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Effectiveness of Dynamic Speed Feedback Signs

In 2019, 26 percent of all traffic fatalities in the United States were speeding-related.[1] Speeding-related crashes cost society hundreds of billions of dollars annually.[2] Speed management tools are available to address this problem, among them education and media campaigns, traditional and automated enforcement, and engineering. A dynamic speed feedback sign (DSFS) measures an approaching vehicle's speed with radar and displays the speed to the driver. DSFSs educate drivers about how their driving behavior aligns with posted speed limits and expected norms, giving drivers real-time feedback on their driving speed, which allows them to "self-enforce" their speed. DSFSs can also be combined with automated enforcement technologies. As an added roadway display element, DSFSs can also be considered engineering tools. DSFS combines the features of all three speed management components: education, enforcement, and engineering.

Study Overview: Using published research, this study performed a comprehensive, quantitative review of the effectiveness of DSFSs in different contexts, where effectiveness was measured by vehicle speed reductions. Results include a literature review, a statistical meta-analysis, and an annotated bibliography. Taken together, they provide evidence that DSFSs can be effective tools for managing speeds and improving traffic safety with data that show statistically and practically significant speed reductions across a range of circumstances.

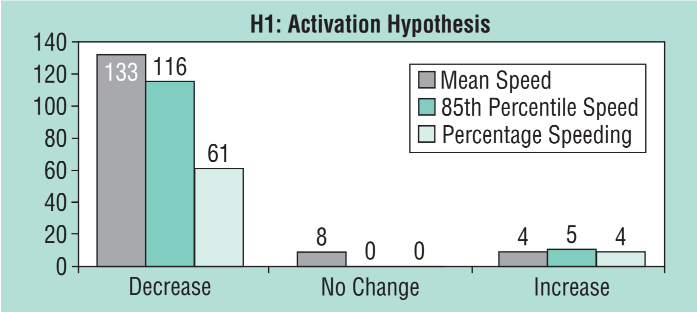
Literature Review and Meta-Analysis

A comprehensive literature review on the effect of DSFSs on driver behavior was conducted. The review identified 77 publications containing domestic studies. Of these, 43 passed screening for relevance and quality and were included in these analyses. A single reviewed publication could include more than one study; for example, one publication could contain studies of both work zones and school zones. Furthermore, each study could contain observations for more than one DSFS site. There were 57 studies reviewed in the 43 publications, with a total of 204 DSFS sites. Three dependent variables dominated in the literature: the average speed, the 85th percentile speed (commonly used to set speed limits), and the percentage of vehicles traveling over the posted speed limit.

DSFSs can lead to different types of speed reduction effects, all of which should be considered when installing or evaluating a DSFS. First, installation of a DSFS can influence speeds at the DSFS when it is **activated**. Second, activation of the DSFS can also affect the speed of vehicles **downstream** of the DSFS. And third, **deactivation** of the DSFS can have a lingering effect on the speed of vehicles at the DSFS and downstream of the DSFS sometime after the DSFS has been deactivated. In this study these three effects are called the *Activation Hypothesis*, the *Downstream Hypothesis*, and the *Deactivation Hypothesis*. While published studies consider different combinations of these hypotheses, this study combines them into a unified framework for the first time.

When a DSFS Is Activated: Of the 145 evaluations of average (mean) speed at DSFS sites, 133 showed statistically significant decreases in average speeds, 8 showed no statistically significant change, and 4 showed increases. The majority of sites (92%) were consistent with the Activation Hypothesis that vehicle speeds would decrease at the DSFS site when activated. The meta-analysis showed substantive reductions of 2 to 4 mph at the DSFS sites. While fewer studies used the 85th percentile speed or percent over the posted speed limit (percentage speeding) as dependent measures, over 90 percent of these sites also showed decreases in speeds (Figure 1).

Figure 1. Number of Studies Showing Speed Changes When DSFS Activated



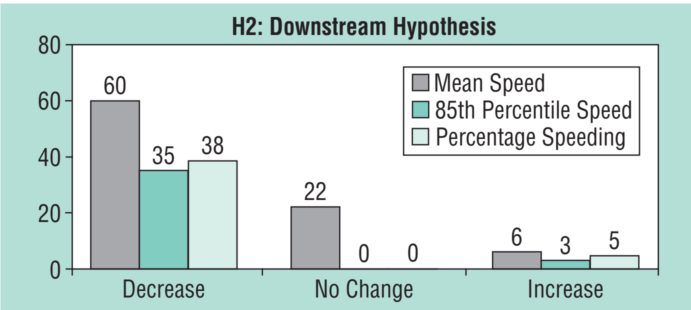
Effects Downstream When DSFS Is Activated: Changes in speed downstream of the DSFS while the DSFS is activated can be measured with respect to the speed upstream of the DSFS

[1] National Center for Statistics and Analysis. (2021, May) *Quick facts 2019* (DOT HS 813 124). National Highway Traffic Safety Administration.

[2] Blincoe, L. J., Miller, T. R., Zaloshnja, E., & Lawrence, B. A. (2015, May) *The economic and societal impact of motor vehicle crashes, 2010.* (Revised) (Report No. DOT HS 812 013). National Highway Traffic Safety Administration.

or the speed at the DSFS. Of the 88 sites using the upstream speed as reference points, over two-thirds (68%) had average (mean) speed reductions. While fewer studies measured changes in 85th percentile speeds or speeds over the posted limit (percentage speeding), about 90 percent of these sites also showed decreases in speeds downstream from the activated DSFS (Figure 2).

Figure 2: Number of Studies Showing Effects Downstream – DSFS Activated



Carryover Effects of DSFS After Deactivation: Compared to the number of studies used to test the first two hypotheses, fewer studies measured the residual effect after DSFS deactivation. The change in speed at the DSFS after deactivation can be measured relative to the DSFS sensor before activation or relative to the DSFS during activation. Three publications with eight sites measured the speed at the DSFS after deactivation relative to the speed at the DSFS sensor before activation. The meta-analysis found reductions of 2 mph at the DSFS sites.

Safety Focus of DSFS Deployments: Evaluations of DSFS effectiveness focused on work zones, school zones, transition zones, and curves. This study found a significant decrease in speeds in 45 of the 52 work zone sites when DSFS was installed, with the meta-analysis indicating average speed reductions of 2.75 mph at the DSFS during activation. School zones showed similar effectiveness, with 24 of 28 sites showing significant reductions in average vehicle speed at the DSFS during sign activation. Speed reductions at the DSFS of 3.21 mph were detected overall in school zones across all vehicle types during DSFS activation. DSFS installations were effective in significantly reducing vehicle speeds at the DSFS during activation in all 29 transition zone sites, with average speeds reduced by 2.79 mph. The meta-analysis also found average speed reductions of 2.27 mph overall along curves.

Annotated Bibliography

The annotated bibliography presents details on each of the 43 publications in a consistent format, allowing in-depth examination of sign types, study designs, and the specific characteristics of each study. Each entry includes information on publication citation and screening for relevance and quality. Other information includes hypotheses evaluated; dependent variables used to evaluate the hypotheses; results of those evaluations; characteristics of the study that the practitioner needs to know to implement the DSFS in a similar setting; and aspects of the experimental design researchers need to know to evaluate the quality of the study.

Conclusions: This report presents evidence that DSFSs can be effective in reducing average speeds, 85th percentile speeds, and the percentages of drivers over the posted speed limits in a range of contexts. Across all types of vehicles and different installation locations, a clear majority of studies found significant reductions in speeds at the DSFSs when the DSFSs were activated. Overall, reductions of 4 mph at the DSFS were detected as a result of DSFS installation for passenger cars, and reductions between 2 and 4 mph at the DSFS were detected across all vehicle types in the different contexts assessed.

Small reductions in speed can make a big difference in traffic safety. Lowering speeds by 2 mph from 40 to 38 mph can reduce fatal vehicle-pedestrian strikes by 20 percent; lowering speeds by 4 mph, for example from 42 to 38 mph, can reduce the risk of fatal vehicle-pedestrian strikes from 50 percent to 37 percent.[3] The effects of DSFSs in reducing vehicle speeds demonstrates that these signs can be effective tools in saving lives.

Project Note: Congress directed NHTSA to establish the National Cooperative Research and Evaluation Program (NCREP) to conduct research and evaluations of State highway safety countermeasures. Each year NHTSA and the Governors Highway Safety Association work with the States to identify potential highway safety research or evaluation topics believed to be important for informing State policy, planning, and programmatic activities. This project was conducted under the NCREP.

The full report, *Effectiveness of Dynamic Speed Feedback Signs, Vol. 1: Literature Review and Meta-Analysis,* and the Vol. 2: *Appendices and Annotated Bibliography* is available for download. at: https://rosap.ntl.bts.gov

[3] Tefft, B. (2001). *Impact speed and a pedestrian's risk of severe injury or death.* AAA Foundation for Traffic Safety.

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