Thirty years on: Do motorcar daytime lights reduce accidents?

Evidence of monitoring studies

In the winter of 1972, Finland enacted the world's first DRL (Daytime Running Lamps) law. The drivers of all vehicles were compelled to have their lights on in daytime.

The next two winters, fewer elk and deer happened to cross the road in daytime.

So daytime multi-party accidents in Finland fell[1].

On the basis in 1977 Sweden too made it compulsory for drivers to have their lights on in daytime all the year round.

To date Norway and Denmark, in Northern Europe; and Canada and Hungary, elsewhere in the World, have followed suit[2].

Monitoring studies of each law were conducted.

Passing over the failure of other accidents besides animal accidents to fall, the study of the Finnish winter law claimed that the law been a success.

A preliminary study of the Swedish law (1979) stated that the law had made no difference. But after extensive statistical remodelling of the data, the final study (1981) claimed instead that the law had been a success.

The studies of the Canadian (1994) and Hungarian (1995) laws likewise claimed that the laws had been a success.

But the studies of the Norwegian (1986 & 1993) and Danish (1993) laws made equivocal or adverse findings[3].

At the same time lay critics scrutinised the Finnish, Swedish, Canadian, and Hungarian data; discovered discrepant or unreliable findings[4]; and disputed the claims of success.

Then in 1995 academic critics Theeuwes & Riemersma in Holland reanalysed the Swedish data, and made the 'revised' finding that the Swedish law had made no difference[5].

No laws were repealed.

Instead first in 1996, Elvik in Norway reanalysed the data of all of the monitoring studies of motorcar daytime lights laws (and a number of motorcar fleet studies besides) together.

He then made a 'meta-finding' that the laws had in fact overall been a success[6].

Second in 1997, Koornstra *et al* in Holland reanalysed the data of the studies, by a common method, separately.

They then made 'revised' individual findings, again, that all of the laws had been a success.

Indeed the findings went further: they demonstrated a progressive increase in the effectiveness of daytime lights from Southern to Northern latitudes[7].

Nevertheless the findings of Elvik and Koornstra *et al* fail to stand up to critical scrutiny:

Elvik 1996: The lay critics had revealed, by 'disaggregating' the Finnish authors' data of multi-party accidents into separate data of multi-vehicle accidents, pedestrian accidents, and other accidents, that, as above:

1. Only animal accidents fell after the Finnish law.

Likewise, by disaggregating the Swedish authors' two-year by two-year data into separate year by year data, they had revealed that:

2. Multi-party accidents were in fact higher in the second year after the Swedish law than in the last year before the law.

By his method, Elvik 'snubbed' the lay critics.

Compounding the 'offence' of the original study authors, he took the 'aggregated' data of each study country, but instead of in turn also disaggregating it, 'reaggregated' the data of all of the studies together yet again.

Elvik's final presentation of findings from the combined data of all of the countries did not therefore, in the spirit of critical review, reveal—and seek to explain—the discrepant findings within, or between, individual study countries.

Rather it concealed the discrepant findings yet more thoroughly than the presentation of the original study authors.

Koornstra et al *1997:* Equally, Koornstra *et al* did not in fact, as they claimed, employ a common method to analyse the data for every country.

On examination, fatally to the 'consistency'—and so scientific validity—of their findings, they employed discrepant methods.

Two damaging points that had been noted by the academic or lay critics were:

1. The failure of the Swedish findings 'in favour of' daytime lights to achieve 'statistical significance'
2. The Norwegian findings 'against' daytime lights.

In response, Koornstra *et al* first disaggregated the Swedish data for reanalysis into separate Summer and Winter data, and thereby 'lent' statistical significance to the favourable final analysis of the original Swedish authors[8].

They then in turn applied the same method to the Norwegian data.

But the method failed to 'upset' the unfavourable analysis of the Norwegian data by the original Norwegian authors[9].

Accordingly, part way through the Norwegian reanalysis, Koornstra *et al* abandoned the method, and reaggregated Summer and Winter data[10].

By the new method they then successfully achieved also a 'revised' analysis of the Norwegian data that was now 'in favour of' daytime lights[11].

So the findings of Elvik and Koornstra *et al* do not 'rescue' the study findings, and 'restore' them in favour of motorcar daytime lights.

Rather, to sum up, the evidence of the monitoring studies remains an inconclusive mish-mash of favourable, equivocal and adverse findings.

Method of monitoring studies

Given the findings of the monitoring studies, it might seem unnecessary to go on to consider also their method.

But in fact the most severe criticism of the claimed findings of the studies in favour of daytime lights goes not to the study findings themselves, but to the study methods.

Thus largely the method that the studies employed was to analyse the study data for a reduction of daytime multi-vehicle (or multi-party) accidents as measured by the 'odds-ratio': namely the ratio of multi-vehicle to single-vehicle accidents in daytime divided by the ratio in nighttime.

The odds-ratio might afford a 'specific', and so satisfactory, measure of the effect of daytime lights if the ratio of multi-vehicle to single-vehicle accidents were constant throughout the daytime and nighttime.
But the ratio of multi-vehicle to single-vehicle accidents is not constant. Rather it falls and rises with changes in traffic density[12].

So by its formulation the odds-ratio will not just respond to a reduction of daytime multi-vehicle accidents from the greater use of daytime lights.
It will also respond in identical fashion to a reduction of nighttime single-vehicle accidents from a lower volume of late evening driving.

The deficiency might be overlooked if during the 1970s and 1980s, at the time of the studies, the volume of late evening driving had been stable.

But notoriously in the study countries the period coincided with an aging driver population; a changing pattern of evening social activities; and police activity directed against drinking and driving.

Or to sum up, the evidence of the monitoring studies is made up of findings that on scrutiny are derived by a method that is irremediably unspecific and worthless.

Prima facie case

Motorcycle studies suggest that accidents seriously 'start to happen' when a driver ignores the right of way of a motorcycle when it is less than 3 seconds (eg 88yd at 60mph [80m at 97kph]) away from him or her.
If the driver of the other vehicle is unalert, the distance may be longer[13].

Likewise for motorcars, it can be taken that the distance is of the same order.

But at less than 100yd a motorcar is clearly visible.
Indeed a study found that, under perfect viewing conditions, people could still see a motorcar at more than 3000m (1.85 miles)[14].

Correspondingly the object of motorcar daytime lights is not to reduce accidents by making the motorcar more 'visible', but by making it more 'conspicuous', ie noticeable.

Against the background, in 1975 Swedish authors conducted a series of experiments intended to establish a satisfactory specification of motorcar daytime lights.
The specification would assure a greater detection distance of the motorcar (1) in central vision, and (2) at 30° peripheral angle, in daytime, without aggravating glare to unacceptable levels on lit roads in nighttime[15].

On the basis of their findings, by way of a practical compromise[16] between darktime glare, and daytime conspicuity, the Swedish authors recommended white 200 candlepower daytime running lights at least 50cm² (7.8sq in) in area.

Four adverse side effects of motorcar daytime lights can be anticipated in the circumstances:

(1) As reflected in the objects of the Swedish authors' specification, daytime lights may cause ‘specific’ glare, namely glare on lit roads at night that adversely affects individual other road users.

The glare may be minimised by a compromise intensity of illumination of daytime lights.

But as the Swedish authors found, beyond a certain point, glare cannot be further reduced without also losing the benefits of daytime lights.

(2) Daytime lights may cause ‘general’ glare, namely glare in daytime or nighttime that aggravates the perceptual ‘hostility’ of the existing road scene to all road users.

(3) ‘What attracts, also distracts’. A light that is powerful enough to act as a peripheral stimulus, and so ‘attraction’, at 30° is also powerful enough to act as a ‘distraction’ at the same angle.

(4) Driver and other road users may fail to give way to a motorcar for other reasons besides that they failed to notice it.

As canvassed above, the ‘critical’ distance at which drivers fail to give way to another vehicle may be under 100yd.

At such a distance other reasons, such as that the driver misestimated the motorcar's speed and distance, are more plausible than that he failed to notice it.

If so, motorcar daytime lights may give drivers a dangerous false confidence that other drivers will give way to them, when in practice an important number of them will not do so.

Further, apart from the side-effects, whereas in 1978, English authors found that 8.7% more pedestrians noticed a motorcycle using daytime lights, just under four years later in 1982, they found that only 4.8% more pedestrians did so[17].

Or in short, pedestrians were ‘acclimatising’ to motorcycle daytime lights.

Similarly, one may expect that the noticeability of motorcar daytime lights too will be substantially diminished over time by the same process of acclimatisation

Or to sum up, daytime lights may make motorcars more noticeable. But on the other side of the coin, they have important side effects. And the effect to make motorcars more noticeable diminishes with time, so may not endure.

Conclusion

A harsh verdict cannot be avoided.

Motorcar daytime lights have important potential adverse side effects. The prima facie case in their favour is equivocal. Daytime lights must therefore be supported by evidence.

However the evidence of the monitoring studies is conflicting, and inconclusive. Even if it were not so, the studies measure the effect of daytime lights by an unspecific method. Correspondingly their findings are worthless.

In 1972 daytime lights were first made compulsory in Finland. They have now also been made compulsory in at least five other countries. Yet thirty years on, a reduction of accidents from motorcar daytime lights remains unproven.

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1 Andersson *et al* 1976: In the Swedish-language main text of their paper, Andersson *et al* list separate data of multi-party accidents under the heads of multi-vehicle, pedestrian, and 'other' accidents.
'Other' multi-party accidents, in turn, they explain, are to a large extent animal accidents: *'Övriga flerpartsolyckor innehåller till en stor del djurolyckor'*.

Per Lehtimäki 1984, reciting compensation statistics, between 1970 and 1975 in Finland, elk (*Alces alces,* or moose) and white-tailed deer (*Odocoileus virginianus,* or Virginian deer) accidents rose from some 400 to 1500 per annum.
Andersson *et al*, by contrast, recite road accident statistics. They report 515 'other' accidents in the winter of 1972/73, and 487 in the winter of 1973/74.

By comparison with nighttime accidents, the figure of daytime 'other' accidents was exceptionally volatile in Finland during Andersson *et al*'s study period.
Thus for the two winters of their 'before' period (1970/71 & 71/72), daytime other accidents totalled 640 and nighttime other accidents 830.
By contrast for the two winters of the 'after' period (1972/73 & 73/74), they totalled 294 and 707.

To break down Andersson *et al*'s findings, they found a fall in the odds-ratio for multi-party accidents from the before period to the after period of 1.88 to 1.76.
The separate figures, on the one hand, for 'other' accidents—*gratis* the halving of daytime accidents in the after period—were a fall of 1.35 to 0.79.
But on the other hand, for multi-vehicle accidents, they were a trivial change from 2.27 to 2.25, and for pedestrian accidents, again, a trivial change from 0.90 to 0.91.

Lehtimäki 1984 conducted an extensive study of elk and white-tailed deer accidents in Finland from 1965 to 1979. The period included the full period of Andersson *et al*'s study (1968–1974).
Lehtimäki found no evidence that elk or deer responded to vehicle lights at all.

2 Norway: 1985 Canada: 1989
Denmark: 1990 Hungary: 1993, 1994

3 Andersson *et al* 1976 Holló 1995
Andersson & Nilsson 1979, 1981 Vaaje 1986, Elvik 1993
Arora *et al* 1994 Hansen 1993

4 Finland:
- Effectively no change of multi-vehicle or pedestrian accidents following law—Fall only of 'other' accidents, (as comprising to a large extent animal accidents)

Sweden:
- Fall of multi-party accidents only in first year after law—Recovery of multi-party accidents in second year after law to higher figure than in last year before law

Canada:
- Fall of multi-vehicle accidents for one-year-old motorcars built in first year after law—But unexplained lower fall for brand-new motorcars built in second year after law

Hungary:
- Confusing background of other road safety measures
- No information of pedestrian accidents
- Fall of multi-vehicle accidents and pedal cycle accidents taken together—But only if rear-end multi-vehicle accidents excluded from analysis

5 Theeuwes & Riemersma 1995

6 Elvik 1996

7 Koornstra *et al* 1997 8 *Ibid* pp 96–102 9 *Ibid* pp 102–112

10 *Ibid* pp 112: 'Because of the significant differences between the summer and winter DRL-effects and their variances, one must not estimate a DRL-effect by an analysis of annual totals, but by the average of summer and winter DRL-effects'

11 *Ibid* pp 112–114

12 To illustrate the corresponding sensitivity of the odds-ratio to changes in traffic density, the hour of onset of darkness changes relative to working hours—and so to the hours of greatest traffic density—through the course of the year.

Andersson *et al* 1976 published a table of the monthly odds-ratio values for multi-vehicle accidents in Finland for 1968–1974.

During the period, the figure of the value ranged from a winter low of 1.29 (Dec 1974) to a summer high of 6.22 (Aug 1974).

[To give scale, as noted earlier, Andersson *et al* relied upon a fall in value of the odds-ratio of just 1.88 to 1.76 for their finding 'in favour' of daytime lights.]

13 Olson *et al* 1981: Olson *et al* conducted a 'gap acceptance' experiment with volunteer motorcycle riders.

The riders travelled along a 55–70kph (34–43mph) thoroughfare at a distance of up to 3sec (46–58m [50–64yd]), behind a 'lead car', and recorded whether motorcar drivers at intersections infringed their right-of-way.

Some 5% of motorcar drivers at intersections did infringe the riders' right-of-way; yet none of the riders had an accident.

14 Hörberg & Rumar 1975 15 *Ibid*

16 Hörberg & Rumar 1975's 'ideal' compromise specification would have been yellow daytime running lights of candlepower 100 ± 50cd (nighttime), or 1000 ± 500cd (daytime), being at least 70 cm² in area.

But they felt constrained by practical considerations to specify a single intensity of illumination for both daytime and nighttime.

17 Fulton *et al* 1980, Donne & Fulton 1985: To render the finding more precisely, the figures of 8.7% and 4.8% represent the difference between:
- The percentage of pedestrians at the same site in Nottingham in 1978 and 1982 who noticed a motorcycle using a 40W low-beam headlight in daytime (24.4% and 21.5%)
- The percentage who noticed a 'control' motorcycle not using daytime lights (15.7% and 16.7%).