



Errors in judging the approach rate of motorcycles in nighttime conditions and the effect of an improved lighting configuration

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ABSTRACT

One of the key contributory factors for accident involvement is misjudgment of approach speed (Department for Transport, 2010). Past research has indicated that individuals can use the rate of visual looming in order to the judge time to passage (TTP) of approaching vehicles, and that smaller vehicles loom to a lesser extent than larger vehicles (e.g., Horswill et al., 2005). However, the judgment of TTP in nighttime conditions has received little attention. This paper explores drivers' abilities to make judgments of motorcycles and car approach speeds in nighttime driving conditions, when only the headlights are visible, as well as the effectiveness of a tri-headlight configuration on the accuracy of motorcycle speed judgments. Results showed that individuals were significantly more accurate at judging the speed of two car headlights compared with the standard solo headlight motorcycle. However, the inclusion of a tri-headlight formation on a standard motorcycle frame significantly improved these judgments. A further investigation demonstrated that tri-headlight configurations with separation between headlights on the horizontal and vertical axes are most effective for yielding accurate speed judgments. The implications of the results for road safety and motorcycle design are discussed.

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1. Introduction

In 2008, the volume of motorcycle traffic in the UK had increased by approximately 44% compared with figures from the 1990s (Department for Transport, 2010). Furthermore, despite accounting for just 1% of all road users in the United Kingdom, motorcyclists accounted for 19% of all road traffic fatalities and 21% of all serious road injuries (Department for Transport, 2010). In combination these figures suggest that motorcyclists represent the automobile group that is at the greatest risk of injury.

A large percentage of the motorcycle literature has focused on the error classification of "Look But Fail To See" (LBFTS) accidents, where an individual pulls out into the path of an oncoming motorcyclist and claims not to have seen them approaching (Herslund and Jørgensen, 2003). In response, a number of studies have stressed the need to improve the conspicuity of the motorcycle and motorcyclist (Williams and Hoffman, 1979; Olson et al., 1981; Hole et al., 1996; Rößger et al., 2011). However, while statistics have indicated that the leading contributory factor to accident involvement is a failure to look properly, the second most common contributory factor

is a failure to correctly judge the path or speed of another vehicle (Department for Transport, 2010).

When a driver is at a junction waiting to pull out, they need to judge whether the time to passage (TTP) of the approaching vehicles on the main carriageway is sufficient to allow them to pull out and join the line of traffic. If asked about how they are making those judgments, most drivers would say that they are judging the distance of oncoming vehicles and their speed. Distance and speed, however, are metric properties of the 3D scene that are not directly available to the observer (Gibson, 1979). Distance can be inferred from cues such as height in the scene, scaled by eye-height, but this is very unreliable in natural road contexts. For example, a vehicle that is travelling at 30 mph and situated 65 m away from the observation point will have a TTP of 5 s. However, an increase or decrease in the slope of the road by just 1° could mean that this depth cue would indicate that the vehicle is approximately 266 m away or just 37 m away respectively. Additionally, cues to absolute distance such as binocular disparity are not effective for the distances typically encountered in road scenes (Tresilian et al., 1999). The most reliable cue to distance for an approaching vehicle is its optic size on the retina, $\theta(t)$, whereas the rate of change of optic size, $\dot{\theta}$ is correlated with speed of approach, and the ratio of the two can indicate TTP without the requirement to judge actual distance, $z(t)$ or speed, $v(t)$ (Lee, 1976):

$$TTP = \frac{z(t)}{v(t)} = \frac{\theta(t)}{\dot{\theta}(t)} \quad (1)$$

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