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Amber Position Lamp as Daytime Running Light for Motorcycle

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Abstract. The ability for motorcycle to be detected is an important aspect in preventing crash involving motorcycle which is the most dominant vehicle in emerging countries. Widely referred as conspicuity, the crash factor is appropriately addressed by the introduction of mandatory daytime running light (DRL) law and is usually a success story in many parts of the world. In 2011, there was a motion introduced in the 64th session of the United Nations Working Party on Lighting and Light-Signalling (GRE) for amber position lamp (APL) to be made mandatory on motorcycle as additional measure to improve motorcycle conspicuity. An experiment was designed to evaluate conspicuity level of motorcycle headlamp and tail lamp equipped with APL over motorcycle with present DRL setting (baseline). 15 participants simultaneously rated both motorcycles which are placed in parallel, at different distances and times of day. Motorcycle with APL was noticeably better detected from rear than front at 50 meter and 100 meter distance, as well as during night time and twilight. Median conspicuity level between night time and daytime and between night time and twilight was also distinctly different for rear lamp. These findings suggest that APL introduction could enhance motorcycle conspicuity especially for rear lamp position.

Introduction

Motorcycle casualties are a growing concern in Malaysia, with the motorcycle users representing more than half of the total traffic fatalities each year with an average of 2% increment for the last ten years [1]. In addition to that particular note, motorcyclists have consistently outnumbered the other road users for the past two decades [1]. The trend of motorcycle fatalities is increasing and shows no sign of declining in the near future [2]. One of the main factors associated with the high crash rates among motorcyclists is conspicuity issue i.e. low motorcycle conspicuity, or the inability of the motorcyclist to be seen by other road users [3]. Based on the study, conspicuity-related crashes which were classified as "any crash involving motorcycles moving straight or turning with the right of way when pedestrians and other vehicles cross their paths"; constitute about 26% of the total fatalities.

Over the years, the rates of conspicuity-related crashes in many countries have declined; largely contributed by the introduction of mandatory daytime running light (DRL) legislation for motorcycles. Practical solution in term of automatic headlight upon ignition was carried out with support from manufacturers via standard fitment to increase conspicuity aspect of motorcycle. The impact of such legislation is evident in the USA whereby 13 percent of reduction in motorcycles crashes was recorded [4]. In local context, DRL campaign and regulation in Malaysia since July 1992 has resulted in 22 percent decrease in motorcycle conspicuity related crashes [3]. Several studies from other countries also reported positive impact of the legislation in reducing crash casualties.

Conspicuity of motorcycle is commonly associated with one of these three definitions; the ability for motorcycle to be detected when the location is known (visibility), when it has to be searched within a scene (search conspicuity), and when it is not deliberately searched although the observer is viewing the scene (attention conspicuity) [5]. Usually observer is able see motorcycle clearly if the vehicle is expected to appear from certain direction. However, the characteristic of motorcycle

riding without dedicated lane has diminished anticipation by other road users especially from peripheral visual field. Therefore, DRL is designed to enhance motorcycle conspicuity and to compensate for the expectation errors of other road users [6].

Nevertheless, efforts are continuously renewed to enhance conspicuity aspect of motorcycles and riders. In 2011, there was a motion in the 64th session of United Nations Working Party on Lighting and Light-Signalling (GRE) for amber position lamp (APL) to be made mandatory on motorcycle [7]. APL was proposed to function in conjunction with DRL to further increase visual sensory perception of the motorcycle. Based on the hypothesis, an experiment was conducted to assess the effectiveness of APL with DRL in enhancing frontal and rear motorcycle conspicuity as opposed to using DRL alone. Furthermore, the effect of time of day and distance are also investigated in the experiment.

Methodology

A sample of 15 participants, 9 males and 6 females were recruited from Malaysian Institute of Road Safety Research. The participants aged between 26 and 52 years with a mean of 34 years. All of them possessed car driving license and had normal or corrected-to-normal vision.

The experiment utilised two Honda Wave 100cc motorcycles positioned in parallel and 3.5 meters apart. APL signal adaptors were fitted to front and rear lamp position of a motorcycle as shown in Figure 1 whereas the other motorcycle maintained normal type of lighting (baseline). The APL adaptor functioned continuously alongside DRL and turned off when direction indicators were activated. New sets of 12 volts battery and bulbs for headlamp and direction indicators were mounted on both vehicles to ensure comparable light intensity.

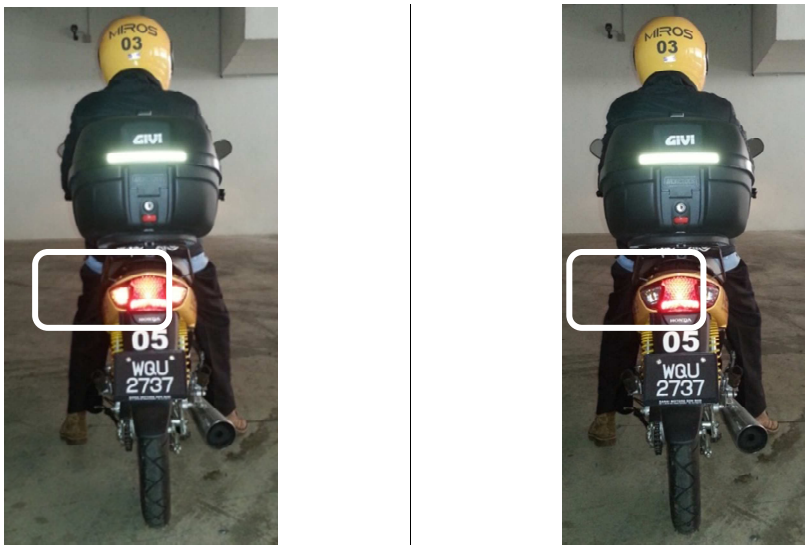

Fig. 1: Rear lamp equipped with APL (left) and the baseline motorcycle (right).

Experimental design. The experiment used independent measures design. The three independent variables were i) time of day (daytime, twilight, or night time); ii) distance (50 meter vs. 100 meter); iii) light position (front lamp vs. rear lamp). These variables were combined to yield a total of 12 conditions.

Procedure. Participants were asked to stand at a specific place, 100 meters distance from the motorcycles, which were positioned in the direction of the participants. The participants were required to assess conspicuity level of both motorcycles and indicate in the form using Likert scale whether they agree the motorcycle with APL is more conspicuous than the baseline. The scales are determined such that score 1.00 indicates APL-equipped motorcycle is more conspicuous than the baseline, 2.00 indicates slight conspicuity advantage towards APL-equipped motorcycle and 3.00 indicates equivalent conspicuity level between the two motorcycles. Scores 4.00 and 5.00 respectively indicates slight and more advantage towards the baseline. The procedure was repeated to satisfy conditions of rear lamp, distance of 50 meter and three sets of time of day.

Data Analysis. The perception of detection for motorcycle equipped with APL as a function of the baseline for each participant was recorded. Medians of motorcycle conspicuity perception were calculated for each participant with variations of experimental variable and condition. Analysis using Mann-Whitney test was used to compare the medians of conspicuity level on each category of time of day, regardless of distance as a function of light position. The test then was repeated for each category of distance, without considering time of day factor. Next, the Kruskal-Wallis test was performed in term of time of day for front and rear lamp separately. Further analysis using yet again Mann-Whitney test was also performed on every combination of time of day variables. All statistical analyses were performed using Statistical Package for Social Science (SPSS) software version 16.0.

Results

Table 1: Medians and P-values of the conspicuity levels for front and rear lamp, according to times of day.

	Median (IqR)		P-value
	Rear	Front	
Night time	1.00 (1.00)	3.00 (0.00)	0.000*
Twilight	2.00 (1.25)	3.00 (1.00)	0.006*
Daytime	2.00 (1.00)	3.00 (1.00)	0.568

Mann-Whitney analysis was performed to determine whether light position had significant effect to participants' perception of conspicuity level based on time of day or distance factors. It was found that regardless of distance, rear light position (median = 1.00) for motorcycle with APL was easier to detect ($p < 0.001$) as compared to front lamp position (median = 3.00) during night time. Similar finding was observed in the experiment for rear lamp (median = 2.00) vs. front lamp (median = 3.00) position when conducted during twilight ($p < 0.01$).

Table 2: Medians and P-values of the conspicuity level for front and rear lamp, according to viewing distances.

	Median (IqR)		P-value
	Rear	Front	
50 meter	2.00 (1.00)	3.00 (1.00)	0.000*
100 meter	2.00 (2.00)	3.00 (0.00)	0.001*

A significant effect of 50 meter distance was observed ($p < 0.001$), corresponding to higher conspicuity level for rear lamp (median = 2.00) rather than front lamp (median = 3.00) for motorcycle with APL. There was also a significant effect of 100 meter distance ($p < 0.001$) with rear lamp (median = 2.00) was easier to detect than front lamp (mean = 3.00) position. These findings were observed without the consideration of time of day factor.

Table 3: Medians of the conspicuity level for rear lamp in groups time of day.

Conspicuity level	n	Median (IqR)	P-value
Night time	30	1.00 (1.00)	0.006*
Twilight	30	2.00 (1.25)	
Daytime	30	2.00 (1.00)	

Analysis using Kruskal-Wallis indicated at least one pair of median conspicuity level for rear lamp between the categories of time of day was significantly different ($H(2) = 10.286$, $p = 0.006$). Subsequent post-hoc analysis (LSD) suggested that median conspicuity level between night time and daytime and between night time and twilight was statistically different. The motorcycle equipped with APL was easier to detect ($p < 0.005$) during night time (median = 1.00) than daytime (median = 2.00) and also ($p < 0.05$) during night time (median = 1.00) than twilight (mean = 2.00). However, distance did not yield any significant effect on the ability for the motorcycle to be detected either for front or rear lamp position.

Discussion and Conclusion

This study indicated a constructive effect of rear APL on perception of motorcycle conspicuity. Generally, the participants agreed that rear APL was better detected during night time and twilight whereas daytime provided almost no difference in conspicuity between motorcycle with APL and normal light configuration. APL improves conspicuity of motorcycle and it is a potential measure to reduce crash casualties involving motorcycle being struck from rear. These findings showed that consideration should be given to introducing APL for motorcycle especially to rear lamp position.

In the experiment, the findings indicated that from rear, motorcycle with APL was easier to be detected than the baseline when sky illumination is low i.e. night time and twilight. During daytime, the retro-reflector on rear light assembly functions upon direct sunlight to provide visibility from rear [8]. Therefore, participant could better observe in night time, the difference made by APL when the stimuli were triggered on the motorcycles.

The effect of distance was also observed because of its direct relationship with motorcycle angular size, as well as with light intensity [9]. Nevertheless, there was no significant effect found presumably because of limitation of viewing distances. 100 meter was the farthest distance that could be utilised in controlled environment at the location of experiment.

With regard to lamp position, rear lamp was easier to detect as compared to front lamp position in almost every level (night time, twilight, 50 meter, and 100 meter) when grouped separately. This was explained by the effect of colour contrast i.e the combination of rear lamp with red and amber light on rear light assembly was more conspicuous particularly when accentuated by dark environment [10].

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