Research Report Summary

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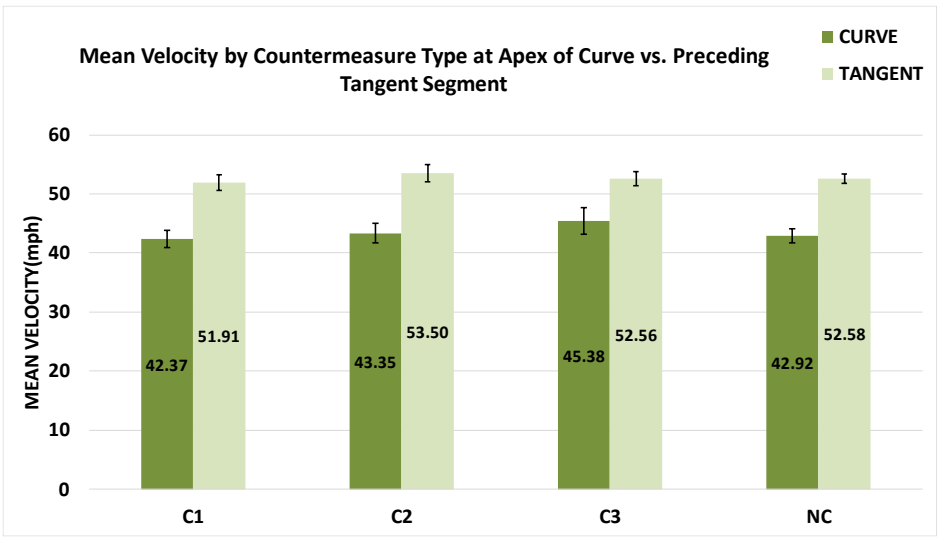
Speeding on Curves and Potential Countermeasures

A Driving Simulator Assessment

The most prevalent types of crashes that occur on horizontal curves are run-off-road (ROR) crashes, head-on crashes and curve-related crashes (Torbic et al., 2004). As a special component of roadway design, curves have a comparatively complex road geometry that makes driving more difficult (Hummer et al., 2010).

A driving simulator experiment was conducted using 48 participants with the objective to evaluate the efficacy of speed-calming countermeasures on horizontal curves. An added aim was to measure the driver's lateral positioning as a function of various speed-calming countermeasures and hazard anticipation.

Speeds at curves were reduced when compared to a tangent section, which highlighted the



Countermeasures and Hazards

Heads-Up Display | Advanced Curve sign with advisory speed limit | Left and Right Chevron Signs

The three types of curve countermeasures that were used for the experiment were heads-up display (HUD), advanced curve warning sign with advisory speed limit, and chevron signs, which are all shown above.

All participants drove eight short virtual drives with a hazard anticipation condition at the apex for each curve. Example hazards were unique to each drive and included a pedestrian crossing a crosswalk obscured by bushes at the curve apex, a truck entering the travel lane from the work zone, and so on.

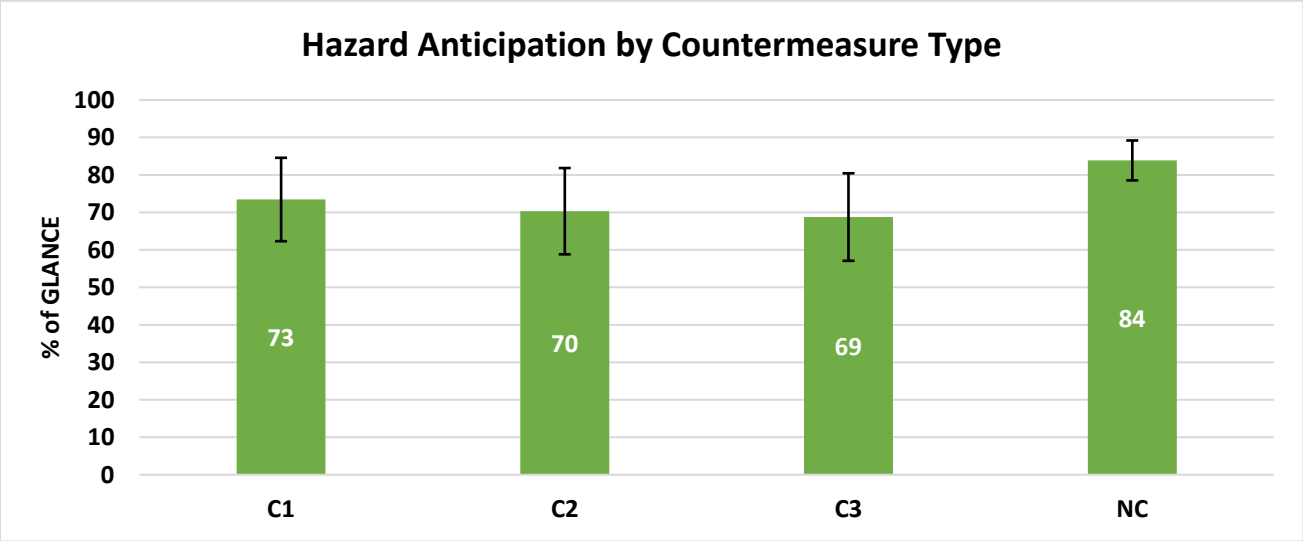
The 48 participants were divided into three groups of 16. Each group encountered only one of the three countermeasures. The control condition, "No Countermeasure," was driven by all 48.

Countermeasure	Participants
C1	16
C2	16
C3	16
No Countermeasure (NC)	All 48

fact that drivers had better speed control and were adhering to recommended speed limit of 45 mph. There was no significant difference in speeds on the tangent section across the three countermeasures. However, it was found that the presence of a heads-up display (HUD) significantly reduced speeds on curves as compared to just chevrons and advanced curve warning signs.

"Heads-up display warning signs were the most effective, not only in terms of speed calming at horizontal curves, but also for increasing hazard anticipation at the apex of the curve."

Results from the experimental study showed that drivers were able to slow down on horizontal curves when provided with countermeasures before the entry of the curve, in the entry tangent section. It was noted that speeds were reduced more for sharp curves than for flat curves.



Scenarios:
C1 – Heads Up Warning Sign + Advanced Curve Warning Sign + Chevrons
C2 – Heads Up Warning Sign + Advanced Curve Warning Sign
C3 – Advanced Curve Warning Sign + Chevrons
NC – Control condition, no countermeasures

The driver's glance rate was higher with HUD warnings as opposed to the traditional advanced curve warning sign and chevron sign. Participants in the virtual drives who had HUD (C1 and C2) as part of the countermeasure were able to anticipate hazards better than drivers who did not, although drivers with no countermeasure (NC) glanced at the hazard more often overall.

References

1. Torbic, D. J., Harwood, D. W., Gilmore, D. K., Pfefer, R., Neuman, T. R., Slack, K. L., & Hardy, K. K. (2004). A guide for reducing collisions on horizontal curves. *NCHRP Report*, *500*(7).
2. Hummer, J. E., Rasdorf, W., Findley, D. J., Zegeer, C. V., & Sundstrom, C. A. (2010). Curve collisions: road and collision characteristics and countermeasures. *Journal of Transportation Safety & Security, 2(3)*, 203-220).