



## Using reflective clothing to enhance the conspicuity of bicyclists at night

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### ABSTRACT

Bicycling at night is more dangerous than in the daytime and poor conspicuity is likely to be a contributing factor. The use of reflective markings on a pedestrian's major joints to facilitate the perception of biological motion has been shown to greatly enhance pedestrian conspicuity at night, but few corresponding data exist for bicyclists. Twelve younger and twelve older participants drove around a closed-road circuit at night and indicated when they first recognized a bicyclist who wore black clothing either alone, or together with a reflective bicycling vest, or a vest plus ankle and knee reflectors. The bicyclist pedalled in place on a bicycle that had either a static or flashing light, or no light on the handlebars. Bicyclist clothing significantly affected conspicuity; drivers responded to bicyclists wearing the vest plus ankle and knee reflectors at significantly longer distances than when the bicyclist wore the vest alone or black clothing without a vest. Older drivers responded to bicyclists less often and at shorter distances than younger drivers. The presence of a bicycle light, whether static or flashing, did not enhance the conspicuity of the bicyclist; this may result in bicyclists who use a bicycle light being overconfident of their own conspicuity at night. The implications of our findings are that ankle and knee markings are a simple and very effective approach for enhancing bicyclist conspicuity at night.

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### 1. Introduction

Walking and bicycling are essential modes of travel and are promoted for their environmental, economic and health benefits. However, these modes of transport are not necessarily safe, and a review of data from a range of countries found that pedestrian and bicyclist fatalities account for nearly a third of all road users killed or seriously injured in road traffic crashes (Kwan et al., 2002). Through an analysis of Australian crash databases, Garrard et al. (2010) highlighted the vulnerability of Australian bicyclists by pointing out that fatality risk rates were between 4.5 and 18.6 times higher (per distance traveled), and injury risk rates 12.9 – 33.5 times higher for bicyclists than for car occupants.

Night-time bicycling is more dangerous than bicycling in daylight. For example, in a study of Swedish cyclists, 40% of bicyclist fatalities were reported to occur at night despite much lower exposure rates than in the day (Jaermark et al., 1991). A high proportion of bicycling fatalities are related to problems with frontal rather than rear conspicuity (Gale and Cairney, 1998). Motorists involved in collisions with bicyclists at night often state that they did not see the bicyclist until it was too late to stop in time (Blomberg

et al., 1986; Räsänen and Summala, 1998). Crashes are also common when bicyclists expect drivers to give them right of way but drivers fail to yield. In many instances, this occurs because drivers do not see the bicyclist, either because they do not scan the road appropriately or because bicyclists are insufficiently conspicuous to drivers at night.

There is considerably more data on pedestrian than bicyclist conspicuity. Although the extent to which the data on enhancing the conspicuity of pedestrians generalizes to bicyclists is unknown, one approach seems particularly promising. There is considerable evidence that the perceptual phenomenon known as biological motion or biomotion – our visual sensitivity to patterns of human motion – can be utilized to enhance the night-time conspicuity of pedestrians (Balk et al., 2008; Blomberg et al., 1986; Owens et al., 1994; Wood et al., 2005). By placing inexpensive retroreflective markers on pedestrians' major joints (including ankles, knees, wrists, elbows, shoulders, etc.) that move during normal gait, drivers recognize the presence of pedestrians more frequently and at much longer distances. This is in sharp contrast to the relatively small benefits associated with the more typical practice of placing retroreflective material only on the chest, as in a retroreflective vest (Balk et al., 2007; Wood et al., 2005).

A key question is the extent to which these conspicuity advantages of biomotion reflective markings generalize to bicyclists.

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