Reduction of travel speeds in the Melbourne CBD after installation of repeater speed signs: Results of a quasi-experimental before-after study with comparison sites

Karen Stephan, Michael Lennė and Bruce Corben
Monash University Accident Research Centre

ABSTRACT

Transport Accident Commission (TAC) research indicates many drivers claim to often be unaware of the speed limit. Drivers may be genuinely unsure of the speed limit if there is inadequate signage, that is, if there are not enough repeater speed signs (RSS). Previous research found RSS to be ineffective in changing vehicle speeds in areas with speed limits over 80 km/h, however, there is no published research regarding the effectiveness of RSS alone in reducing speed in areas of lower speed limits (e.g. 50 km/h). In this study, RSS were installed on two routes in the Melbourne CBD, and a Before-and-After study with comparisons was conducted. Vehicle speeds were measured for two 14 day periods; the first prior to installation of RSS, and the second after installation. Changes in average vehicle speed on the treatment routes after installation of RSS were compared to changes in vehicle speeds on the comparison routes over the same time-frame. Considering the effectiveness of RSS might vary according to the day of the week and time of day, the recording periods were categorised into six time periods. There was a strong net reduction in mean speed after installation of RSS during all six time periods, the minimum being a net 1.59 km/h reduction during the day on weekdays, to the maximum of a net 3.63 km/h reduction on weekend nights. The proportion of speeding vehicles was also significantly reduced. These results indicate that installation of RSS can effectively reduce travel speeds in 50 km/h speed zones.

BACKGROUND

Research conducted by the Victorian Transport Accident Commission (TAC) indicates that many drivers report wanting to adhere to the speed limit, but are often unaware of what the speed limit is. This phenomenon has also been reported in the United Kingdom (RoSPA, 2005) and Israel (Gitelman & Hakkert, 2002). Two reasons could explain why drivers may be genuinely unsure of the speed limit: either they are not paying attention,

or the speed limit has been inadequately sign-posted (RoSPA, 2005). Inadequate sign-posting can be addressed by the installation of more frequent Repeater Speed Signs (RSS).

Previous research has found the installation of RSS to be ineffective in reducing vehicle speeds in areas with speed limits above 80 km/h (Prescott, Hall & Rutley, 1990, cited in Maze, Kamyab & Shrock, 2000; Gitelman & Hakkert, 2002), however, there is no published research regarding the effectiveness of RSS alone in reducing speed where speed limits are lower (e.g. 50 km/h). A UK report recommended that a trial of RSS in 30 mph (48.3 km/h) areas should be conducted (RoSPA, 2005). The TAC also recognised the need to determine the effectiveness of RSS, initially in city areas with 50 km/h speed limits. As a result, the TAC contracted Monash University Accident Research Centre (MUARC) to determine if the installation of RSS in the Melbourne central business district (CBD) would reduce traffic speeds.

METHOD

Study design

The study used a Before-and-After design with comparisons. Changes in vehicle speed on the treatment routes after installation of RSS were compared to changes in vehicle speeds on the comparison routes over the same time frame. This study design attempts to control for the effect of factors apart from the RSS that may affect vehicle speeds, for example, weather, traffic density, road safety campaigns and police presence. By looking at changes in speed on the comparison routes, which are subjected to all of these other factors, and comparing this to changes in speed on the treatment routes, the net effect of RSS can be assessed.

Route selection

Routes were selected in consultation with TAC, Melbourne City Council and VicRoads. Both treatment and comparison routes were chosen as routes where substantial road safety benefits could be derived with a reduction in speed. Benefits were anticipated to be higher in areas where vulnerable road users are most concentrated and at intersections, where lower speeds offer considerable potential for improvement in crash and injury risk. Unfortunately, average traffic speeds on each route were not available prior to commencement of the study. Although it was difficult to find comparison routes

that matched the treatment routes in every aspect, they were chosen to be similar to the treatment routes in terms of important factors such as traffic density, type of traffic, and surrounding features.

Routes in the Melbourne CBD were assessed according to these criteria. Other factors that might have affected traffic movements were noted, including existing speed signage, pedestrian activity, ongoing road works and perceptions of road width and use, such as the presence of trams and kerbside/centre-parking. Two treatment routes and two comparison routes were selected. Lonsdale Street was chosen as one treatment route with Queen St as the corresponding comparison route, while Exhibition St was selected as a second treatment route with Russell St as the comparison route. During site visits, the high level of pedestrian activity in Lonsdale St was noted, which emphasised its suitability as a route where substantial road safety benefits could potentially be derived. Exhibition St, Russell St, and Queen St were all classified as similar in appearance and function to Lonsdale St, and all have both kerbside and centre parking. For this study, the advantage of centre parking was that it provided opportunities for placing speed signs in the centre median, unlike roads with trams or without centre parking.

Location for installation of RSS

Exhibition St runs in a north-south direction and consists of four main blocks (LaTrobe to Lonsdale St, Lonsdale to Bourke St, Bourke to Collins St, and Collins to Flinders St). Lonsdale St runs east-west and the four block section from Exhibition St to Queen St was chosen as the area of interest for this study.

On the 11th December, 2005, one pair of RSS were placed in the first half of each main block on Exhibition St and Lonsdale St, in each direction. Hence, there were 32 RSS installed in total; four pairs of signs in each direction for each route. Sign locations were chosen to be a sufficient distance away from the intersection to be visible to drivers and riders turning into the street. Preference was given to affixing the signs to existing poles and structures. Having as few structures as possible provides a safer environment with less potential for collisions and less visual pollution is caused if existing poles are used. Also, existing sign poles have generally been placed where signs will be visible. It was also more convenient and cost effective if only the signs need to be installed.

Speed measurements

Amphometers were used to measure vehicle speeds. Speed was measured at two locations on both treatment roads and comparison roads, that is, eight locations in total. Due to budgetary constraints, speed was measured in one direction only, and across both lanes of traffic in that direction. On Exhibition, Queen and Russell Sts, vehicle speed was measured in southbound lanes (chosen due to the presence of roadworks in the northbound lanes of Exhibition St), while for Lonsdale St, speed was measured in the westbound lanes. Vehicle speeds were measured for 14 days in October 2005 prior to the installation of RSS, and for 14 days after installation, in March 2006.

RESULTS

During data collection, 1,497,342 vehicle speeds were recorded. Data were checked for quality and outliers. Outliers, defined as any speed that exceeded 90 km/h, were removed. Removing these observations did not change the mean, median, or the 99th percentile speed. Mean speed was 32.98 km/h (SD 11.26 km/h).

The effectiveness of the RSS may vary according to the day of the week and time of day. For example, during peak traffic times, traffic speed is low, and hence there is less opportunity for the speed signs to have an effect. During the night and early hours of the morning however, there is less traffic and thus more chance of drivers exceeding the speed limit. After consultation with project advisors, the recording periods were categorised into six time periods according to time of day and day of week (refer to figure 1).

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12am-1am	Weekend night	Weeknight				Weekend night	
1am-7am	Weekday early hours					Weekend early hours	
7am-7pm	Weekday					Weekend Day	

7pm-11pm	Weeknight	Weekend Night

Figure 1. Categorisation of time periods according to day of week and time of day

Effect of repeater speed signs on mean speeds and proportion of vehicles travelling over 50 km/h

For each time period, average vehicle speeds were calculated for each route prior to installation of RSS at the treatment routes (the before period) and afterwards (after period), pooled across amphometer location and lane of travel. This data is shown in the appendix (table A1).

Multiple regression was used to determine whether the speed change between the before and after periods at the treatment routes differed from the speed change at the comparison routes. This technique provides an estimate of the change in speed on the treatment routes, adjusted for any change on the comparison routes (table 1). If the RSS were affecting travel speeds, we would expect a decrease in speeds on the treatment routes relative to the comparison routes.

In addition, for each time period, the proportion of traffic travelling above 50 km/h was calculated for each route in the before and after periods, pooled across location and lane of travel (refer to appendix, table A2). Logistic regression was performed to compare how the odds of speeding on the treatment routes in the after period changed relative to the before period, compared with the comparison routes. The net change in proportion of vehicles travelling over 50 km/h on the treatment routes, relative to the comparison routes, is displayed in table 1.

For both the mean speed and proportion of vehicles speeding, three separate analyses were performed; the first to look across both treatment routes (Lonsdale and Exhibition Sts) compared with both comparison routes (Queen and Russell Sts), and the second and third to look at each treatment route and its associated comparison route separately (Lonsdale and Queen Sts, and Exhibition and Russell Sts, respectively).

Table 1. Summary of the effects of RSS on mean speed and proportion of vehicles speeding, adjusted for changes on the comparison routes, for each time period.

	Net change on the treatment route, relative to the comparison route (95% confidence interval)					
	Lonsdale St		Exhibition St		Over both routes	
Time period	Mean speed reduction (km/h)	Reduction in proportion speeding	Mean speed reduction (km/h)	Reduction in proportion speeding	Mean speed reduction (km/h)	Reduction in proportion speeding
Weekday	**2.1 (1.96, 2.23)**	**43% (39%-47%)**	**0.75 (0.62, 0.88)**	**37% (30%-42%)**	**1.59 (1.49, 1.68)**	**35% (32%-39%)**
Weeknight	**4.75 (4.38, 5.11)**	**56% (52%-60%)**	**1.06 (0.79, 1.35)**	**31% (22%-40%)**	**2.11 (1.88, 2.33)**	**41% (36%-45%)**
Weekday early hours	**4.25 (3.75, 4.76)**	**59% (54%-63%)**	**1.79 (1.36, 2.23)**	**39% (31%-46%)**	**3.37 (3.04, 3.70)**	**52% (49%-56%)**
Weekend day	**3.68 (3.42, 3.94)**	**56% (52%-59%)**	**2.61 (2.41, 2.82)**	**45% (39%-51%)**	**3.53 (3.37, 3.69)**	**58% (55%-60%)**
Weekend night	**6.26 (5.93, 6.59)**	**68% (65%-71%)**	*0.14 increase (-0.13 decrease to 0.41 increase) (p=0.32)*	**30% (18%-40%)**	**3.63 (3.43, 3.84)**	**63% (60%-66%)**
Weekend early hours	**3.32 (2.75, 3.89)**	**40% (31%-48%)**	***0.53 increase (0.05, 1.02) (p=0.03)***	*2% increase (13% decrease to 21% increase) p=0.78*	**3.17 (2.82, 3.52)**	**50% (45%-54%)**

* Statistically significant effects are shown in bold type. All changes were significant at the 0.0001 level apart from those in italics, where the associated probability is indicated.

Looking across both treatment routes, there was an overall net reduction in mean speeds and in the proportion of vehicles speeding across all time periods, with greater reductions occurring on weekends and during the early hours on weekdays. When the two treatment routes are considered individually, the RSS led to a greater reduction in

mean speeds and the proportion of vehicles speeding on Lonsdale St than they did on Exhibition St for all time periods. Despite this, Exhibition St still experienced a reduction in speeds in most time periods, but of a smaller magnitude. The only situations in which the RSS appeared not to be effective in reducing speed were on Exhibition St during weekends at night and in the early hours of weekends. In fact, in the early hours of weekends there was a statistically significant, but small, net increase in mean speeds on Exhibition St (0.53 km/h).

DISCUSSION

Overall, the use of RSS in 50 km/h zones in Melbourne's CBD led to a decrease in mean vehicle speeds and a reduction in the proportion of drivers exceeding the speed limit. That RSS have now been demonstrated to be effective in 50 km/h zones is encouraging, especially in view of the inability of previous research to demonstrate their effectiveness in higher speed zones (Prescott, Hall & Rutley, 1990, cited in Maze, Kamyab & Shrock, 2000; Gitelman & Hakkert, 2002).

RSS appeared more effective in lowering mean speed and the proportion of drivers speeding on Lonsdale St than on Exhibition St. This is most likely due to the higher mean speeds and a larger proportion of speeding vehicles that were observed on Lonsdale St prior to introduction of the RSS, and so there was more opportunity for the signs to have an effect. As the mean traffic speed on Lonsdale St was faster than on Queen St (its comparison route) prior to the installation of RSS, the comparison might be considered invalid. For example, speeding interventions other than the RSS that were implemented between the before and after periods could also have had more opportunity to reduce speeds on Lonsdale St than Queen St. Thus, the observed reduction in speed on Lonsdale St compared to Queen St may have been due to more than just the RSS. The authors are not aware of any other speeding interventions specific to the period of time between the before and after data collection periods. If however, such an effective intervention was implemented during the same time period, one would expect to observe at least some reduction of speeds on the comparison routes during the before and after period. This was not observed. Therefore, we believe the reduction in speed at both treatment routes to be attributable to the RSS intervention.

Notwithstanding the limited possibility of the differential effects of other speeding interventions on Lonsdale St compared to the other sites, a conservative assessment of the results of this study might choose to focus only on the Exhibition St/Russell St comparison, which did not suffer from a noticeable difference in speeds in the before period. Even with this conservative approach, RSS had a significant effect on traffic speeds and proportion of speeding vehicles when considering only the Exhibition St/Russell St comparison.

Although it might seem disturbing that the RSS appear to have led to an increase in the mean speed on Exhibition St in the early hours of weekends, the statistical significance of these results must be considered in light of the practical importance of the effect observed. The net increase in mean speed was only 0.53 km/h, which is rather small. When assessing the importance of research results, both statistical significance and practical importance must be considered. Statistical significance indicates how likely it is that the observed effect was due to chance, while practical importance involves assessing whether the magnitude of the effect is of practical relevance. Statistical significance is affected by sample size and even a very small difference will be statistically significant when the sample size is large. The current study had a large sample size of close to 1.5 million observations. Thus it is not surprising that such small p-values were observed. For the statistically significant results, the real issue lies in considering the magnitude of the observed net changes in speed and the proportion of vehicles speeding to decide whether they are practically important. A net increase in mean speed of 0.53 km/h on Exhibition St during the early hours on weekends is not large, and considering the beneficial effects of the RSS that were observed during the other time periods, would seem to be of little concern.

This study highlighted the importance of using a before-after design with comparisons. Without using comparison routes, it is impossible to determine if changes observed on the treatment routes are due to RSS, or due to other factors that changed over time (e.g. weather, traffic density, police presence). The logic of using comparison routes that are similar to the treatment routes in all but the installation of RSS, is that the effect of other variables that change over time can be accounted for.

The positive findings from this study lend support to drivers' claims that they would like to adhere to the speed limit but that they are often unaware of what the speed limit actually is. The reduction in mean speeds and in the proportion of drivers speeding after installation of RSS seems likely to be due to an increased awareness amongst drivers of the true speed limit on the routes involved.

Critics of this approach may argue that RSS are unnecessary, because drivers should be aware that the default speed limit in built up areas in Victoria is 50 km/h. It is possible, however, that there is some confusion as to when the 50 km/h limit applies. The speed limit on many of the roads leading into the CBD is 60 km/h. A number of the routes through the CBD do have one set of 50 km/h speed signs located immediately upon entry into the CBD, however, if the driver misses that single speed sign, they may not realise they have entered a lower speed zone, particularly because the 60 km/h zones they have just travelled through appear as "built-up" as the CBD.

Although RSS were found to be effective in reducing mean speed and the proportion of vehicles speeding, there were still drivers who sped on the treatment routes after installation of RSS. Therefore RSS are only part of the solution to speeding drivers, and other countermeasures need to be employed to target drivers who speed when the speed limit is clearly indicated.

In the present study, speed was measured approximately two months prior to, and two months after, installation of RSS, and a positive effect on speed and the proportion of vehicles speeding was observed. It is unclear whether this effect will be sustained, and this can only be answered by conducting follow-up speed measurements at a later date, preferably 12 months after installation. Nonetheless, this study has found that RSS were associated with reductions in mean speed in the Melbourne CBD, typically around 2 -3 km/h and reductions in the proportion of vehicles speeding. Speed reductions of this magnitude would be expected to lead to a reduction in the number of fatal and injury crashes, and measurable safety benefits in the mid and long-term.

REFERENCES

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APPENDIX

Table A1 Mean speed on all four routes before and after the repeater speed signs were installed on the treatment routes, for each time period.

Time period	Route		Before	After
Weekday	Treatment	Lonsdale	34.84 (10.97)	34.47 (11.51)
		Exhibition	26.93 (10.26)	26.85 (9.81)
		Overall	31.49 (11.37)	31.03 (11.42)
	Comparison	Queen	29.92 (9.67)	31.65 (10.32)
		Russell	28.99 (10.25)	29.66 (10.40)
		Overall	29.42 (9.99)	30.55 (10.41)
Weeknight	Treatment	Lonsdale	40.7 (10.89)	38.92 (11.76)
		Exhibition	34.37 (10.07)	33.53 (10.35)
		Overall	37.65 (10.97)	36.45 (11.45)
	Comparison	Queen	37.19 (10.02)	40.16 (10.61)
		Russell	34.19 (9.44)	34.41 (9.67)
		Overall	35.15 (9.73)	36.05 (10.28)
Weekday early hours	Treatment	Lonsdale	46.51 (10.28)	44.85 (10.72)
		Exhibition	39.6 (9.99)	39.34 (9.59)
		Overall	43.86 (10.71)	42.37 (10.59)
	Comparison	Queen	40.97 (10.34)	43.56 (11.05)
		Russell	40.81 (9.31)	42.34 (9.50)
		Overall	40.87 (9.71)	42.75 (10.06)
Weekend day	Treatment	Lonsdale	36.75 (10.70)	34.01 (11.07)
		Exhibition	33.19 (10.04)	30.09 (10.52)
		Overall	35.31 (10.59)	31.72 (10.92)
	Comparison	Queen	37.41 (9.68)	38.35 (10.40)
		Russell	32.39 (10.09)	31.9 (10.68)
		Overall	34.14 (10.23)	34.08 (11.02)
Weekend night	Treatment	Lonsdale	38.60 (11.48)	34.08 (12.06)
		Exhibition	31.53 (10.81)	31.07 (9.68)
		Overall	36.2 (11.75)	32.43 (10.93)
	Comparison	Queen	35.23 (10.01)	36.97 (10.68)
		Russell	31.57 (10.18)	30.97 (9.71)
		Overall	32.76 (10.27)	32.62 (10.34)
Weekend early hours	Treatment	Lonsdale	44.61 (10.29)	40.6 (11.12)
		Exhibition	37.81 (9.16)	38.24 (9.50)
		Overall	42.96 (10.44)	39.54 (10.49)
	Comparison	Queen	38.85 (11.01)	38.17 (10.78)
		Russell	38.93 (9.05)	38.83 (9.17)
		Overall	38.91 (9.65)	38.66 (9.60)

Table A2. Percentage of vehicles that were speeding on all four routes before and after the repeater speed signs were installed on the treatment routes, for each time period

Time period	Route		Before	After
Weekday	Treatment	Lonsdale	8.17	8.96
		Exhibition	1.80	1.48
		Overall	5.47	5.58
	Comparison	Queen	1.90	3.62
		Russell	1.93	2.47
		Overall	1.91	2.99
Weeknight	Treatment	Lonsdale	19.97	18.41
		Exhibition	5.68	5.12
		Overall	13.09	12.32
	Comparison	Queen	9.15	17.27
		Russell	3.77	4.88
		Overall	5.49	8.41
Weekday early hours	Treatment	Lonsdale	38.42	32.82
		Exhibition	14.52	13.23
		Overall	29.25	24.00
	Comparison	Queen	18.49	30.28
		Russell	14.68	20.19
		Overall	16.10	23.55
Weekend day	Treatment	Lonsdale	10.77	7.70
		Exhibition	4.53	3.17
		Overall	8.25	5.05
	Comparison	Queen	8.59	12.76
		Russell	3.23	4.02
		Overall	5.10	6.97
Weekend night	Treatment	Lonsdale	16.06	9.94
		Exhibition	3.94	2.58
		Overall	11.96	5.91
	Comparison	Queen	6.67	11.43
		Russell	2.70	2.51
		Overall	3.99	4.96
Weekend early hours	Treatment	Lonsdale	31.09	21.1
		Exhibition	8.30	10.05
		Overall	25.57	16.14
	Comparison	Queen	14.04	13.94
		Russell	9.71	11.49
		Overall	10.94	12.11