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LED strips for pedestrian conspicuity: A driving simulator study investigating the experiences of younger and older drivers during daylight and after dark conditions

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Introduction

Vulnerable road users (VRUs), such as pedestrians and cyclists, are disproportionately affected by road traffic crashes, resulting in casualties and short and long-term injuries (World Health Organisation, 2023). Many driver factors (e.g., age, vision problems, distraction) and environmental factors (e.g., limited lighting, infrastructure, adverse weather conditions) are thought to contribute to pedestrian fatalities (Rella Riccardi et al., 2023) and the conspicuity of vulnerable road users (Wood, 2023). To tackle this, different interventions have been developed to improve the conspicuity of VRUs, such as using reflective or self-luminous devices (e.g., LED strips) to reveal biomotion (e.g., Wood, 2023). It is, therefore, important to understand how drivers interact with VRUs and how they perceive VRU safety interventions such as bio-motion markers to enhance the conspicuity of VRUs. This study investigated the experiences of younger and older drivers when interacting with pedestrians using LED strips in a driving simulator during daylight and after dark conditions.

Research methodology

The study was conducted with 23 younger drivers (Mdn_{age} = 22, Min_{age} = 21, Max_{age} = 25, 11 male) and 19 older drivers (Mdn_{age} = 64, Min_{age} = 60, Max_{age} = 73, 18 male). A mixed design approach was applied with five within-participants factors (*secondary task engagement*: no task, 2-back task; *pedestrian position*: no pedestrian, standing pedestrian, walking pedestrian; *the presence of LED bio-marking*: with and without LED strips on the ankles/wrist; *the presence of a zebra crossing*: with crossing, without crossing; and *ambient lighting condition*: simulating daylight, after dark) and one between-participants factor (*age*: younger, older).

After arrival at the experiment site, participants were briefed about the experiment (Ethics approval: AREA FREC 2023-0446-395). They first completed a practice drive, experiencing each of the events under daylight and after dark conditions. After the practice period, participants completed two drives (one in daylight and one after dark). Participants encountered 40 different events (e.g., a pedestrian equipped with LED strips standing on a marked zebra crossing) in each 25-kilometre drive. Drivers were asked to drive as they normally would in the real world, considering the speed limit and other traffic rules. After the experimental drives, participants completed a survey focusing on their acceptance of the LED strips (across daylight and after dark conditions), adapted from Van der Laan et al. (1997), and also one on the perceived ease of detecting pedestrians. For perceived ease, each of the four pedestrian types (standing with/without LED strips, walking with/without LED strips) was evaluated separately

during daylight and after dark (referred to as night-time) driving. The experimental session lasted two hours, and participants were paid £40 for their voluntary participation.

Results

Differences in drivers' acceptance of LED strips were analysed with a 2 (acceptance: usefulness, satisfying) x 2 (lighting: daylight, after dark) x 2 (age: younger, older) mixed factors ANCOVA. Interacting with pedestrians using LED strips was perceived to be more useful than satisfying (p_{bonf} = .003, d = .37), and overall acceptance was higher for night-time driving than day-time driving (p_{bonf} < .001, d = -1.19).

Perceived ease of detecting pedestrians was analysed with a 2 (lighting: daylight, after dark) x 2 (LED strips: without, with) x 2 (pedestrian position: standing, walking) x 2 (age: younger, older) mixed factors ANCOVA. Younger drivers reported recognising pedestrians more easily than older drivers (p_{bonf} = .037, d = .39). The interaction effect of lighting by LED strips showed that pedestrians without LED strips during after dark condition were the most difficult to see and pedestrians with LED strips during daylight and after dark conditions were the easiest.

Discussion and conclusions

Supporting the findings of Wood (2023), both younger and older drivers found interacting with LED strips with pedestrians to be particularly useful at after dark condition, helping them to identify pedestrians more easily. From the drivers' perspective, LED strips were an acceptable and beneficial intervention to increase pedestrian conspicuity in limited lighting conditions.

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