of the sample) were dropped from the dataset after being identified as outliers. In these observations, the participants (2 males, 2 females) did not deactivate the turn signal for at least 28s. Based on the video recordings, they were assumed to have forgotten to deactivate the turn signal.

Riding Performance Measures

During the right turn events, period of signal activation and deactivation, maneuvering speed and deceleration were defined as the measures of riding performance. Turn signal activation was calculated from the start of signal activation until the right turn maneuver into the junction. In the event where participants fully stopped before the right turn maneuvering, turn signal activation was calculated up until the time they stopped. Turn signal deactivation was calculated from the point when participants completed the right turn maneuver until they turned the signal off. Maneuvering speed was defined as the speed when participants started the right turn maneuver. Deceleration was calculated from the start of signal activation (speed A) to the point where participants started the right turn maneuver (speed B) or when they stopped.

RESULTS

Effects of Oncoming Vehicles

The riding performances of participants were compared when there were presences of oncoming vehicles at junctions. Oncoming vehicles were defined as the presence of any vehicle from the opposite direction in the footage captured by the forward view camera from the point of signal activation to the point when participants maneuver into the junctions.

Gender Difference. In the group of female riders (n = 35), Mann-Whitney U test revealed no significant difference in all riding performances (See Table 1).

Table 1. Mann-Whitney U test result of female riding performances

Riding performances	Mann-Whitney U test	Median	
		No oncoming vehicles (n = 18)	With oncoming vehicles (n = 17)
Activation Period (s)	U = 132, Z = -0.957, p = 0.339	15.0	12.0
Deactivation Period (s)	U = 122, Z = -1.030, p = 0.303	4.0	5.0
Maneuvering Speed (km/h)	U = 98, Z = -1.836, p = 0.066	19.7	14.1
Acceleration (m/s^2)	U = 103, Z = -1.429, p = 0.153	0.5	0.6

However, in the group of male riders (n = 55), Mann-Whitney U test revealed significant effects of oncoming vehicles on period of signal activation and maneuvering speed (see Table 2).

Table 2. Mann-Whitney U test result of male riding performances

Riding performances	Mann-Whitney U test	Median	
		No oncoming vehicles (n = 31)	With oncoming vehicles (n = 24)
Activation Period (s)	U = 167, Z = -3.497, p < 0.001	10.0	16.0
Deactivation Period (s)	U = 355, Z = -0.293, p = 0.770	4.0	4.0
Maneuvering Speed (km/h)	U = 98, Z = -3.228, p < 0.05	21.4	14.1
Acceleration (m/s^2)	U = 103, Z = -0.017, p = 0.986	0.7	0.6

Male riders activated the turn signal longer when oncoming vehicles were present. This finding could suggest that male responded to the oncoming vehicles (potential hazards) by switching the turn signal on longer before maneuvering. Even though this study could not determine whether ample and sufficient signaling was given to the oncoming vehicles, gender difference was obvious in the way learner riders responded to hazard at junctions. Interestingly, female riders activated the signal longer when there were no oncoming vehicles. Significant differences were also observed in male median maneuvering speed. Male riders reduce their speed significantly when oncoming vehicles were present. More in depth research on hazard perception and responding of learner riders will be beneficial to further investigate the finding of this study. Figure 1 displays the estimated means to 95% confidence intervals of activation period and maneuvering speed when oncoming vehicle was considered. No significant differences were found in deactivation period and deceleration for both male and female.

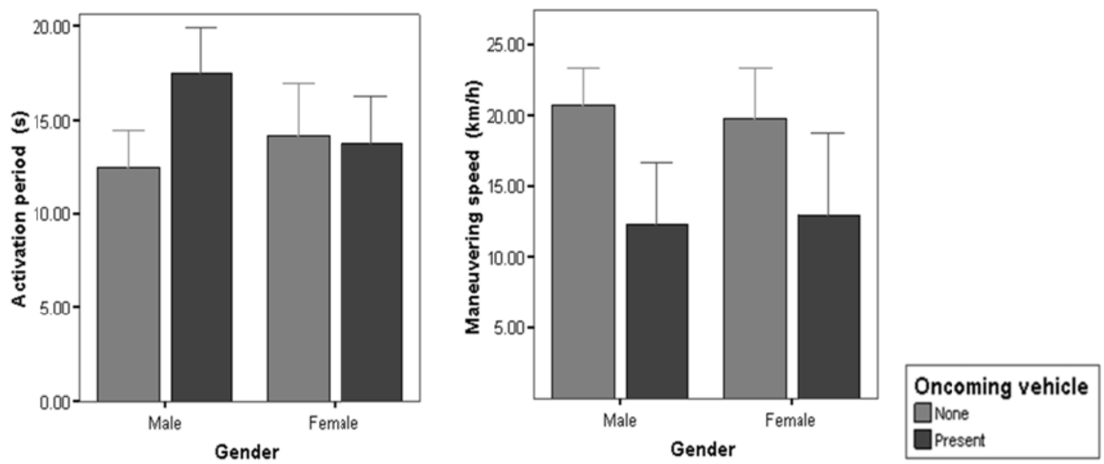

Figure 1. Mean values comparing male and female participants

Age Difference. Performance of participants were compared between younger (25 and below) and older (26 and above) group to investigate age factor. In the younger group (*n* = 76), an independent-samples t-test revealed a significant difference in the period of signal activation when there were oncoming vehicles (*M* = 15.89, *SD* = 5.57) and no oncoming vehicles (*M* = 12.61, *SD* = 5.34) present; t (75) = 2.61, $p < 0.05$. We found that in presence of oncoming vehicles, younger riders activated the signal significantly longer before making a turn. Another significant difference was found in maneuvering speed when there were oncoming vehicles (*M* = 13.13, *SD* = 10.73) and no oncoming vehicles (*M* = 20.64, *SD* = 7.0) present; t (74) = -3.68, $p < 0.01$. Younger riders reduced their speed significantly before maneuvering into the junctions when there were oncoming vehicles. No significant differences were found in deactivation period and deceleration. In the older group (*n* = 14), a Mann-Whitney U test revealed no significant difference for all riding performances. The result could be more meaningful if the sample was larger. Figure 2 displays the estimated means to 95% confidence intervals of younger and older riders' performances when oncoming vehicle was considered.

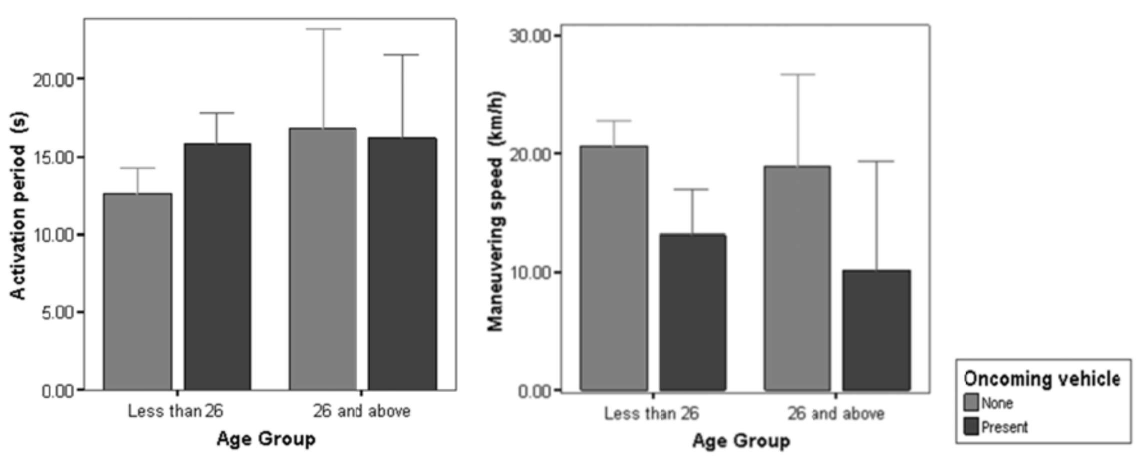

Figure 2. Mean values comparing participants' age group

DISCUSSION

The primary aim of this study was to evaluate the riding performance of the learner riders unobtrusively using instrumented motorcycle after they have completed the Malaysian graduated rider training and licensing. Another purpose was to study the feasibility of using small motorcycle as an instrumented vehicle. The analysis focused on participants' riding performances at junctions and overall use of speed. It was found that male and female riders behave differently in turn signal usage when there were oncoming vehicles (hazards) at junctions. The period of turn signal activation did not differ significantly in the female group as compared to male. Significant decreases in maneuvering speed were also observed in the male group. These findings raised a question whether the learner riders' hazard perception and responding were improved during training.

An evaluation on the relationship between age and period of signal activation revealed that younger riders (25 and below) activated the turn signal significantly longer when there were oncoming vehicles at junctions. They also reduced their speed significantly before maneuvering. These were not observed in the group of older riders. Assuming that these riders had similar level of riding experience, the result suggested that age is also a significant factor in hazard perception and responding of learner riders. Thus, age and gender are factors that could be explored in future research to find the most suitable improvement of rider training and licensing program.

On the instrument side, we found that the use of small instrumented motorcycle was viable in motorcycle naturalistic study although some critical improvements are needed for more in depth research. Possible modification will be to add laser rangefinder for lane keeping and following distance studies. Additionally, more advanced sensors are needed in detailed braking studies. We nonetheless are of the opinion that instrumented motorcycle is not suitable to study riders face expressions due to limited camera mounting space and sun glare. The use of simulator will be more fitting for this purpose.

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