Sat navs and the "human" factor

I have an interest in transportation statistics, so I read Tobias Jolly’s article, "Could a safest option on sat navs save lives?" (Significance, July 2014), with interest. I want to point out some aspects in which the highlighted statement – that 124 traffic deaths per year in the UK could be saved – is problematic.

The data analysed by the author are from an observational study. The death rates are the outcomes; the drivers’ choices (the road class taken) constitute the treatment variable; and there are a host of background variables which summarise the trips (the use of the roads). Other background variables to be considered are the drivers’ schedules, skills, road congestion, road condition during the trip, and the like – but they are not available.

Driver choices are not under control, as they might be in a “1984” world in which we are told (or programmed) what, when and how to do things, and where the execution of our every task is machine-like. Sat navs influence drivers’ choices, by encouraging certain selections for a given start and end of a journey, but they do not control them.

Drivers are a heterogeneous lot. Most of them are confident that their skills are well above both the average and the median – this fact (or my presumption of it) disqualifies those opinions outright. However, the suggestion that we are just drivers and the death rates, quoted (estimated) in microcents per mile, apply to every one of us is not realistic. I conjecture that not only do we differ in some overall assessment of our driving skills, but we also have relative strengths and weaknesses, not necessarily known to us or to anyone else.

Not all accidents and deaths can be attributed solely or partially to the victims or their drivers, but drivers’ conduct and skill are certainly non-ignorable factors in many deaths. We cannot dismiss the hypothesis that there is a sizable minority of drivers who are safer on rural A roads than on motorways, despite the overall assessment that motorways are much safer.

Therefore, the advice about safety – implied by the author, is worthwhile taking only by an average driver or, more precisely, one with no relative strengths or weaknesses in driving. One strength may be that some drivers are safer on roads with nicer scenery and other features that they like or that come closer to matching their current psychological disposition affected by everyday mundane affairs. Thus, there are numerous confounders in the analysis (not all of them touched on above), and not having them recorded is not a good reason for assuming that they are irrelevant.

The public health perspective is more complex matter. Safety of a road class is not a property solely of the roads (the constructions, signages, police supervision, and the like), but also of its clientele (drivers and their journeys) and their interactions, broadly interpreted, which include the level of congestion. If drivers change their practices (how they select roads for their trips), the characteristics of the various road classes are bound to change. In brief, the human – a driver, rider or other participant in traffic – is an important cause in addition to the immobile features of the roadway.

In this perspective, the author’s estimate of the lives saved by changed practices – that is, by altering the values of some of the confounders – is without any merit, because it disregards the “human” factor.

The general subject of making causal inferences (what would happen if…?) from data collected in observational studies is treated in a very readable way by Rosenbaum in Design of Observational Studies (Springer-Verlag, 2010).

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Should have been 8%, not 5%?

Mark Kelley provided an excellent historical review of the surprisingly loose choice of 5% as the statistical significance level in his piece “Emily Dickinson and monkeys on the stair, or: What is the significance of the 5% significance level?” (Significance, October 2013).

One logical approach that could have been used is to examine the shape of the normal distribution curve and determine whether or not any threshold exists. Beyond that threshold, a rapidly decreasing probability density will result in a marked increase in the number of subjects in the case of clinical research. As a result, the cost of the trial would increase disproportionately for the return achieved.

The standard way to look for a threshold is to determine when there is a spike in the second derivative. This approach is used commonly for edge detection during image enhancement, it is recognized in business and has been used in clinical research.

The first and second derivatives of the standard normal distribution curve, with mean of 0 and variance of unity, are as follows:

\[ df(x) / dx = \phi(x) \exp(-x^2 / 2) \]

\[ df(x) / dx = (x - 1) \phi(x) \exp(-x^2 / 2) \]

The second derivative is maximal when \( x = \pm 1.732 0.5 \), which corresponds to a \( p \)-value of 0.083.

An alternative approach might be to determine the point where the concavity in the normal distribution curve is maximal relative to the first derivative:

\[ k(x) = \left( \frac{df(x)}{dx} \right)^2 \left[ 1 + \left( \frac{df(x)}{dx} \right)^2 \right]^{-1.5} \]

The maximal curvature \( k(x) \) occurs when \( x = \pm 1.349 83 \), which corresponds to a \( p \)-value of 0.08.

Perhaps the statistically significant \( p \)-value should be 8% rather than 5%. The 5% level is too deeply entrenched to be changed, but at least 8% has some justification.

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References
