National Center for Sustainable Transportation

POLICY BRIEF

Average Impact and Key Features of Onboard Eco-driving Feedback

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Issue

Driver behavior has a significant impact on vehicle fuel economy and emissions. Eco-driving refers to anything a driver can do to improve on-road fuel economy; see Figure 1 for examples. The most common strategy used to promote eco-driving is an in-vehicle display that provides the driver with feedback about their fuel efficiency, typically in real-time, as shown in Figure 2.

Researchers conducted an extensive review and analysis of many studies of eco-driving feedback in order to determine the average impact of feedback on fuel economy and improve understanding of what types of feedback are most effective. It provides the most accurate estimate to-date of the average impact of in-vehicle feedback on fuel economy and summarizes the current state of knowledge regarding characteristics of eco-driving feedback interventions that determine effectiveness.

Although studies of eco-driving feedback find it can be effective in improving fuel economy, results are widely variable. This inconsistency is likely due to a variety of factors that differ across studies, including feedback design, study participants and setting, and length of the feedback intervention. For example, feedback designs range from accelerator pedals that create resistance when the driver attempts to over-speed, to complex visual displays that gamify fuel economy, rewarding the driver with points or positive images. Many studies use vehicle simulators, while others outfit participants' personal or work vehicles with feedback devices. Some involve professional drivers of fleet vehicles and others civilian drivers of private vehicles.

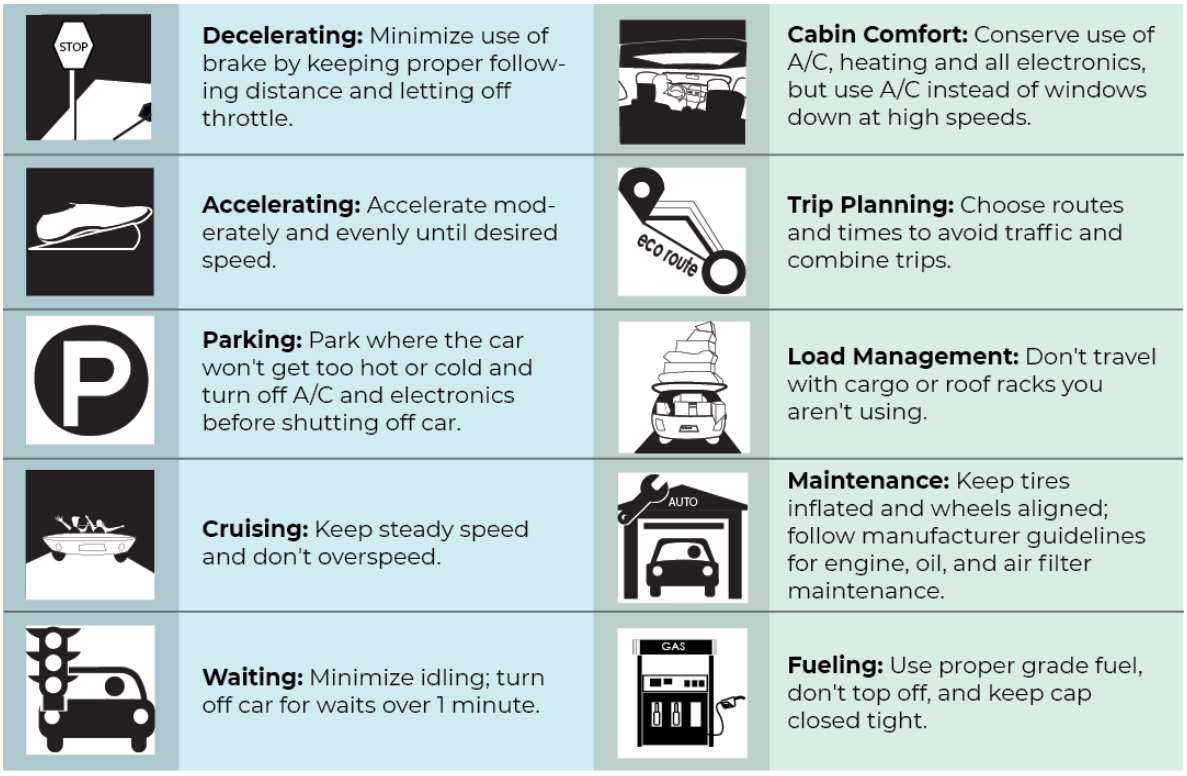

Figure 1. Categories and examples of eco-driving.

No policies require manufacturers to provide eco-driving feedback, however, feedback systems of increasing variety are appearing in vehicles. Drivers are receiving more and increasingly complicated data from their vehicle as they drive, which raises concern for driver distraction. Understanding what types of feedback are effective can help drive efforts to standardize information and reduce driver distraction.

Key Research Findings

The average effect of in-vehicle eco-driving feedback is 6.6% improvement in fuel economy. This is a weighted average across 17 studies analyzed, which takes into account study sample sizes. The effect is statistically significant and there is a 95% chance that the true effect would fall between 4.9% and 8.3% improvement in fuel economy. The average fuel economy without feedback in these studies (i.e., in baseline phases or control groups) was about 25 MPG. A 6.6% improvement from this baseline would be equivalent to 1.7 MPG. Those implementing eco-driving programs can expect results in this range.

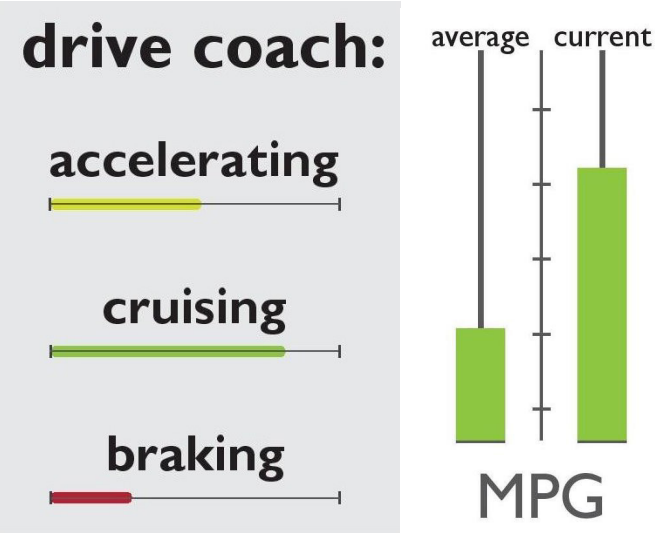

Figure 2. These images depict two types of eco-driving feedback displays, located on an instrument cluster, center screen, or aftermarket digital device. On the left, the position and color of the horizontal bars reflect the efficiency of specific acceleration, cruising, and braking events. On the right, current and average miles per gallon (MPG) displayed side-by-side enable the driver to easily compare, assess, and set a goal to maintain or improve.

Eco-driving feedback effects often deteriorate over time. On average, the effects of feedback decreased as the length of interventions increased (about -0.1% per day). This is not to say the effects of all types of feedback always wear off. Further research might identify feedback designs that are sufficiently salient and motivating that drivers do not end up tuning them out and reverting to old habits. For example, auditory and haptic pedal (counter-pressure) feedback are far less common than visual feedback, but may be more salient.

Behavioral theory can inform more effective eco-driving feedback designs. Although this research was not able to identify with statistical certainty any specific feedback design features that make it more or less effective for improving fuel economy, trends in the data and behavioral theory suggest that driver feedback should include the following features:

- Multiple modalities (e.g., visual and haptic or auditory rather than visual only)
- Fine- and course-grained information (e.g., average and instantaneous fuel economy)
- Feedback standards against which to compare performance
- Game-like design elements (e.g., points, levels, badges)
- In addition, they should be used in combination with other interventions, such as education and rewards contingent on performance.

Further Reading

This policy brief is based on "Onboard Feedback to Promote Eco-Driving: Average Impact and Important Features," a white paper from the National Center for Sustainable Transportation, prepared by Angela Sanguinetti of the University of California, Davis. To download the white paper, visit: https://ncst.ucdavis.edu/white-paper/onboard-feedback-promote-eco-driving/

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doi:10.7922/G2V98688