| Project Title |
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| Interactively visualising street design scenarios for communicating bike infrastructure options to communities and policymakers |
| **Project Code** |
| 3-021 |
| **Milestone** |
| M004: Final Project Report |
| **Lead Organisation** |
| Transport for NSW (TfNSW) |
| **Other Participants** |
| The University of NSW (UNSW) |
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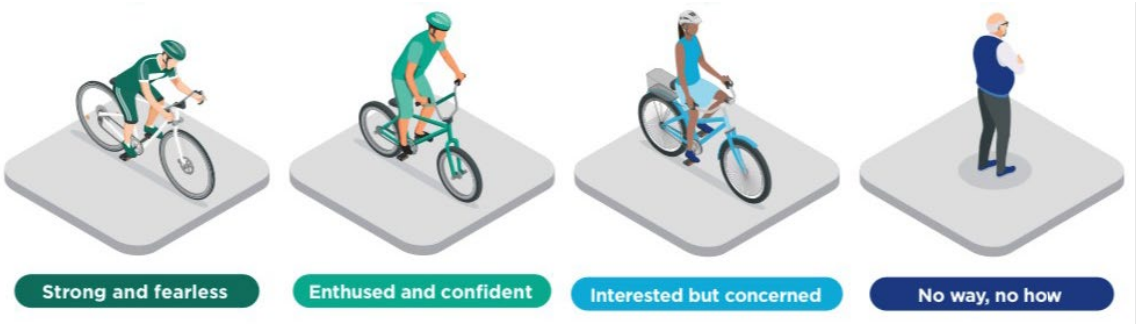
# Executive Summary

This report documents the findings from the cycling simulator testing of the 'Interactively visualising street design scenarios for communicating bike infrastructure options to communities and policymakers' study, commissioned by Transport for New South Wales (TfNSW) through iMOVE Australia.

The study aimed to investigate perceptions and behaviours of the "Interested but Concerned" cohort while cycling in a Virtual Reality (VR) bicycle simulator through several different bicycle facility designs. The "Interested but Concerned" cohort consists of potential riders who "would ride if they felt safer on the roadways—if cars were slower and less frequent, and if there were more quiet streets with few cars and paths without any cars at all" (Geller, 2009). The number of potential riders in this cohort is substantial, estimated to be 48 percent of the adult population of New South Wales (NSW) (Transport for NSW, 2013).

**Figure 1. The four types of cyclists**




### The study

In this study, six proposed designs of cycling facilities were tested in the VR bicycle simulator to understand the preferences of the "Interested but Concerned" cohort for bicycle facility design options. The bicycling simulator environments in this study were modelled after two existing streets in NSW: Smith Street in Wollongong and Derby Street in Penrith. For Smith Street, three bicycle facility scenarios were tested:

**S1: Two-way pop-up bicycle path**: A 2.4m wide, two-way bicycle path separated from vehicle parking and travel lanes using bolt-down plastic kerbs with high-visibility plastic vertical posts.

**S2: Interim two-way bicycle path**: A 2.4m wide, two-way bicycle path, demarcated by signage and line marking, but no physical barrier.

**S3: Quietway**: A street in which design elements and visual cues reduce motor vehicle speeds and volumes, and riders share the roadway space with motor vehicles.

For Derby Street, three bicycle facility scenarios were tested:

**D1: One-way bicycle path**: A 1.4m path for one-way bicycle traffic, separated from vehicle parking and travel lanes using concrete or landscaped barriers.

**D2: Two-way bicycle path**: A 2.4m path for two-way bicycle traffic, separated from vehicle parking and travel lanes using concrete or landscaped barriers.

**D3: Shared path**: A 2.5m path on one side of the roadway, separated from the roadway by a kerb and planted verge, where riders and pedestrians share the path.

An initial screening survey identified people who fit the definition of "Interested but Concerned" riders and met the testing criteria. A total of ninety-eight people took part in the VR bicycle simulator experiment located at University of NSW (UNSW) Sydney. Sixty of these participants went through the Smith Street scenarios, while the remaining thirty-eight went through the Derby Street scenarios. All participants cycled in three different simulator scenarios in Smith Street or Derby Street depending on their assigned street location. Observation of participants during the experiment included recording of head position, eye tracking and physical stress indicators, including heart rate and electrodermal activity.

Following these testing scenarios, participants completed a series of questionnaires to capture their riding experiences.

### Key Findings

The following key findings emerged from this study:

#### Bike Riding Behaviours

No significant difference in mean speed or lateral position (average position of a rider right or left of the centre of a simulated travel path) was observed between the different types of bicycle facilities, suggesting that when riders' movement is not impeded by other road users, the type of bicycle facility does not notably influence participants' bike riding speed or lateral position in the simulator.

#### Preferences for Cycling Infrastructure

The 'interested but concerned' cohort expressed a clear preference for dedicated bicycle paths. Cycling facilities which provide exclusive cycling space separated from other traffic were rated as the most comfortable and preferred option amongst the three bicycle infrastructure options tested in each street.

#### Perception of Safety

In both Smith Street and Derby Street environments, participants rated scenarios with dedicated paths (e.g., 'Two-way pop-up bicycle path', 'One-way bicycle path', and 'Two-way bicycle path') to be significantly safer than the scenarios with the mixed traffic paths, regardless of whether the mixing was with vehicles or pedestrians (e.g., 'Quietway' and 'Shared path'). On the other hand, while some difference in participants' hazard scanning behaviour were observed in the simulator scenarios

presented, there was no discernible evidence in the simulator data which suggests that any of the bicycle facility options induced any risky behaviours by riders.

**Willingness to Cycle**

Consistent with the above, participants stated a greater willingness to cycle on streets with dedicated bicycle paths. Cycling facilities such as ‘‘Two-way pop-up bicycle path’, ‘One-way bicycle path’, and ‘Two-way bicycle path’ were rated to be more appealing to participants compared to ‘Quietway’ and ‘Shared path’ options which require them to share the space with motorists or pedestrians.

**Conclusions**

The findings from this study underscore the role dedicated cycling infrastructure plays to attract the 'Interested but Concerned' cohort. This group, typically focused on cycling safety and comfort are hesitant about cycling in mixed traffic environments, are more likely to be encouraged to bicycle when high-quality dedicated bicycle paths are available. The study outcomes emphasise the importance of investing in and prioritising cycling infrastructure to foster bicycling as an attractive and viable mode of transport.

**It is important to note that a ‘do nothing’ scenario was not included alongside the six bicycle facility scenarios. As discussed in the Literature Review phase of this research project, there is clear evidence that existing mixed traffic environments have failed to attract the ‘Interested but Concerned’. The question for the VR scenarios was thus focussed on how ‘Interested but Concerned’ participants responded to different types of bicycle facilities. It should be acknowledged that had a ‘do nothing’ scenario been included it is highly likely all six scenarios would have rated higher in comparison.**

**Recommendations**

- A connected network of dedicated bicycle paths is required to attract the Interested but Concerned to riding on a regular basis. Building a connected dedicated bicycle path network should be the priority if the goal is to increase bicycle mode share.
- The type of separation for bicycle paths has an impact on the degree of safety and facility attractiveness to the Interested but Concerned. Grade separation, in the form of a kerb to parked cars, provides the most comfort.
- One way bicycle paths should be prioritised over two-way bicycle paths. One way bicycle paths were the most comfortable, safe, and attractive facility type for the Interested but Concerned in this study.
- Gentler bends in protected intersections should be investigated. For the Interested but Concerned in this study, the greater the deviation through an intersection the less comfortable the cohort.

Signalised intersections were more comfortable than protected signalised intersections and protected signalised intersections were more comfortable than protected roundabouts.

- Quietways ranked the lowest overall in this study for the Interested but Concerned due to the necessity of sharing space with cars. Quietways may not provide a sufficient sense of safety for the Interested but Concerned in NSW and therefore may be inadequate for priority cycling routes if these routes are intended to attract new bike riders. Based on the negative responses exhibited by the Interested but Concerned participants to mixing with traffic, even within streets with common traffic calming techniques, quietways should be considered supplementary or interim solutions. If a quietway has the aim of attracting new riders, core principles should be fewer and slower car traffic. This is best achieved through three key interventions: 1) Modal filters to reduce traffic volumes and speeds while still providing access for private vehicles, 2) Priority treatments for bicycle riders and pedestrians at intersections to enhance visibility to cars and improve safety, 3) Reallocation of road space to provide improved facilities and safety for bike riders and pedestrians.
- Shared paths do not provide a sufficient sense of safety and comfort for the Interested but Concerned. Based on the negative responses exhibited by the Interested but Concerned participants in this study to mixing with pedestrians on shared paths, these facility types should be considered supplementary or interim solutions. Where shared paths exist or are implemented, raised pedestrian and bicycle priority crossings should be provided at all side streets. This study has found the most significant reduction in stress levels for the Interested but Concerned at intersections on existing infrastructure can be achieved by replacing stop and give way side street crossings with raised pedestrian and bicycle priority crossings.

To the authors' knowledge, this study is the first project in NSW that utilises an interactive VR bicycle simulator as a visualisation platform to communicate and evaluate bicycle facility design options to users. The outcomes from this study demonstrate the feasibility of VR bicycle as a data collection platform to collect objective cycling data for refining and validating alternative bicycle facility options.