Estimating the safety benefits of separated cycling infrastructure: Does modelling the mechanism matter?

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Abstract

Separated cycling infrastructure that removes interaction between cars and cyclists is assumed to reduce risk of collision. However, the potential for separated infrastructure to act against other mechanisms also assumed to contribute to cyclist safety has not been empirically explored. We constructed an agent-based model to investigate the potential effects of introducing separated cycling infrastructure to a transportation network. Results suggest that in transportation networks where behavioural adaptation among drivers is assumed to be active, low levels of separated infrastructure that reduces exposure of drivers to cyclists while providing incomplete origin-destination coverage may provide little or no overall safety benefit.

Background

At face value, the addition of safe cycling infrastructure that separates cyclists from motorised vehicles appears to be a logical step in efforts to reduce risk exposure for vulnerable road users, and therefore, deaths and injuries associated with car vs cyclist collisions. However, the safety benefits of separated cycling infrastructure, and the extent to which it contributes to reductions in car vs bicycle collisions remains a contested issue. Beyond the 'activist' position taken by some that cyclists should attract equal weighting as motor vehicles on public roads (Furness, 2007), aspects of the safety benefits assumed to underlie separated cycling infrastructure may run counter to popular understanding of how population-level cyclist safety is achieved through other means.

For example, the Safety in Numbers (SiN) theory suggests that cyclist vs car collisions reduce in a non-linear fashion with increasing numbers of cyclists in a transport system. Although the mechanisms underlying SiN remain contested (Bhatia & Wier, 2011; Christie & Pike, 2015), various authors have suggested it may be influenced by behavioural adaptation among drivers (Jacobsen, Ragland, & Komanoff, 2015), cyclist density (Thompson, Savino, & Stevenson, 2015), or separated infrastructure (Christie & Pike, 2015; Pucher, 2001).

There may be truth to each of these candidate mechanisms, which have usually been studied in isolation. It is unclear, however, whether each works in concert to produce an overall safety effect, or whether, under the right (or wrong) circumstances, these individual mechanisms may act against one another to increase risk. For example, if behavioural adaptation by drivers works through increasing exposure of drivers to cyclists, this poses potential issues for the the role of separated infrastructure, which by default, *reduces* exposure to cyclists by removing them from the road.

Method, Results & Discussion

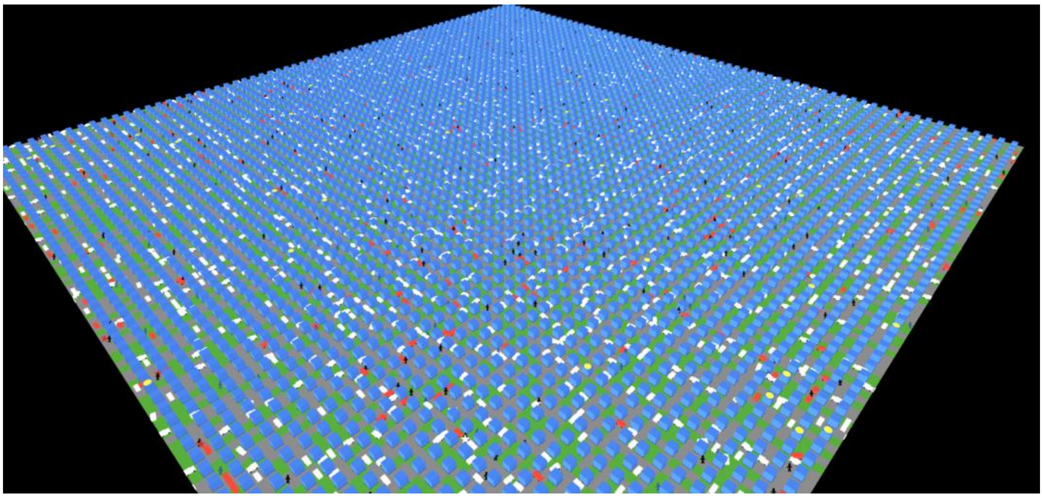

Figure 1. Birds-eye view of the simulated transport system

In the absence of in-situ laboratories, Agent-Based Models (ABMs) offer an efficient means of exploring proposed mechanisms underlying cycling safety to determine whether their effects can be replicated in simulated environments.

We constructed a simulated transport network using an ABM consisting of 2000 cars and 400 cyclists (see Figure 1). Among a population of simulated drivers who displayed behavioural adaptation in response to exposure to cyclists consistent with the proposed mechanisms underlying the SiN theory, we then altered road infrastructure throughout the network to include increasing saturation of separated cycle-pathways.

Preliminary results showed that under circumstances where behavioural adaptation operated among simulated drivers, low levels of separated cycling infrastructure (<25%) led to little or no change in car vs bicycle collisions to consequent reductions in behavioural adaptation by drivers. However, as separated cycling infrastructure reached peak saturation across the network, significant reductions in collisions were observed.

This study demonstrates the importance of modelling potential psychological and behavioural mechanisms associated with cyclist and vehicle interaction when estimating the safety benefits of new urban infrastructure. Practically, it suggests that critical levels of separated cycling infrastructure, beyond those currently present in many western cities, may be required to off-set reductions in behavioural adaptation among drivers before reductions in deaths and injuries might be expected.

References

Bhatia, R., & Wier, M. (2011). "Safety in Numbers" re-examined: Can we make valid or practical inferences from available evidence? *Accid Anal Prev*, *43*(1), 235—240. doi: 10.1016/j.aap.2010.08.015

Christie, N., & Pike, I. (2015). Is it safe in numbers? *Injury Prevention*, *21*(4), 276-277. doi: 10.1136/injuryprev-2015-041687

Furness, Z. (2007). Critical Mass, Urban Space and Vélomobility. *Mobilities*, *2*(2), 299-319. doi: 10.1080/17450100701381607

Jacobsen, P. L., Ragland, D. R., & Komanoff, C. (2015). Safety in Numbers for walkers and bicyclists: exploring the mechanisms. *Injury Prevention*, *21*(4), 217—220.

Pucher, J. (2001). Cycling safety on bikeways vs. roads. *Transportation Quarterly*, *55*(4), 9-11.

Thompson, J., Savino, G., & Stevenson, M. (2015). Reconsidering the safety in numbers effect for vulnerable road users: an application of agent-based modeling. *Traffic Inj Prev*, *16*(2), 147—153. doi: 10.1080/15389588.2014.914626