Safety in Numbers: A Strategy for Cycling?

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1 Introduction

Cyclist safety is a key issue both for people who want to take up cycling and governments trying to encourage bicycle use for the health, environmental and economic benefits it offers. Safety is one of the main reasons people give for not cycling (e.g. Bonham and Clement 2005; McClintock and Cleary 1996) and, as Rietveld and Daniel (2004) put it, is a major generalised cost of cycling. While there seems to be broad agreement amongst cycle researchers, policy makers and cyclists that safety is an issue, there is on-going discussion about the context and causes of cycle crashes (McCarthy and Gilbert 1996), rates and severity of different types of crashes (Rodgers 1995; Stone and Broughton 2003; Wang and Nihan 2004; Lapparent 2005), the population sub-groups that are vulnerable to crashes (Ekman, Welander, Svanström, Schelp and Santesson 2001; Rosenkranz and Sheridan 2003; Schrøder Hansen, Eide, Omenaas, Birger Engesæter, Viste 2005) and the best ways to address cyclist safety in terms of infrastructure provision, particularly On-road and Off-road facilities (for an overview see McClintock and Cleary 1996).

In this paper, we are interested in the risks (to person and bicycle) that cyclist face and the extent to which levels of cycling impact upon cyclist safety. As governments and bike lobby groups work to encourage cycling, it is important to understand the likelihood of cyclists being involved in a crash and whether increasing volumes of cyclists will increase an individual's risk of crashing. This knowledge can guide agencies in the level and type of investments they make for cyclists.

Research undertaken in Northern Europe and the United States casts doubt upon the conventional wisdom that an increase in cycling will lead to an increase in cycle crashes (fatal, injury, or property damage). Working at a macro spatial scale, the national and citywide level, Peter Jacobsen (2003) found that as the number of cyclists or the total distances travelled by bicycle increases there is a rise in the absolute number of cyclist fatalities and/or injuries. However, this increase is not directly proportional. Rather, as cyclist numbers increase the likelihood of an individual cyclist being involved in a fatal crash actually decreases. This observation has been coined the 'Safety in Numbers' theory. Similar results have been found at the macro level in Australia (Robinson, 2005).

Research into cycling and walking at the micro spatial scale by Ekman (cited in Jacobsen 2003) and Leden (2000) in Sweden and Leden (2002) in Canada shows the same trend. In Malmö, Sweden, Ekman compared cyclist and pedestrian volumes against serious cycling and pedestrian crashes at 95 intersections. He found no discernible relationship between the volumes of pedestrians and the numbers of incidents involving pedestrians. However, there was an inverse relationship between volumes of cyclists and the number of crashes that involved cyclists. In Leden's study of 300 points throughout Hamilton, Ontario where pedestrian paths intersected with roads, he found that where there were greater numbers of pedestrians fewer pedestrians were involved in crashes.

The implications of work by Jacobsen, Ekman and Leden may be significant for cycling strategies in Australia. If increasing cyclist numbers will in itself increase the safety of individual cyclists, then cycling policy makers and planners may need to reconsider the type of investments made into cycling.

This paper reports on research undertaken in Adelaide, South Australia where the authors examined the relationship between cyclist volumes and cyclist crashes at different spatial scales: road, intersection and local government area. The first section provides an overview of the data and method of analysis followed by a report of the findings. In the final section, we discuss the findings and comment on their implications for policy and further research.

2 Data and Method

Our main interest in this research was to determine whether there was a relationship between levels of cycling and cycling crashes and the nature of that relationship, positive or negative. We were also interested in putting the safety in numbers thesis to the test at different spatial scales in the South Australian context.

Our analysis required matching cycle crash data with sites and localities where cycle counts had actually been taken. Cycle crash data is available for the entire state of South Australia but data on cycle journeys is limited both spatially and temporally.

2.1 Crash data

Police crash data for the years 1999 and 2000-2004 were used in this analysis. We included all recorded crashes in the analysis whether they resulted in property damage only, injury or fatality. Although many cyclist crashes are not recorded in any official data sets, we believed this under-reporting would be even across all sites and localities and should not impact on the robustness of the analysis.

2.2 Cyclist data

Three sources of data were used to estimate volumes of cyclists at each spatial scale: Adelaide City cordon counts, intersection counts and the 1999 Metropolitan Adelaide Household Travel Survey.

Adelaide City cordon counts have been used as a measure of cyclist volumes on selected Adelaide roads. The Adelaide Central Activities District is surrounded by Parklands and there are only 17 entry points – roads and paths – through these parklands into the city centre. The Department for Transport, Energy and Infrastructure (DTEI) annually determine the volume of cyclists entering the city along roads and cycling paths between 7am and 10am on a week day with fine weather in spring. For logistical reasons, the count is actually conducted over a series of days; each day a different section of the city is ‘cordoned’ off, and the totals of each section are summated to obtain a ‘typical’ day’s total.

We used cordon count data for the five year period 2000-2004. For the purposes of this analysis, the cordon counts were seen as an indicator of cycle traffic volumes on the major roads leading up to, and thereby corresponding with, each of the city entry points. For example, the count for the Peacock Road entry point was taken as an indication of cyclist volumes along the entire length of King William Road. Because cordon counts only provide data for 17 locations, we have used crash data only for the major roads that correspond with these entry points. We understand the problems associated with using data from one point along a road as an indication of cyclist volumes along the entire length of the road; however, the paucity of cycling data has made such compromises necessary.

Intersection counts were used as a measure of the volume of cyclists at various metropolitan intersections. These counts were undertaken by DTEI on an annual basis from 1998-2003. Data for the period 2000-2003 only have been used in this study. Cyclists have been counted at a total of 37 intersections throughout the Adelaide metropolitan area although more than one quarter (11) of these counts were taken within or at the edge of the Adelaide CAD. Unfortunately counts have not been taken at all intersections every year.

The 1999 Metropolitan Adelaide Household Travel Survey was used for the regional cyclist volumes. This random sample survey was undertaken by Transport SA and travel information was gathered from all members of selected households for two consecutive days. Each household was identified as being within a particular transport zone and there are a total of 296 travel zones throughout the metropolitan area. For the purposes of our analysis, we aggregated these zones into local government areas.

The problem with using traffic counts and travel diary data is that it represents cycling movements for one or two days of the year whereas crash data covers the entire year. To address this problem, we extrapolated our one and two day counts over the entire year. That is, the daily weekday cordon and intersection counts were assumed to be an indicator of cyclist movements through those points for each weekday of the year. This assumption was not unreasonable given that roads and intersections which recorded low levels of cyclist movements (say less than 20 per day) for one count recorded similar low numbers for each count in subsequent years. Whereas roads which recorded high levels of cyclist movements (say above 150 per day) in one count recorded high levels of cyclist movements in counts over the following years. The single traffic counts were multiplied by the number of weekdays per year to give an indication of cyclist movements along each road and through each intersection per year. For consistency, a yearly estimate of cycle movements to and from each local government area for 1999 was calculated from the two day household travel data.

The analysis involved correlating cyclists – using a particular road, passing through a particular intersection, originating from or arriving at a particular local government area – to cyclist crashes recorded for that same road, intersection or local government area. For road and intersection counts, trips were transformed to ‘log trips’ since the original data is very right-skewed. The log transformation gives a quite good Normal distribution, which is desirable for regression analysis. The analysis was undertaken with two tasks. In the first task, we used regression to examine the strength and nature of the relationship between actual numbers of cyclist trips and reported crashes. In the second analysis, we used the same tests but this time related the percentage of cyclists that crashed at each location with the number of cyclist trips recorded at that location.

3 Findings

It was clear from the analysis that there was a positive relationship between the number of cyclist movements and the number of cyclist crashes. Locations that recorded low cyclist volumes also recorded low numbers of crashes whereas localities with high volumes of cyclists recorded higher numbers of crashes. It was also clear that cycle crashes did not increase at the same rate as cyclist numbers. This finding prompted an

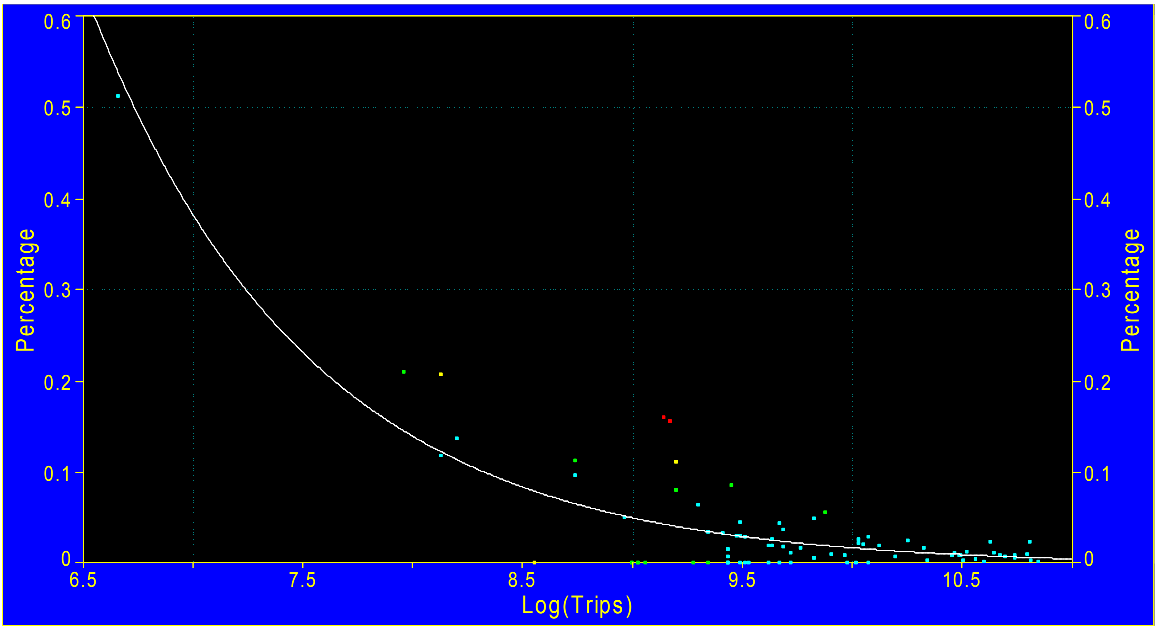

Figure 1 Percentage of Cyclists that Crash by Cyclists Trips on Roads leading into Adelaide CBD 2000-2004

analysis of the percentage of cyclists that crashed at each location to determine the likelihood of crashes with different cyclist volumes.

Figure 1 shows that for the various entry roads into the Adelaide CBD the number of cyclists accounted for 78% (R-squared = 0.78) of the variability of percentage of cyclist crashes. A non-linear (exponential) regression was found to be the best fit (TableCurve v 5.01) taking accuracy and parsimony into account.

The result for roads was not reflected at the intersection level where the trend toward an inverse relationship was complicated by numerous zero crash intersections. These zero crash intersections appeared randomly at sites with both high and low cyclist volumes. When the analysis was re-run excluding zero crash intersections, there was a strong inverse relationship between the likelihood of crashing and the volumes of cyclists (Figure 2). At intersections where crashes occurred, almost 70% (R-squared = 0.66942) of variability in those crashes was explained by volume of cyclist trips. The curve of best fit was again an exponential regression.

Results of the Local Government Area analysis are shown in Figure 3. The line of best fit indicates an inverse relationship between crashes and cyclist volumes and while the regression is significant ($p < 0.5$) it does not explain much of the variability in the crashes (R squared = 14.4%). This is the best overall fit.

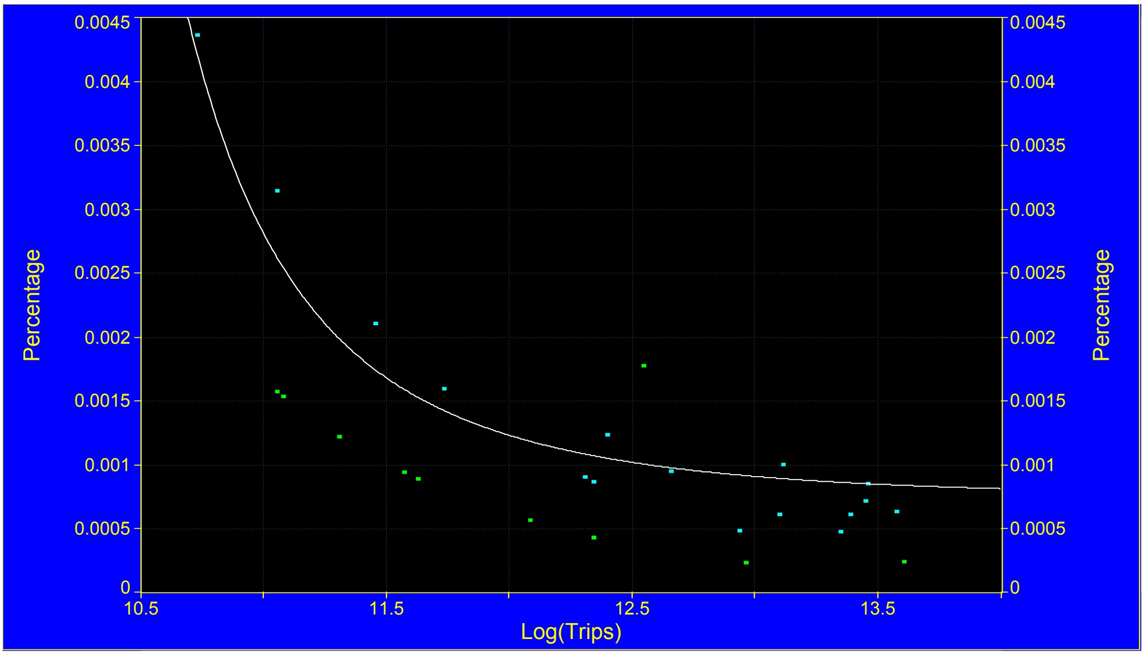

Figure 2 Percentage of Cyclist that Crash by Cyclist Trips at Metropolitan Adelaide Intersections (excluding zero crash intersections) 2000-2003

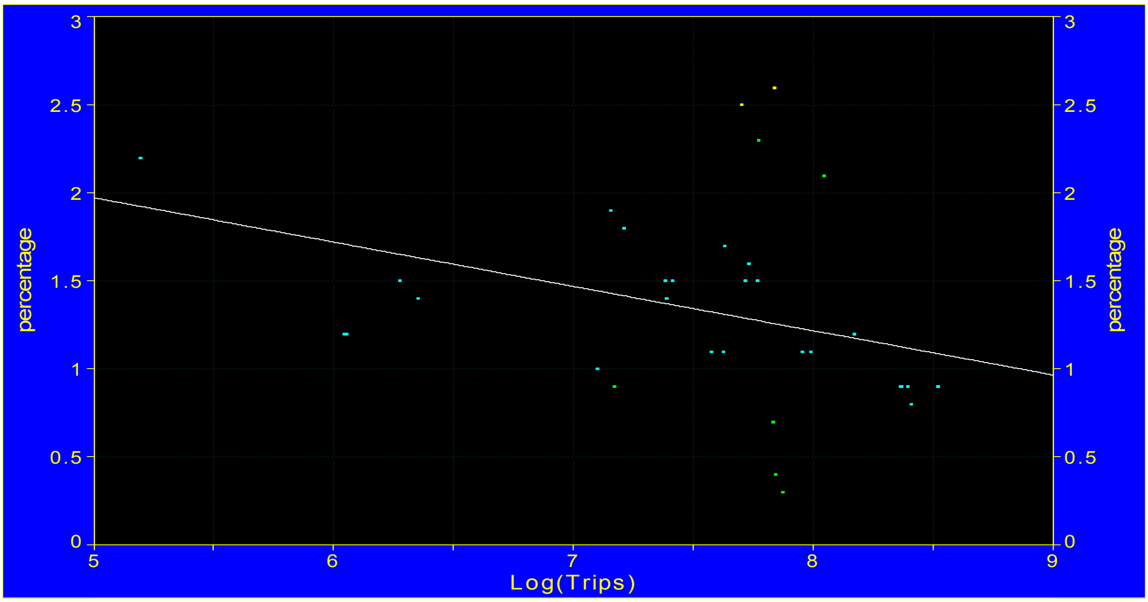

Figure 3 Percentage of Cyclist that Crash by Cyclist Trips for Metropolitan Adelaide Local Government Areas (1999)
NB While there were 19 LGAs in total, origin and destination data points have been included in the same analysis thereby giving a total of 38 data points (i.e. the LGA is counted first as an origin and then as a destination)

4 Discussion

Our results for Roads and Intersections (excluding zero crash sites) are in line with the findings of both Jacobsen and Leden. The analysis shows that although increases in the number of cyclists lead to an increase in the absolute number of cyclist crashes the *likelihood* of an individual cyclist being involved in a crash actually declines.

Jacobsen argues that factors such as roadway design, traffic laws and social mores have an impact on cyclist crashes but these influences occur slowly and cannot explain sharp changes in short periods of time (2003). Drawing on work by Todd, Jacobsen suggests that behavioural changes amongst motorists are the most likely explanation for variation in cyclist crashes. Todd found that motorists drive more slowly when there are many pedestrians and faster when there are few. Further, in those localities where there are high rates of cycling and walking, motorists are likely to be cyclists and pedestrians hence they have greater consideration for these road users.

We contend that in the South Australian context the personal experience of motorists as cyclists is less important in cycle safety than the prevalence of cyclists on the road. South Australian Health Omnibus data (1990-2004) shows that around 18% of the metropolitan adult population are regular cyclists (ride once a month or more often) and while these people, as motorists, may behave cautiously in relation to cyclists, it cannot account for intra-urban differences in cycle crashes (Department of Health 2005).

Ian Walker's (2005) work has greater explanatory value for the South Australian experience. Following Moray (cited in Walker), Walker argues that motorists can only take into account a limited number of factors when they are driving. They select these factors according to the frequency with which they experience them. When they encounter cyclists and pedestrians frequently they will take them into account in their driving behaviour. When motorists encounter cyclists infrequently they do not register them at a conscious level. These mental models 'guide attention to the areas of the surrounding scene most likely to be important' (Walker 2005 p8) and these patterns become entrenched over time. Work by Herslund and Jørgensen (2003) relates search strategies to driving experience of motorists and suggests these patterns become fixed after about seven years.

Walker's explanation is complicated in our research by the fact that greater numbers of cyclists played an important role in cyclist safety at specific locations: major roads and intersections. However, cyclist volumes have limited explanatory power at the broader spatial scale of the Local Government Area. The difference in results between roads/intersections on the one hand and LGAs on the other may be accounted for by two different but closely related factors: the cycling/motoring environment and cyclists/motorists themselves.

Local Government Areas are made up of diverse travelling environments, from arterial roads to residential streets. Aggregating different road types into an area wide analysis may mask or distort the relationship between cyclist volumes and cycle crashes. A further step in testing the Safety in Numbers hypothesis would be to analyse cyclist volumes and crashes by road type. Current data bases provide the location of reported crashes but we would need to gather cycle route data to get an indication of cyclist volumes on different roads.

The other key factors, inextricably related to the first, are the motorists and cyclists using different road environments. Taking cyclists first and following the work of McClintock and Cleary (1996), it is reasonable to assume that adults and confident cyclists are more inclined to use main roads and major intersections. There may be less variability in the behaviour of these cyclists so that any adjustments a motorist makes because of cyclist volumes will allow cyclists and motorists to travel together in greater safety. The safety in numbers response may be working alongside other behaviours.

In contrast and again following work by McClintock and Cleary (1996), children and less confident cyclists are more likely to ride along residential streets in Local Government Areas avoiding main roads and major intersections. Further, children make up a disproportionately large share of cycle crashes and these crashes are most likely to occur in residential areas (Petch and Henson 2000). If child cyclists were removed from our analysis, the safety in numbers hypothesis might have greater explanatory power at the local government level. Taking these factors together, the type of cyclists that use residential streets is likely to complicate the safety benefits associated with greater numbers of cyclists. Further, if motorists do not adjust their behaviour as they move from main roads to the complex conditions of residential streets then changes in relation to cyclist volumes may be cancelled out by factors such as excessive speed for the specific road context.

While the Safety in Numbers hypothesis holds to a greater or lesser degree across different spatial locations, it may also hold in terms of the temporal concentration of cycling journeys. The highest number and percentage of crashes occur in the inter-peak period between 9am and 4pm rather than in the morning or afternoon peaks. Although, combining the morning and afternoon peak periods together there are more cycle crashes at these times. Cyclist frequencies are recorded in 15 minute intervals, although the data is generally made available when aggregated into four or six hour time periods. The next step in the analysis is to recover the data in its 15 minute interval form to correlate crashes per hour against volumes per hour. This work will be made easier with the use of data from 24hr traffic counters currently being installed on major cycle routes in Adelaide.

5 Conclusions and Further Research

The analysis undertaken in this study suggests that policies which lead to an increase in cycling will not increase the likelihood of cyclist crashes. From the work reported here, it seems the more cyclists there are on the roads the lower the risk that any individual cyclists will be involved in a collision. Road safety professionals concerned about reducing the likelihood of cycle crashes might consider measures that increase cycling.

Although cyclist volumes account for a great deal of the variability in crashes, almost thirty percent of crashes are explained by other factors. A further step in this research will be to identify these other factors, traffic volumes and speeds, road design and cycle lanes are key variables, and determine the influence they have on cyclist crash rates. A temporal analysis will also assist in determining whether cyclists are safer in peak times, when there are more cyclists on the road, or whether the fact that a road is a well used cyclist route is enough to improve their safety or whether the overall reduced speed of motor vehicles during peak periods has an effect.

Another important direction for this research will be to run an analysis for crashes occurring on different road types. Different types of road environments cater to different types of cyclists yet motorists do not necessarily adjust their behaviour according to their context. If we can determine the nature of the relationship between cyclist volumes and cyclist crashes on different types of roads, then the findings of that analysis may lead to a closer examination of driver and cyclist behaviour in the different environments.

One of the most important issues to come out of this study is the dearth of data on and research into cycling. Historically, considerable investments have been made in gathering and analysing data on motor vehicles but similar investments have not been made into cycling. South Australia and Victoria have improved cycle data collection in recent years (vicroads 2006). However, a much greater commitment to data gathering and research are required if cycling is to play an important role in health strategies - through Active Travel - and environmental strategies.

In line with countries such as the United States and Sweden, Australia is witnessing an increase in cycling (Ekman 2001; Rosenkranz and Sheridan 2003; Bonham & Clement 2005). Fuel prices and the high health and environmental costs of motoring will act to encourage greater numbers to cycle. Further, bicycle manufacturers are conducting research into the needs of commuter and urban cyclists so as to produce bicycles which better fit the needs of these people (cyclingnews.com 2005). Research will be fundamental in addressing the needs of the emergent cycling community and data collection is central to good research and analysis.

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