Accident Analysis and Prevention 108 (2017) 91–99

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Full length article

On the use of naturalistic methods to examine safety-relevant behaviours amongst children and evaluate a cycling education program

J. Hatfield[a,*], M. Dozza[b], D.A. Patton[a], P. Maharaj[a], S. Boufous[a], T. Eveston[c]

[a] Transport and Road Safety [TARS] Research, The University of NSW, Sydney, Australia
[b] Department of Applied Mechanics, Chalmers University of Technology, Gothenburg, Sweden
[c] ACT Education and Training Directorate, Canberra, Australia

ARTICLE INFO

Keywords:
Naturalistic study
Cycling safety
Cycling education
Cycling training

ABSTRACT

School-based cycling education programs aim to improve cycling safety and participation amongst children. Available research suggests that typical programs, which focus on bicycle manoeuvring skills, have limited effects on behaviour observed on a track or planned route. The current study uses theoretically more valid, naturalistic cycling data, to evaluate *Safe Cycle*, a program that incorporates hazard and self-awareness training. Soon after *Safe Cycle* was delivered at treatment schools, research bicycles instrumented with a rearward- and a forward-facing camera were loaned to six children from treatment schools and six children from (waitlist) control schools. In each group half the children were in Year 6, and half were in Year 7/8. Each child was instructed to ride the research bicycle instead of their own bicycle for the 1–2 weeks that they had a research bicycle. Video data were reduced using a purpose-designed coding scheme that identified whether participants performed specific safety-relevant behaviours in appropriate circumstances. While the participants controlled their bicycles well, gave way appropriately to traffic at intersections, and stopped at red lights, participants frequently removed one or both hands from the handlebars, and seldom signalled turns, conducted over-shoulder-checks when changing lanes, or looked in multiple directions at intersections (except when crossing a road). While aspects of design and small sample sizes limited evaluation findings, this research demonstrated the feasibility and potential of naturalistic data to support cycling education program evaluation. Further, the study substantially extended available naturalistic study of children's cycling behaviour to highlight behaviours which might be targeted by cycling safety initiatives.

1. Introduction

Cycling education programs exist in many countries – mostly in school settings (see Hatfield, 2012; Richmond et al., 2014). Many of these programs aim to improve safety, as well as participation. In Australia between 2008 and 2009, children aged between 10 and 14 years had the highest rate (per 100,000 population) of hospitalisation due to bicycling-related injury. Among children aged between 5 and 17 years who were seriously injured due to land transport accidents, 36% were injured while bicycling compared to 17% while the occupant of a car (Henley and Harrison, 2012). Strategies for reducing bicycle-related injuries should accompany initiatives to promote cycling participation (OECD/International Transport Forum, 2013).

From their review of evaluations of cycling education programs for children, Richmond et al. (2014) concluded that "educational and skills training bicycling programmes may increase knowledge of cycling safety, but this does not seem to translate into a decrease in injury rate, or improved bicycle handling ability and attitudes" (Richmond et al., 2014, p191). Importantly, one case-control study (Carlin et al., 1998) reported that children aged 9–14 years who were treated in an emergency department for injuries sustained in a cycling crash (n = 148) were more likely to have participated in Bike Ed (a state-wide school-based cycling safety program) than control cyclists (n = 130) – even with adjustment for sex, age, socioeconomic status, and cycling exposure.

The content of cycling education programs for children has changed little in the past 30 years (Richmond et al., 2014). In particular, cycling education programs still tend to focus on knowledge and skills relating to vehicle handling and manoeuvring in traffic – as did early driver education. Such "first generation" driver education appears to be of little benefit (see Ker et al., 2008 for Cochrane review), and may even increase crash risk (Vernick et al., 1999) by causing overconfidence (Gregersen, 1996). "State of the art" driver education addresses higher-level capacities, including awareness of risk and self-evaluation (see

* Corresponding author.
E-mail address: j.hatfield@unsw.edu.au (J. Hatfield).

http://dx.doi.org/10.1016/j.aap.2017.08.025
Received 28 February 2017; Received in revised form 18 July 2017; Accepted 21 August 2017
Available online 06 September 2017
0001-4575/

Hatakka et al., 2002). Carlin et al. (1998) hypothesised that Bike Ed "may inadvertently lead susceptible children to undertake risky behaviour" (p.26).

Safe Cycle is a school-based cycling education program that was informed by "state of the art" driver education – with equal emphasis on skill and risk awareness. It involves theoretical as well as practical sessions. The program was developed by a teacher to build teachers' capacity to deliver cycling education with resources that are readily available in schools, and to align the Australian Curriculum. Generally, the program is delivered to students during a single class each week for eight weeks.

Improvements in safety-relevant behaviour would appear to be an important mechanism for reduction in crashes and injury. Over half of the 23 evaluations reviewed by Richmond et al. (2014) examined the effects of training on behaviour. Three evaluations relied on self-reported behaviour, which is associated with an inherent potential for errors of recall and/or reporting. Among the 10 evaluations involving behavioural observations, only four studies showed improvements in behaviour, whereas the two Randomised Controlled Trials showed no effect of training on behaviour. However, given the emphasis of training on skills, the reviewed evaluations generally assessed the ability to perform cycling manoeuvres correctly (e.g. the ability to signal a left turn), rather than the "day-to-day" practice of safety-relevant behaviours (e.g. signalling when turning left, slowing to check for traffic at an intersection). However, Colwell and Culverwell (2002) measured self-reported "safe cycling" (e.g. "give an arm signal before turning") and "showing off" (e.g. "Do tricks or stunts on the road") and found no relationship with self-reports of having participated in cycle training under the National Cycling Proficiency Scheme.

In recent years, naturalistic data have become increasingly available for cycling safety research, uncovering cyclist behaviour in critical situations (Dozza and Werneke, 2014) and everyday cycling (Gustafsson and Archer, 2013; Schleinitz et al., 2017). In naturalistic studies, participants ride bicycles that are fitted with instrumentation to record aspects of their cycling behaviour during their *normal everyday riding* (Dozza and Fernandez, 2014; Mohanty et al., 2014). Naturalistic studies offer the unique opportunity to objectively record cyclist behaviour in the real-world, including cyclists' interaction with other road-users (Petzoldt et al., 2017). Naturalistic data may be complemented with self-reports, and are likely to be more valid than cycling behaviour observed on a track or planned route (Klauer et al., 2006). Despite the potential of naturalistic data for measuring *genuine* rider behaviour, naturalistic data have not yet been used for evaluations of cycling education programs or cycling safety initiatives in general.

Only one research group has conducted a naturalistic study with child cyclists: "Pedalportal" (Hamann et al., 2014) was conducted in Johnson County Iowa in 2013 and involved 10 children (5 male, 5 female, 11–13 years) who rode their bicycles at least four times per week. The helmet of each participant was equipped with a GPS-enabled, forward-facing camera and participants were instructed to record all of their bicycle trips for one week. Around 14 h of riding footage was available for analysis, which focussed on behaviours that were against traffic rules or put others in danger (as well as bicyclist risk exposure, route choice, and use of bicycle-specific infrastructure). Categories employed for video coding were very broad: Slowed inadequately to check for traffic (no traffic present); Failure to Stop or Yield; Reckless toward a pedestrian; Reckless toward another bike; Riding against traffic. Hamann et al. (2014) recognised that the codes were adapted to their adult participants but were not adapted to their child participants, particularly because the children mostly rode on footpaths. The most common error for children was slowing inadequately to check for traffic (n = 11).

In the current study, naturalistic data were collected and analysed as part of an evaluation of *Safe Cycle*, a relatively new school-based cycling education program that is being implemented in schools in Canberra, Australia. Informed by "state of the art" driver education, the program includes hazard and self-awareness training in addition to more typical cycling education content, e.g. handling skills and traffic manoeuvres. Bicycle-mounted instrumentation included rearward- and forward-facing cameras, which allowed measurement of specific safety behaviours that were addressed by *Safe Cycle*. Beyond the evaluation, the data also gave insights into safety-relevant cycling behaviours amongst a group of Australian school children.

2. Setting

Safe Cycle was developed by a teacher to build teachers' capacity to deliver cycling education with resources that are readily available in schools, and to align the Australian Curriculum. It involves theoretical as well as practical sessions. *Safe Cycle* includes several components to promote awareness of the risks involved with cycling, and to reach participants to manage these risks. For example, participants are shown real-world images of scenes that they may encounter while riding (from the rider's perspective), highlight the hazards in the scenes, and discuss ways of managing their risk. Scenes include approaching an intersection on a path and crossing an arm of the intersection. Participants in *Safe Cycle* are given information and practice to perform various safety-relevant activities including: checking over the shoulder when riding forwards, arm-signalling when turning, giving way appropriately, turning right in traffic, using a roundabout correctly. *Safe Cycle* participants are also informed about regulations relating to cycling in the Australian Capital Territory [ACT] of Australia. Generally, the program is delivered to students during a single class each week for eight weeks.

When the present evaluation was conducted *Safe Cycle* had been rolled out in a small group of schools in Canberra, in the ACT. "Canberra has one of the most extensive walking and cycling networks in Australia, comprising off-road shared paths, on-road cycle lanes and roads. All ACT footpaths, as well as shared paths, are able to be used by both pedestrians and cyclists." (ACT Government Health Directorate, 2012, p.29) Nonetheless, in a 2011 survey of 328 children in Years 5–8, only 20% reported that they normally ride to school (ACT Government Health Directorate, 2012).

3. Design

The *Safe Cycle* evaluation was conducted with a naturalistic study and a survey (see Fig. 1) with the current study reporting on the results of the former. Because of time-constraints, a Treatment/(Waitlist) Control design was adopted for the naturalistic study. At Treatment schools *Safe Cycle* was delivered for 8 weeks during Term 2 of 2014,

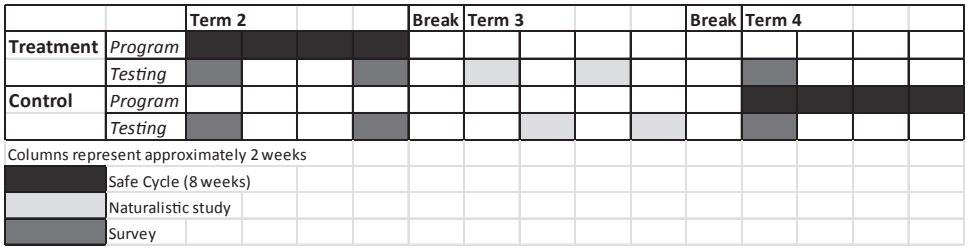

Fig. 1. The naturalistic study embedded within the Evaluation design.