ABSTRACT

EFFECTS OF NOVEL EHMIS ON PEDESTRIAN-VEHICLE INTERACTIONS

Dissertation for the degree of Doctor rerum naturalium
submitted to the School of Science at Technische Universität Dresden
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Effective communication is crucial for safe and efficient interactions in traffic. As automated vehicles (AVs) become increasingly common, understanding how they should communicate with other road users, particularly vulnerable ones like pedestrians, has sparked a lively debate. A key point of contention is whether AVs should be equipped with novel external human-machine interfaces (eHMIs) to convey vehicle intent to nearby road users. While numerous designs have been proposed and evaluated, the broader effects of eHMIs on pedestrian-vehicle interactions remain insufficiently understood.

This thesis addresses this gap through five experimental studies grounded in psychology, communication theory, information theory, human-computer interaction, and behavioral economics, all framed within a holistic systems science perspective. The studies explored the complex interdependencies between eHMI-equipped vehicles, pedestrians, and the traffic context.

Study I demonstrated that pedestrians' comprehension of eHMI messages is significantly influenced by the situational context that surrounds the pedestrian-vehicle dyad. Study II found that while eHMIs can significantly influence pedestrian behavior (such as crossing decisions) conventional communicative cues (like vehicle speed and distance) remain crucial. Thus, eHMIs should be understood as complementing, rather than replacing, familiar cues. Study III emphasized the importance of aligning eHMIs with pedestrians' expectations by highlighting the potential for misinterpretations when they do not.

Studies IV and V explored the long-term implications of introducing eHMIs into traffic. They found that exposure to eHMIs can reshape pedestrian behavior and perceptions of traffic interactions, including those involving conventional human-driven vehicles. The extent of these effects depended on the prevalence of eHMIs in traffic. Study V revealed that individual differences play a crucial role in behavioral adaptations to an increasing presence of eHMIs, highlighting the need to design eHMIs that accommodate the diversity of road users.

In summary, this thesis demonstrates that eHMIs can effectively communicate vehicle intent but emphasizes their transformative potential for pedestrian-vehicle interactions overall. The findings underscore the critical role of context in shaping the effects of eHMIs. They advocate for a holistic perspective in future eHMI research, design, and policy to contribute to a seamless integration of AVs into the traffic system.