Urban Traffic Calming and Environmental Noise: Effects and Implications for Practice

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Summary

For up-to-date knowledge relating to healthy public policy

This summary is the third in a series of five[1] short documents based on a literature review published in 2011.[2] In what follows, we first present the mechanisms of action underlying traffic-calming strategies,[3] as these mechanisms help explain and predict the effects of such strategies on traffic noise. Next, we summarize the results of studies having evaluated two approaches to traffic calming[4] (please refer to the brief descriptions of black-spots and area-wide approaches below). Lastly, we consider the implications of such results for public health.

Two approaches to traffic calming

The black-spots approach is typically aimed at improving road safety. It encompasses strategies advocating the installation of calming measures (speed humps, roundabouts, etc.) at one or more specific locations considered to be at high risk for collision.

The area-wide approach, while it also often includes road-safety objectives, aims more generally to improve the living environment. It encompasses intervention strategies whose scope of application is a network comprising more than one street.

Mechanisms of action underlying traffic-calming strategies

Five mechanisms of action help to explain and predict the effects of traffic-calming strategies on traffic noise.

Reduction of vehicle speeds

In general, vehicle noise increases with speed. This association is stronger for cars than for heavy vehicles. In fact, the noise made by heavy vehicles is mainly generated by the engine and the exhaust system, and thus does not vary much with speed, unlike the noise caused by the friction of tires on pavement (Abbott, Tyler, & Layfield, 1995).

Traffic-calming strategies generally aim to reduce driving speeds (often to about 30 km/h), and particularly those of the fastest drivers (Transportation Demand Management Encyclopedia, 2010). Consequently, calming strategies that succeed on this level should contribute the most to reducing vehicle noise.

Reduction of speed variations

Increasing the magnitude, the frequency and the rate of accelerations and decelerations tends to increase the noise generated by accelerating motors and by brakes, for example.

Traffic-calming strategies can lead to speed variations when, for example, a speed hump is installed, since vehicles may have to slow down to drive over it. However, they can also reduce speed variations, particularly when several speed humps are installed one after the other to encourage low, constant speeds, or when mini-roundabouts are installed at intersections to improve traffic flow at low speeds, for example. It is thus reasonable to expect that calming schemes which reduce speed variations help reduce the amount of noise generated by vehicles, whereas those which, inversely, increase speed variations lead to an increase in noise.

[1] The four other documents focus on road safety, air quality, active transportation and inequalities.

[2] To consult the comprehensive version of the literature review, please see our document entitled *Urban Traffic Calming and Health: A Literature Review* at: http://www.ncchpp.ca/175/publications.ccnpps?id_article=686.

[3] Our definition of "traffic calming" is presented in the introduction to our literature review, and its historical origins are detailed in our document entitled *Traffic Calming: An Equivocal Concept*, available at: http://www.ncchpp.ca/175/publications.ccnpps?id_article=648.

[4] For a detailed description of the two approaches and the political contexts surrounding them, please see our document entitled *Traffic Calming: Political Dimensions*, available at: http://www.ncchpp.ca/175/publications.ccnpps?id_article=670.

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Reduction of traffic volume

The relationship between traffic volume and noise is variable. A reduction in the number of motor vehicles on a street or in an area, for example, can reduce the average noise level generated by traffic there. However, depending on the street configuration, a reduction in the number of motor vehicles can also lead to an increase in the speed of the remaining vehicles, which are no longer limited by the presence of as many other vehicles. When such an increase in speed occurs, an increase in the maximum noise level emitted by each of the remaining motor vehicles is to be expected.

Consequently, the effect on noise levels of interventions that reduce traffic volume on a street or in an area should depend on the implementation context and, in particular, on the volume of traffic before and after the intervention, as well as on the characteristics that determine the speed of vehicles in the affected area.

Introduction of textured materials

Textured materials, such as paving stones, can increase noise from vehicles travelling over them by causing their bodywork to vibrate, for example.

The use of calming measures incorporating this type of material, such as textured pedestrian crossings, could contribute to an increase in traffic noise.

Introduction of vertical deflections

Vertical deflections of the pavement, such as those produced by speed humps or speed cushions, can increase suspension noises or noise from objects carried in a trailer, for example.

Strategies that incorporate calming measures including such deflections are thus likely to increase noise from vehicles affected by vibrations. The impact of these calming measures therefore depends on their design and on the type of vehicles travelling on the streets where they are used.

Results of evaluative studies

Study results are categorized into the two approaches described to highlight their respective effects.

To provide a few points of reference concerning noise perception, it is generally accepted that a variation of:

- 1 decibel A (dB(A))[5] is only perceptible under controlled conditions;
- 3 dB(A) is perceptible;
- 6 dB(A) is obvious;
- 10 dB(A) is perceived as the doubling or the halving of the loudness of a sound.

(Environment Agency, 2004)

EFFECTS OF THE BLACK-SPOTS APPROACH

Reduction of maximum noise level of cars

One report concludes that the installation of traffic calming measures with vertical deflections leads to substantial reductions in the maximum noise level of cars (-6.6 to -10.3 dB L_{Amax})[6] due to important reductions in speed (-15 to -18 km/h) (Abbott et al., 1995).

Increase in maximum noise level of heavy vehicles

The same report indicates that with the exception of speed humps (-2.1 dB L_{Amax}), calming measures with vertical deflections tend to increase the maximum noise level of heavy vehicles (+2.1 to +7.9 dB L_{Amax}) despite substantial reductions in speed (-2 to -20 km/h) (Abbott et al., 1995).

Reduction of average noise level at roundabouts

One article indicates that replacing an intersection controlled by traffic lights with a roundabout reduces the average ambient noise level both during the day

5 The A-weighted decibel or dB(A) is a unit of measurement weighted according to a filter, A, to take into account the way the human ear responds to sound frequencies.

6 **L_{Amax}**: The maximum A-weighted sound pressure level. This indicator should be used to measure a limited number of discrete sounds, such as the passage of a few cars at night on a local street with little traffic (World Health Organization [WHO], 1999; WHO Regional Office for Europe, 2009).

and at night (-1 dB L_{Aday} to -2 dB L_{Anight})[7] (Campolieti & Bertoni, 2009).

Favourable perception

Another article reports that residents perceived a reduction in noise nuisances following calming of their street (Morrison, Thomson, & Petticrew, 2004).

EFFECTS OF THE AREA-WIDE APPROACH

Reduction of maximum noise level of cars

One report indicates that an area-wide strategy which incorporates various calming measures (raised intersections, pedestrian refuges, curb extensions, raised crosswalks, speed cushions, medians, mini-roundabouts and gateways) reduces the maximum noise level of cars (-0.7 to -6.5 dB L_{Amax}) (Cloke et al., 1999).

Increase in maximum noise level of heavy vehicles

The same report measured the maximum noise level of heavy vehicles at a mini-roundabout equipped with speed cushions and found the maximum noise level of these vehicles had increased (+4.5 to +6.2 dB L_{Amax}) despite a substantial decrease in vehicle speed (-7.1 to -13.8 km/h) (Cloke et al., 1999).

Reduction of ambient noise levels

Taking into account all noise sources, the same report measured a decrease in the highest noise levels (exceeded 10% of the time) at nearly all locations where measurements were taken (-0.1 to -6.8 dB L_{A10}),[8] both during the day and at night, but reports more variable measurements of background noise (levels exceeded 90% of the time [L_{A90}])[9] (Cloke et al., 1999). The authors of this report link decreased noise levels to reduced traffic speeds and volumes in the area. Another article, focused on a scheme involving installation of 21 mini-roundabouts, reports reductions in average noise levels at the three intersections evaluated (-1.6 to -4,2 dB L_{Aeq}) (Hyden & Várhelyi, 2000).

Neutral or favourable perception

Two reports indicate that the majority of residents questioned had not noticed any difference when asked if noise levels had changed after their area was calmed (Cloke et al., 1999; Hemsing & Forbes, 2000). Nevertheless, one of these reports, having compared the answers given before and after the intervention, found that fewer respondents said they were disturbed by noise after the interventions (Cloke et al., 1999).

Implications for practice

It is important to underline the fact that traffic calming is mainly promoted as a way of reducing collisions, injuries and deaths, and not of reducing the amount of noise generated by motor vehicles. While many studies demonstrate the effectiveness of traffic calming for improving road safety, studies are less abundant and less conclusive concerning the effects of calming on environmental noise.

However, these studies lead to the conclusion that the **two approaches to traffic calming** can reduce traffic noise, when the traffic flow comprises few or no heavy vehicles. The latter are more sensitive than cars to vertical deflections, which can cause vibrations, and to speed variations, which can lead to an increase in the maximum noise levels emitted by their engines and exhaust systems. It follows that reductions in the average and maximum noise levels due to speed reductions may be annulled and may even be replaced by increases when such vehicles travel over calming measures with vertical deflections or through areas where interventions have resulted in speed variations. On streets where heavy vehicles circulate and where noise is a major concern, it is thus preferable to avoid the use of such calming measures and to reserve them for use on local residential streets where they can help reduce noise nuisances.

The studies focused on **the black-spots approach** point more specifically to the advantage of using calming measures with vertical deflections on

7 **L_{Aeq} T**, **L_{Anight}**, **L_{Aday}**: The A-weighted equivalent average sound pressure level for a time period, T, or over an entire night or day. This indicator should be used to measure relatively continuous noise, such as road traffic on a major artery (WHO, 1999; WHO Regional Office for Europe, 2009).

8 **L_{A10}**: The A-weighted noise level which is exceeded 10% of the time for a given time period. This indicator, less commonly used today, was widely used in the past to measure the relatively continuous noise of road traffic, but it is generally very strongly associated with the noisiest isolated events, as measured by L_{Amax} (WHO Regional Office for Europe, 2009).

9 **L_{A90}**: The A-weighted noise level which is exceeded 90% of the time for a given time period. This indicator, less commonly used today, was used in the past to measure background noise, which excludes the noisiest isolated events (WHO Regional Office for Europe, 2009).

residential streets where few or no heavy vehicles circulate. Indeed, these measures can produce substantial reductions in the maximum noise level (-6.6 to -10.3 dB L_{Amax}) by considerably reducing vehicle speeds (-15 to -18 km/h) (Abbott et al., 1995). For roads with higher volumes of circulation and where the presence of heavy vehicles is more pronounced, it is worth noting that the replacement of traffic lights with roundabouts can lead to a slight reduction in average ambient noise levels (-1 dB L_{Aday} to -2 dB L_{Anight}) by encouraging lower, more constant speeds (Campolieti & Bertoni, 2009).

The **optimal discrete interventions** for reducing traffic noise are those that help reduce both driving speeds and speed variations, such as roundabouts designed to achieve these effects.

As regards studies focused on **the area-wide approach**, these highlight the advantages of interventions that reduce the volume of traffic while also encouraging low and constant speeds on all streets within a calmed area where noise is a major concern. It is particularly worth noting that the implementation of a traffic-calming scheme including mini-roundabouts at intersections where few or no heavy vehicles circulate can reduce noise levels at these intersections by 1.6 to 4.2 dB L_{Aeq} by reducing speeds and speed variations (Hyden & Várhelyi, 2000).

The **optimal area-wide strategy** for reducing traffic noise reduces traffic volume, or is implemented in conjunction with measures that reduce volume, while encouraging low, constant speeds.

For public health actors who consider it relevant to promote traffic calming strategies based on the area-wide approach, the mechanisms of action identified show two theoretical advantages over the black-spots approach:

1. By intervening in a systematic way throughout an area, the area-wide approach seems better adapted than the black-spots approach to the development of schemes that **encourage low, constant driving speeds**, schemes that opt, for example, for the installation of calming measures in close succession, which discourages speed variations between calmed points on the street network.
2. The other advantage of the area-wide approach is that it attempts, more often than the black-spots approach, to **reduce the volume of traffic** in a given area and, thus, to remove a portion of the vehicles responsible for noise.

That said, it is important to distinguish between **two ways of reducing the volume of traffic** in a given area, because they have potentially different effects on health and its determinants:

- The first is predicated on **modal shift**, that is, it aims to reduce the number of trips made by automobile, in particular, by increasing active (cycling, walking, etc.) and collective (subway, tramway, etc.) transportation. In addition to having beneficial effects on other health determinants (physical activity, air quality, injuries, etc.), reducing the number of trips made in motor vehicles in an environment where low, constant speeds are encouraged is the manner most conducive to reducing the amount of noise generated by road transportation.
- The second way consists of **redirecting some of the traffic** using local residential streets toward the main road network (arteries, highways). This approach, often at the heart of area-wide calming strategies, is sometimes promoted as a way to encourage a modal shift toward cycling or walking, for example. Nevertheless, in certain contexts, this approach carries the risk of increasing **health inequalities** by simply shifting the noise onto arteries and highways. In reality, persons with less favourable socioeconomic circumstances tend to be overrepresented as residents close to these roads (Smargiassi, Berrada, Fortier, & Kosatsky, 2006). Thus, when a calming strategy is designed to divert some portion of traffic, it is important to examine the potential effects of this traffic on the roads toward which it is redirected (risk of congestion, traffic volume, air quality, etc.) and on their residents (presence or absence of residents, health status, socioeconomic status, etc.). In some cases, this examination may make it necessary to seek ways to offset these effects (redirection toward arteries located far from any residents, demand management initiatives[10]

[10] Demand management refers to strategies aimed at increasing people's mobility by increasing road capacity by less than anticipated demand, by preserving existing capacity, or even by reducing it. In concrete terms, this often consists of diversifying travel options (subway, tramway, carpooling, cycling, walking, etc.) to reduce car travel.

focused on the affected sections of arterial and highway networks or on the network as a whole, installation of sound barriers, etc.).

> Channelling traffic on residential streets toward transit roads may reduce noise levels on residential streets, but increase noise levels on transit roads. In certain cases, this type of intervention can contribute to an increase in **health inequalities**, because the residents close to these roads tend to have less favourable socioeconomic characteristics. Therefore, it is necessary to search for ways to mitigate these effects — for example, by redirecting traffic toward transit roads without residents, by integrating demand management efforts, or by setting up acoustic barriers.

While calming strategies that do not favour the use of calming measures comprising vertical deflections or resulting in speed variations on streets used by heavy vehicles generally lead to a reduction in traffic noise, the decision to promote such strategies should be based on **a global perspective** that also takes into account their effects on other health determinants. The literature review we carried out demonstrates that, in general, the interventions evaluated: (1) substantially reduced the number and severity of collisions; (2) increased per vehicle air pollutant emissions, although area-wide strategies that reduce traffic volume can reduce total emissions; (3) were, in some cases, accompanied by an increase in active travel, although it was not possible to determine why this increase was not observed in other cases (Bellefleur & Gagnon, 2011). In urban environments, the mechanisms of action point toward the conclusion that better results can be expected from strategies based on the area-wide approach. However, excepting the effects on air pollutant emissions, the evaluative studies are inconclusive in this regard.

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