Effectiveness of speed indicator devices: An observational study in South London

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Abstract

Speed indicator devices (SIDs) are vehicle activated signs displaying the real-time speeds of passing vehicles. They are part of the array of road safety measures for managing speeds on local authority roads in the United Kingdom. This paper documents an evaluation of the effectiveness of SIDs that was carried out in South London in 2008. SIDs were installed at 10 sites in South London for periods of between one and three weeks. The overall effect of the SIDs being installed was a reduction in vehicle speeds of 1.4 mph and a significant reduction in the proportion of vehicles exceeding the speed limit.

The research also investigated the distance over which the SIDs are effective and the effect on vehicle speeds once the SID is removed. The results showed that a speed reduction occurred over a distance of up to 400 m and that once the SID is removed then, in general, the mean vehicle speeds returned to pre-SID levels by the end of the first week.

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1. Introduction

Each year, around one quarter of fatal casualties in Great Britain are injured in collisions where excessive or inappropriate speeds were among the contributory factors recorded by the police (DfT, 2009). Reducing vehicle speeds is therefore an important consideration for road safety specialists. In London, reducing vehicle speeds is a key target for Transport for London, the body responsible for the transport systems in the capital. Speed indicator devices (SIDs) are part of the range of methods that are being used to attempt to reduce vehicle speeds in London.

SIDs are signs that detect and display the speeds of passing vehicles. They are generally temporary, being relocated regularly, and this study is confined to the effects of these temporary SIDs. In addition to displaying vehicle speeds, some SIDs also display smiley or sad faces to drivers obeying or exceeding the speed limit, whilst others display a 'slow down' message to speeding drivers. Their aim is passive – to change drivers’ speed choices, rather than to have an enforcement role.

The research that was commissioned by Transport for London and is reported in this paper was designed to assess the effectiveness of SIDs across a range of sites in London. The study was also designed to investigate the characteristics of SIDs in more detail, such as their effectiveness over time and distance downstream of the SID.

The research questions that are discussed here are:

Q1: Do SIDs have an effect on vehicle speeds in free-flowing conditions?
Q2: Does the effect exist beyond the immediate vicinity of the SID?
Q3: Does the effect continue after the SID is removed?

There are very few formal evaluations of dynamic speed devices although SIDs are regularly used and evaluated by local authorities in the United Kingdom as a method of reducing vehicle speeds. Cruzado and Donnell (2009), McCoy et al. (1995), Rose and Ullman (2003) and Poulter and McKenna (2005) all evaluated these devices with before–after studies and conclude that the devices have an effect on reducing speeds whilst in operation, with the biggest effect being on drivers exceeding the speed limit by a large amount. However, once they are removed the effect does not remain. The majority of these studies have been carried out in America, primarily on high speed interstate highways and only one study evaluates the effectiveness of these devices on urban routes in the United Kingdom.

Poulter and McKenna (2005) installed a SID at five sites in the Royal Borough of Kingston-upon-Thames on a 30 mph road using a four weeks long trial. During the first week of the study, ‘before’ data were collected for week-days only, the SID was then installed and data were collected for two weeks. A week of follow-up ‘after’ data was collected once the SID was removed. Poulter and McKenna found that overall mean vehicle speeds reduced by 1.3 mph in the first week and 1.2 mph in the following week whilst the SID was active. A small decrease (0.2 mph) in mean speed was detected in the week after the SID was removed.

The study reported here applied similar methods to Poulter and McKenna, with some refinements. In addition to an overall...
assessment of the effectiveness of SIDs, this study investigates the effectiveness of SIDs further down the road and after the SID is removed. In addition SIDs were installed for between 1 and 3 weeks in order to assess the ‘novelty’ effect. These refinements allowed a more detailed analysis than was possible in the study by Poulter and McKenna.

2. Method

Ten study sites on single carriageway roads were selected in South East London. It was necessary to pick the study sites to be typical of a situation where a SID might be used by local authorities, so sites that were selected had a known speeding problem or a speed related collision in the previous three years. In addition, the site selection was controlled in respect of several factors so that interpretation of the results could be as consistent as possible. The chosen sites were all 30 mph sections of two-way single carriageway roads with no traffic calming, speed cameras, red light cameras, major junctions, sharp bends and no or few pedestrian crossings in the vicinity: all of these factors may influence speed choice.

Vehicle speeds were recorded at three or four points on the road near the position of the SIDs before, during and after the SIDs were operational, so for practical reasons, sites were also required to be on a long stretch of road in order to get sufficient space for three or four loops 200 m apart, and additional lengths at either end to ensure that traffic speed was not affected by vehicles approaching or leaving junctions – approximately 1 km of road was required between junctions for a three loop site and 1.2 km for a four loop site. Routes that remained un-congested for the majority of the day were chosen in order to observe as much free-flowing traffic as possible, so routes close to schools were rejected. No on-road parking was preferable; however, this was not always possible because of other restrictions on site selection and there was on-road parking at three sites.

In the study, the SID was installed for one week at three sites, for two weeks at four sites and the remaining three sites had a SID installed for three weeks. The signs were installed on different days, on roads with different traffic flows and for different periods in a designed experiment which was balanced as far as possible in order to reduce the possible effect of these external factors on the results. For example, it is unknown whether a SID is more effective if it is put in on a Monday or any other day, so a balance of installation days (day when the SID was installed) was required to control for this factor. It was not possible to implement a completely balanced design as there were three lengths of SID period and ten main study sites, however installation of the ten SIDs at the ten sites was spread or a speed related collision in the previous three years. In addition to this criterion, an additional speed criterion was added as speed distribution plots showed more vehicles travelling at lower speeds (i.e. less than 20 mph), in particular at rush hour, than would be expected.

Free-flowing traffic was therefore defined as all vehicles which were travelling above 20 mph with a headway of greater than 2 s.

The resulting database (all sites and all days combined) was used to investigate the following research questions:

Q1: Do SIDs have an effect on vehicle speeds in free-flowing conditions?
Q2: Does the effect exist beyond the immediate vicinity of the SID?
Q3: Does the effect continue after the SID is removed?

The individual vehicle speed data at each site were adjusted by the mean speed for that site in the before period at 200 m pre-SID. This controlled for the variability between sites and differences between speeds could be meaningfully compared across all sites in a combined-site analysis. All research questions were investigated by comparing the mean speeds before the SID was in place with the speeds of interest whilst controlling for the baseline speeds, defined as those observed at 200 m pre-SID. It was necessary to control for baseline speeds at 200 m pre-SID as this reduced the chance of a speed difference being due to an external random effect rather than the SID. The detectable effect \( \delta_x(t) \) equation for period \( t \) at location \( x \) is detailed below in Eq. (A) and is an ANOVA contrast or planned comparison on the mean speeds \( \mu_x, \mu_{1,\text{before}} \):

\[
\delta_x(t) = (\mu_x(t) - \mu_{1,\text{before}}(t)) - (\mu_1(t) - \mu_{1,\text{before}}(t)) \quad \text{(A)}
\]

where \( x \) is defined from 1: 200 m pre-SID to 4: 400 m post-SID.

It should be noted that due to the way that the contrast is calculated, the contrast calculated for a group of sites is not the average of the contrasts calculated for the individual sites.

These effects are conservative estimates of the effect of the SIDs as they assume that the drivers were not affected by the SID from 200 m pre-SID. This may not always be the case as the driver may well have seen the SID being activated by a vehicle in front and reacted by slowing down. In addition the filtering process may also contribute to a conservative effect. For example, all speeds less than 20 mph were eliminated, this may lead to more cases being filtered in the ‘during’ SID operating phase if vehicles travelling at slow speeds are also affected by the SID (i.e. they travel even slower and as a result are filtered out).

Each question is investigated by analysis of an appropriate subset of the complete database. To answer question Q1, mean speeds in the ‘before’ and ‘during’ periods at the SID site were compared, controlling for the baseline speed before the SID site (200 m pre-
SID), that is $\delta_{\text{at SID}}$ (during) in Eq. (A). Q2 was answered by testing the difference between the ‘before’ and ‘during’ periods at loop3 and at loop4 (taking into account the differences at loop1 in both cases), that is, $\delta_{200 \text{ m post-SID}}$ (during) and $\delta_{400 \text{ m post-SID}}$ (during). Q3 was answered by testing the difference between the ‘before’ and ‘after1’ period at loop2: $\delta_{\text{at SID}}$ (after1) and testing the difference between the ‘before’ and ‘after2’ period at loop2: $\delta_{\text{at SID}}$ (after2).

4. Findings

4.1. Q1: Do SIDs have an effect on vehicle speeds in free-flowing conditions?

The conservatively estimated detectable effects of SIDs on vehicle speeds in free-flowing traffic are detailed in Table 1. The overall estimate is a reduction in mean vehicle speeds of 1.4 mph over the whole period of operation relative to the baseline speed differences at ‘200 m pre-SID’ and ‘at SID’. On a site by site basis, the largest effect, a reduction in mean speeds of 2.6 mph, was observed at one site where the SID was active for the maximum three week period. The minimum detectable effect was observed at a site where the SID was active for only one week.

In addition there were significant reductions in the proportion of vehicle speeds recorded that were exceeding the speed limit (from 57% before to 45% during). These proportions relate to the set of data selected to represent free-flow conditions, so the proportions for the full set of data would be lower; the pattern, however, is obviously of interest.

4.2. Q2: How far beyond the SID does the speed reduction last?

The detectable effects 200 m and 400 m downstream of the SIDs are shown in Table 2. The mean reduction in vehicle speeds 200 m after passing the SID was 0.2 mph, and reductions at individual sites varied from 0.6 mph to 0.1 mph, relative to the before data.

Further downstream (400 m after passing the SID) an overall increase of 0.6 mph in speed was detected compared to the baseline results. Individual site analyses showed that the maximum decrease in mean speed was 0.2 mph and at one site an increase in mean speeds of <0.1 mph was detected. The overall result is higher than the minimum individual site effect due to the contrast method not being an average of the individual sites.

4.3. Q3: Does the effect continue after the SID is removed, and if so for how long?

Once the SIDs had been removed from study sites, two further weeks of vehicle data were collected to investigate whether there was any continuing effect. Table 3 shows that overall no detectable effect on mean speeds was observed during the first week after the SIDs were removed, and a small rise in mean speeds was observed in the second week. Some continuing effect (up to a decrease of 0.5 mph) was observed at sites where a large effect was recorded whilst the SID was active.

4.4. Estimated collision reductions

There has been much research into the link between vehicle speed and the frequency of injury collisions (e.g. Taylor et al., 2000, 2002; Nilson, 2004). Clearly the number of collisions is also affected by other road and traffic conditions, however it is generally accepted that higher speeds lead to more collisions. Taylor et al. (2000) concluded that the reduction in collisions per 1 mph speed reduction on urban medium speed (mean speed 25–35 mph) roads is 4%. It is assumed in this relationship that the reduction in number of collisions is equally distributed across all severities. Nilson (2004) presents a similar relationship, however this includes a different relationship for different collision severities. At 30 mph, a reduction in speed of 1 mph is predicted to reduce injury accidents by 6.6%, serious injury accidents by 9.7% and the number of fatal accidents by 12.7%.

These two results from Taylor et al. (2000) and Nilson (2004) have been used to estimate the collision reduction that might be expected from installing SIDs in London using the approach adopted in this study.

### Table 1

Overall effect of SID on mean speed at the SID during operation.

<table>
<thead>
<tr>
<th>Site</th>
<th>Effect (mph)$^a$</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites$^b$</td>
<td>$-1.4^c$</td>
<td>(-1.46, -1.39)</td>
</tr>
<tr>
<td>Max</td>
<td>$-2.6^c$</td>
<td>(-2.67, -2.46)</td>
</tr>
<tr>
<td>Min</td>
<td>$-0.6^c$</td>
<td>(-0.73, -0.49)</td>
</tr>
</tbody>
</table>

$^a$ A value <0 indicates a reduction in speed whilst SID is operational.
$^b$ Includes full data for seven sites and incomplete data for another site.
$^c$ Indicates a statistically significant effect.

### Table 2

Effect of SID on mean speed at 200 m and 400 m post-SID.

<table>
<thead>
<tr>
<th>Site</th>
<th>200 m post-SID</th>
<th>400 m post-SID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect$^a$ (mph)</td>
<td>95% confidence interval</td>
</tr>
<tr>
<td>All sites$^b$</td>
<td>$-0.2^c$</td>
<td>(-0.24, -0.17)</td>
</tr>
<tr>
<td>Max</td>
<td>$-0.6^c$</td>
<td>(-0.66, -0.45)</td>
</tr>
<tr>
<td>Min</td>
<td>$-0.1^c$</td>
<td>(-0.25, 0.14)</td>
</tr>
</tbody>
</table>

$^a$ A value <0 indicates a reduction in speed whilst SID is operational.
$^b$ Includes full data for seven sites and incomplete data for another site.
$^c$ Indicates a statistically significant result.

### Table 3

Effect mean speed once the SID is removed.

<table>
<thead>
<tr>
<th>Site</th>
<th>After 1 week</th>
<th>95% confidence interval</th>
<th>After 2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect$^a$ (mph)</td>
<td>95% confidence interval</td>
<td>Effect$^a$ (mph)</td>
</tr>
<tr>
<td>All sites$^b$</td>
<td>0.0$^c$</td>
<td>(-0.07, 0.01)</td>
<td>0.1$^c$</td>
</tr>
<tr>
<td>Max</td>
<td>$-0.5^c$</td>
<td>(-0.66, -0.42)</td>
<td>$-0.5^c$</td>
</tr>
<tr>
<td>Min</td>
<td>0.6$^c$</td>
<td>(0.51, 0.78)</td>
<td>0.6$^c$</td>
</tr>
</tbody>
</table>

$^a$ A value <0 indicates a reduction in speed whilst SID is operational.
$^b$ Includes full data for seven sites and incomplete data for another site.
$^c$ Indicates a statistically significant result.
The overall speed reduction achieved by an active SID was shown to be 1.4 mph, although this reduction applied only over a relatively short stretch of road and for up to three weeks of installation. The Taylor conclusion suggests that a 6% reduction in injury collisions might be expected on the section of road where the SID is influencing drivers’ speed choice and Nilsson suggests that the estimated reduction of all injury collisions would be 9%, of serious injuries by 14% and fatalities by 18%.

5. Limitations of study

The aim was to collect speed data continuously from one week before the SID was operational, during the SID operation until two weeks after the SID was removed, at three or four points per site. In practice the ATCs were not always reliable and around 10% of the data were missing or unreliable due to mechanical failure of the ATC.

These missing data have led to the analysis not including three of the ten sites, and the during3 and after periods for a further site, due to insufficient or inconsistent baseline data. The sites that remained had much less missing data and the data that were available were sufficiently representative to be used to produce an estimate.

The SIDs used in this study were temporary and not part of a rotation scheme, so the cost of adapting a lamp column to power the SID could not be justified. Therefore, the SIDs were powered by battery. SIDs were revisited 10 days after installation to replace the batteries. Further visits were made to replace the batteries of SIDs which were on site for longer periods.

The SID batteries were not totally reliable, and four sites had periods where the SID was installed but not operational. During these times, drivers may have seen the SID but no speeds would have been displayed. Data collected during these times were excluded from the analysis. In practice it was impossible to tell exactly when a SID stopped displaying speeds and so it is likely that the excluded data contains some data collected whilst the SID was operational, which is another reason for suggesting that the results are conservative.

6. Conclusions

An overall speed reduction of 1.4 mph was detected across all sites whilst the SIDs were activated. This is similar to the reduction of 1.3 mph found by Poulter and McKenna (2005). The speed reduction at all sites was statistically significantly better than no effect. The effect varied across sites from 2.6 mph at one site where the SID was installed for three weeks to 0.6 mph at one site where the SID was only implemented for one week.

The Texas Transportation Institute report (Rose and Ullman, 2003) suggested that SIDs are especially effective on speeding drivers. To confirm this suggestion, the proportions of drivers exceeding 30 mph were evaluated and shown to be significantly reduced at all sites whilst the SID was in operation, showing that speeding drivers are affected by SIDs.

At most sites and overall there was a small yet statistically significant reduction in mean speeds at 200 m downstream from the SID (a reduction of 0.2 mph in the during period compared to the before period). This effect was less than a quarter of the effect recorded at the SID at most sites. An even smaller effect or an opposite effect (increase in speeds of 0.6 mph) was observed 400 m downstream implying that any effect after 400 m is likely to be negligible. The increase in speeds of 0.6 mph observed at 400 m downstream could suggest some migration of risk; however a larger study would be required to confirm this. Overall, this study has shown that there is a small to negligible effect of the SID downstream.

In addition, there was no lasting effect after the SID was removed. A small reduction in speeds remained at those sites where the SID had most effect when in place.

The overall mean speed reduction of 1.4 mph has been used to estimate that a reduction in injury collisions of between 6 and 9% could occur at sites where a SID was operational for a short period of time, and that the proportion of fatal collisions could reduce by 18%. This effect is likely to be limited to a stretch of road about 400 m in length and the effect is unlikely to continue after the SID is removed. The overall effect of the estimated casualty saving is not large. Formally, the decision whether to adopt SIDs would require the discounted costs (capital and operational costs) and benefits (casualty reduction, and environmental) to be compared. A full cost benefit analysis was outside of the scope of this research, so it has not been possible to judge whether the speed reductions that have been identified can justify a wider SIDs programme. However, SIDs are one of the many speed management measures available and can be used in combination with other speed management strategies. The use of SIDs may be the best, most appropriate or cost effective solution in some areas for a short period of time.

References


