Differences in drivers' perception and interactions with boom-controlled rail level crossings in urban versus rural environments

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Abstract

Efforts to improve rail level crossing (RLX) safety are hampered in part by the sheer number of RLXs; approximately 10,500 in Australia, with diverse characteristics. The plethora of RLX environments means a single standard RLX design may not be appropriate, since the same infrastructure could generate distinct interactions depending on its surrounding context. Using instrumented vehicles, we compared drivers' perceptions and interactions with boom-controlled active RLXs in two vastly different on-road environments: urban and rural. Results suggest that although urban RLX environments are more complex and demanding, drivers in rural areas are more likely to perceive RLXs as hazardous.

Background

RLXs continue to pose a substantial safety risk within road and rail networks. In Australia alone there are approximately 10,500 RLXs on public roads and paths (RISSB, 2014), which vary in both their infrastructure and the surrounding environment. Our previous research has revealed differences in drivers' behavior and expectations between crossings with different infrastructure when comparing actively-controlled crossings (i.e., boom barriers, lights and bells) to passively-controlled crossings (i.e., Stop or Give Way sign; Lenné et al., 2013; Salmon et al., 2013, 2014). However, the plethora of RLX environments means there may also be functional differences in crossings that have similar infrastructure with different surrounding context, e.g., in suburban Melbourne vs. regional Victoria (see Figure 1). The current study sought to empirically examine this by comparing driver behavior at boom-controlled RLXs that were embedded in either urban or rural driving routes.

North Road, Ormond   Williamson Street, Bendigo

Figure 1. Examples of boom-controlled rail level crossings included in the urban (left) and rural (right) on-road study routes

Method

Forty-two participants drove a pre-specified test route in an instrumented vehicle, in either an urban or rural environment, while providing concurrent verbal protocols, which provide a measure of situation awareness. Eye and head movements were recorded, together with all vehicle parameters. Following the drive, participants completed structured interviews regarding two RLX encounters. Verbal protocol and post-drive interviews were audio recorded and then transcribed verbatim. Together these measures provided a range of objective (speed, stopping behavior, eye glances and head checks) and subjective data (situation awareness, decision-making strategies, etc.) to give a comprehensive assessment of driver behavior at RLXs.

Urban route

Twenty drivers (12 novices aged 18-22; 8 experienced aged 29-53) completed an 11km urban drive in the south-eastern suburbs of Melbourne. The route incorporated six active RLXs, which were all protected with boom barriers, lights and bells.

Rural route

Twenty-two drivers (11 novices aged 19-21; 11 experienced aged 33-55) completed a 30km drive in and around rural Bendigo. The route incorporated six active RLXs (five with boom barriers, lights and bells, one with lights and bells only) and four passive RLXs. To maximize comparability with urban RLXs, the current analysis included only the five boom-controlled RLXs.

Results and Conclusions

Drivers were significantly more likely to encounter a train at urban vs. rural RLXs, due to higher volume of trains on urban lines. Despite this, data across a range of measures suggest that rural drivers were more likely to view the RLXs as a safety threat: they were more likely to actively check for trains, even after noting that the signals were inactive, and expressed more safety-related concerns (e.g., possibility of signal failure, need to double-check to confirm no trains were approaching, and other potential dangers of RLXs).

In contrast, urban drivers showed more distributed situation awareness (Stanton et al., 2006), that is, they derived considerable information about the RLX situation from other road users (e.g. other drivers slowing or stopping) or from traffic signals (i.e., lights being active/inactive), and used this information to guide their decision-making without necessarily having to comprehensively assess the situation themselves (i.e. by making extensive visual checks). Drivers in urban areas were more likely to view RLXs primarily as a source of delays rather than a potential hazard.

The results highlight two important points. First, our findings reinforce previous research suggesting that drivers' perceptions of safety and threat potential are not necessarily aligned with objective data (e.g., Charlton et al., 2014). Second, these findings provide a reminder of the need to appropriately adapt infrastructure designs within local contexts, rather than assuming that solutions that function well in urban areas will exhibit equivalent performance on rural roads, and vice-versa. This is consistent with the existing Australian Level Crossing Assessment Model (ALCAM), which is used to identify risks and priorities for RLX upgrades, whereby local knowledge about the specific RLX is used to review the appropriateness of available treatment options. However, the current findings highlight the potential for additional customization when developing future treatment options; that is, that the diversity of local contexts should be used to develop new designs that are intended to capitalize on local knowledge, which in turn would permit for further optimization of the safety of RLXs.

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