



# The effects of on-street parking and road environment visual complexity on travel speed and reaction time

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## ABSTRACT

On-street parking is associated with elevated crash risk. It is not known how drivers' mental workload and behaviour in the presence of on-street parking contributes to, or fails to reduce, this increased crash risk. On-street parking tends to co-exist with visually complex streetscapes that may affect workload and crash risk in their own right. The present paper reports results from a driving simulator study examining the effects of on-street parking and road environment visual complexity on driver behaviour and surrogate measures of crash risk. Twenty-nine participants drove a simulated urban commercial and arterial route. Compared to sections with no parking bays or empty parking bays, in the presence of occupied parking bays drivers lowered their speed and shifted their lateral position towards roadway centre to compensate for the higher mental workload they reported experiencing. However, this compensation was not sufficient to reduce drivers' reaction time on a safety-relevant peripheral detection task or to an unexpected pedestrian hazard. Compared to the urban road environments, the less visually complex arterial road environment was associated with speeds that were closer to the posted limit, lower speed variability and lower workload ratings. These results support theoretical positions that proffer workload as a mediating variable of speed choice. However, drivers in this study did not modify their speed sufficiently to maintain safe hazard response times in complex environments with on-street parking. This inadequate speed compensation is likely to affect real world crash risk.

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## 1. Introduction

On-street parking is frequently found in urban retail road environments, as it is convenient for shoppers and does not require the space used by a dedicated parking lot. Unfortunately, on-street parking is also associated with increased crash risk compared to roads of the same category without on-street parking (Greibe, 2003; Pande and Abdel-Aty, 2009; Roberts et al., 1995). It is important to understand the reasons behind this elevated crash risk in order to design appropriate countermeasures.

At a practical level, one potential reason for increased crash risk is narrowed road width. Parked vehicles leave less space for travelling vehicles, forcing them to drive closer to vehicles in the next lane (which may be travelling in the opposite direction). Similarly, narrow roads are associated with shifts in lateral position closer to the centreline (Lewis-Evans and Charlton, 2006), as well as higher crash rates than standard roads (Greibe, 2003). Greibe's (2003) modelling research found that both parking and road width were significant predictors of crash rates on road links, and that the contribution of

parking to increased crash rates was larger than that of road width. This implies that factors other than road width must underlie the higher crash risk when on-street parking is present.

In complex urban environments, drivers must monitor movements of both pedestrians and vehicles. Parked cars may obstruct the view of the road ahead, making it more difficult to see crossing pedestrians. Parked cars may also suddenly become moving cars, and rejoin the traffic stream. It has been found that the number of (moving) vehicles in a scene negatively affects situation awareness and hazard avoidance (Gugerty, 1997), and parked vehicles may contribute to this effect, as they require monitoring to determine whether or not they are moving. The presence of parked cars therefore increases the uncertainty, mental load and potential risk associated with the road environment.

It would be surprising if drivers were oblivious to these changes and did not adapt their behaviour accordingly. In fact, traffic observations in residential areas have found that high parking densities correlate with slower speeds (Daisa and Peers, 1997). Psychological research offers further insight into this adaptation. Chinn and Elliot (2002) asked drivers questions about sketches of road scenes with various features, and found that on-street parking increased ratings of tension and decreased the perceived safe speed. This is consistent with theories of driver behaviour that maintain drivers reduce their speed when they perceive a road environment as being risky,

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