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Radar Detectors and Speeds in Maryland and Virginia

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Before 1974, the speed limit on most interstate highways in the United States was 65 to 75 mph. Most other rural highways were posted at or above 55 mph. In 1974, maximum speed limits of 55 mph were introduced in every state, and motor vehicle fatalities declined dramatically—32 percent on interstate highways and 15 percent overall (National Research Council 1984). Speed is important because high speed increases crash likelihood and severity.

Despite the lifesaving benefits of lower speed limits and lower travel speeds, many motorists exceed the speed limit. For example, the Federal Highway Administration estimates that the average proportion of U.S. drivers traveling faster than 65 mph on rural interstates has increased from about 9 percent in 1981 to 17 percent in 1985 (U.S. Department of Transportation 1981; 1985). It has been claimed that the increasing noncompliance with highway speed limits is at least partly due to increasing use of low-cost radar detectors, which can alert speeding drivers to the presence of police radar. These radar detectors are small specialized receivers tuned to sense police radar signals in use on the highway.

The Maryland State Police reported that 33 percent of 7,632 passenger vehicles cited for speeding between June 1985 and May 1986 had radar detectors; most of the speed stops were triggered by VASCAR, which is a nonradar method of speed detection. Of the 1,190 commercial vehicles that were cited, 79 percent had detectors (Maryland State Police 1986). Radar detectors are currently legal in all jurisdictions except Virginia, Connecticut, and the District of Columbia. Virginia State Police issued about 35,000 citations between January 1, 1985, and April 30, 1987, for possessing radar detectors (Robinson 1986; 1987).

A pilot study in Texas using both conventional police radar and radar that had been retuned to a slightly different frequency to prevent its detection found that average speeds declined three miles per hour in the presence of police radar. Among gravel-hauling trucks on one highway, the average slowdown was 15.6 mph (from 73.2 to 57.6 mph). In addition, some cars traveling over 65 mph slowed down rapidly in response to suddenly activated police radar.

The current study was undertaken to measure the influence of radar detectors on speeding. Data were collected on similar roadways in two adjacent states: Virginia, which prohibits radar detectors, and Maryland, which does not. The study was designed to measure the extent to which vehicles violating speed limits slow down when a police radar unit is activated and the extent to which overall vehicle speeds are affected as a result of some vehicles having radar detectors.

METHODS

Three sets of data were collected in Maryland: speed distributions in the presence and absence of conventional police radar as measured by an automatic speed monitoring station; speed distributions in the presence or absence of police radar as measured by nondetectable radar; and speed changes among fast vehicles as measured by nondetectable radar when police radar was suddenly activated. Data collection procedures were similar in Virginia except that speed distributions from monitoring stations were not collected. A standard radar unit was retuned for use in this study so that its signals could not be picked up by commercial radar detectors. All data were gathered during clear or overcast weather with dry pavement on mostly level, straight roadways on interstate and primary highways posted at 55 mph. Speed measurements were obtained in freely moving traffic. At nearly all times during collection of data, Citizens Band (CB) radio conversation (on Channel 19) was monitored to determine if drivers with radar detectors were alerting other drivers of the presence of radar signals. However, only limited discussion of this kind occurred.

Speed Distributions from a Monitoring Station

Vehicle speeds were measured using Maryland Department of Transportation "inductance loops," which are wires embedded in the pavement and connected to electronic recorders at the roadside. Pairs of loops in each lane, one loop several feet ahead of the other, are used to measure the speed and length of a vehicle as it passes over and induces an electrical current in the loops. Three vehicle length categories were used to indicate vehicle type: vehicles 20 feet or less in length typically include passenger cars and light trucks; those 20 to 40 feet in length include most straight (large single-unit) trucks, buses, and bobtails (tractor units without trailers); and those 40 feet or more in length include most combination (tractor-trailer) trucks.

The monitoring station was located on a rural segment of I-70 eastbound in Washington County, Maryland, which is a four-lane interstate highway. Conventional police radar was deployed during alternating hours during the day and evening on Friday and Saturday, December 12 and 13, 1986, while the monitoring station was automatically recording traffic data. The radar unit, which was used solely as a transmitter of signals capable of activating radar detectors, was placed adjacent to the electronic recorders at the roadside and was switched on or off at the start of each hour. Data included hourly vehicle counts according to vehicle length and lane use, as well as numbers and proportions of vehicles exceeding 60, 65, and 75 mph during each one-hour interval.

Speed Distributions from Radar

In this part of the study, speed data were collected using a conventional police radar unit and a radar unit that was retuned to a slightly different transmission frequency so that its signal was effectively nondetectable by commercial radar detectors. By Federal Communications Commission regulation [47 *CFR* Sec. 90.19 (5)(6)], police Doppler radar can operate on only two frequencies. Testing demonstrated that radar detectors responded to the retuned radar unit only at distances of four feet or less. With conventional police radar systems, the detectors responded at distances of up to 8,000 feet.

With the nondetectable radar, speeds of vehicles in free-flowing traffic were measured at four sites each in Maryland and Virginia. Two of the four pairs of sites were interstate highways, one pair included divided highways with nearby intersections, and the fourth pair included two-lane rural roads. All had posted speed limits of 55 mph. Data were gathered during daylight hours between Monday and Thursday during two weeks of August and September 1986. The site locations and number of observations are as follows:

<u>Maryland</u>

I-270, Montgomery Co., mile 12, four lanes; 940 obs.

I-95, Harford Co., mile 20, six lanes; 1,083 obs.
U.S. 301, Charles Co., mile 13, four lanes; 676 obs.
U.S. 15, Frederick Co., mile 2, two lanes; 612 obs.

Virginia

I-66, Prince William Co., mile 49, four lanes; 799 obs.
I-95, Stafford Co., mile 144, six lanes; 1,013 obs.
U.S. 301, King George Co., 2 miles north of Port Royal, four lanes; 257 obs.
U.S. 17, Fauquier Co., near Delaplane, two lanes; 482 obs.

In both states, all speed measurements were taken using the nondetectable radar unit; the conventional police (detectable) unit was used solely as a transmitter of radar signals capable of activating radar detectors. Speeds for vehicles were determined first with the nondetectable radar unit operating for 30 or 45 minutes, and then as both the nondetectable and detectable radar units were operating for 30 or 45 minutes. After at least a 15-minute pause, this same alternating pattern was repeated.

Both types of radar units were located in a Chrysler Corporation minivan, which is not typically used or perceived as a police vehicle. The minivan was parked off the left or right shoulder of the road and was oriented either parallel or perpendicular to the traffic flow, depending on roadside features, and was clearly visible to approaching traffic. The distance from the minivan to the nearest lane of traffic varied from about 10 to 90 feet, due to terrain and the availability of roadside rest areas, side roads, and service roads adjacent to the selected sites.

The transmitting antennas of the radar units were kept out of view inside the observation vehicle; the antenna of the nondetectable radar was aimed at either approaching or receding traffic about 350 to 1,300 feet from the observation point, and the antenna of the detectable radar was nearly always aimed at approaching traffic. Vehicles were observed moving only in one direction, except on the two-lane roads, where traffic moving in both directions was monitored.

Three corrections were applied to each indicated vehicle speed. First, because the radar unit truncated decimal fractions of speed (for example, an actual vehicle speed of 60.9 mph was displayed as 60 mph), a value of 0.5 mph was added to each indicated speed to compensate for the average amount truncated. Second, the angle between the direction of vehicle travel and the transmitted radar beam varied from three to nine degrees, depending on site location and vehicle lane position. As the angle between the traveling vehicle and the radar beam increased, vehicle speeds indicated by radar declined from the vehicle's actual speed; hence, speed measurements were adjusted upward by dividing by the cosine of the angle. Third, a correction was applied to account for the increase by 1.45 percent in transmission frequency of the nondetectable radar compared to the frequency of the detectable radar. Each speed reading was reduced by this percentage to obtain actual vehicle speed. The net effect of the three corrections on indicated speeds was a reduction averaging 0.1 to 0.2 mph.

Other data collected were travel lane, vehicle type, and state of registration. Vehicles were classified into five main types: passenger cars, sports/specialty cars, light trucks, straight trucks, and tractor-trailer trucks. Sports/specialty cars were defined according to Highway Loss Data Institute (1986) criteria as two-seaters, convertibles, midsize and larger cars with two or fewer designated rear seating positions, and luxury vehicles. Passenger cars were defined as cars other than sports/specialty cars. Light trucks were defined as all pickups, vans, and utility vehicles (gross vehicle weights typically under 10,000 pounds). Straight trucks were defined as all single-unit trucks with gross vehicle weights generally over 10,000 pounds (for example, step vans and dump trucks); buses were included with straight trucks. Tractor-trailer trucks were defined as combination trucks with one or more trailers; bobtails were included with tractor-trailers.

Observed speeds were analyzed by the GLM procedure of SAS (SAS Institute 1985). Variables included as predictors of speed were vehicle type, travel lane, road pair, and the presence or absence of detectable radar. Results for significant effects are presented in terms of mean speeds estimated by the least squares method of GLM.

Speed Changes in Response to Activated Detectable Radar

Nondetectable radar was aimed at approaching traffic and left on for periods from ninety minutes to three hours at seven paired locations in Maryland and Virginia. On all roads, traffic moving in only one direction was monitored. When an unobstructed vehicle traveling at an initial speed of 62 mph or more was observed, the detectable radar unit, which was also aimed toward approaching traffic, was activated for 15 to 30 seconds and any change in vehicle speed indicated by the nondetectable radar unit was recorded. The observation equipment was as described in the preceding section, except that a Nissan pickup truck or a two-door Ford Escort were often used instead of the minivan. Data were collected during daylight hours on weekdays and weekends between late September and late October 1986. Data for comparison roads in Maryland and Virginia were collected either on weekdays or weekends for both roads (additional data only for I-66 were collected on a weekday). Two of the seven pairs were interstate highways, one was an interstate paired with a primary highway built to interstate standards, one was a limited access primary highway, two were unlimited access primary highways, and one pair was of two-lane highways. The locations of sites where vehicle speeds were measured using suddenly activated radar were as follows:

Maryland

I-270, Montgomery Co., mile 12, four lanes.
I-70, Washington Co., mile 19, four lanes.
U.S. 48, Garrett Co., mile 27, four lanes.
U.S. 29, Howard Co., near Ellicott City, six lanes.
U.S. 301, Charles Co., mile 12, four lanes.
U.S. 50, Dorchester Co., mile 91, four lanes.
U.S. 15, Frederick Co., mile 2, two lanes.

Virginia

I-66, Prince William Co., mile 42, four lanes.
I-81, Frederick Co., mile 320, four lanes.
I-64, Louisa Co., mile 165, four lanes.
U.S. 29, Fauquier Co., near Remington, four lanes.
U.S. 301, King George Co., 2 miles north of Port Royal, four lanes.
U.S. 17, Fauquier Co., near Bealeton, four lanes.
U.S. 17, Fauquier Co., near Delaplane, two lanes.

A speed change was defined as the initial observed speed minus the speed after the detectable radar was activated. A speed change of at least 5 mph in the presence of suddenly activated detectable radar was used to infer the use of a radar detector in vehicles traveling at speeds of 62 mph or greater. A slowdown of at least 5 mph (speed change $\geq$ 5 mph) was chosen because this reduction was judged large enough to reflect an intentional change in travel speed in response to the radar signal rather than a change due to other reasons. At least 30 seconds elapsed after each observation before the detectable radar was turned on for the next target vehicle. This waiting period minimized the possibility that the subsequent vehicle would have detected the radar signal intended for the previous vehicle.

The indicated initial and final speeds were each corrected for the truncation of decimal fractions and the transmission frequency shift of the nondetectable radar, as described in the previous section. The speeds were then rounded to the nearest whole numbers before the speed change was calculated. However, no individual adjustments to any speeds were made to account for the changing angle between each target vehicle's direction of travel and the radar beam. Instead, it was determined empirically that under the roadway geometry encountered during data collection, speeds indicated by the radar unit could decline as much as 2 mph as vehicles approached and passed the observers at constant speeds. Therefore, a minimum calculated speed change of 7 mph was required to conclude that an intentional 5 mph speed change had occurred.

Other data collected for targeted fast vehicles included vehicle type, travel lane, and state of registration. Effects of these variables on the proportions of vehicles apparently with and without radar detectors in use were assessed by the GLM procedure of SAS (1985).

RESULTS

Speed Distributions from the Monitoring Station

Table 1 indicates the proportions of vehicles exceeding 65 and 75 mph according to vehicle type during the periods when detectable radar was and was not operating at the Interstate 70 site in Maryland. The proportions of tractor-trailers and passenger vehicles exceeding 65 mph significantly decreased when radar was operating. During the 11 hours when the radar was on, only about 11 percent of the tractor-trailers exceeded 65 mph; during the comparison 11 hours with the radar turned off, about 27 percent exceeded 65 mph. For passenger vehicles, 21 percent exceeded 65 mph when the radar was on, and 25 percent exceeded this speed when the radar was off. The proportion of passenger vehicles exceeding 75 mph declined significantly to 1.6 percent when the radar was on, compared to 2.8 percent when it was off. Overall, in the presence of detectable radar, the proportions of vehicles exceeding 65 and 75 mph declined by 20 percent and 44 percent, respectively.

Speed Distributions from Radar

Table 2 lists mean vehicle speeds with detectable and nondetectable radar in operation and table 3 lists

TABLE 1

PERCENTAGES OF VEHICLES EXCEEDING 65 AND 75 MPH ON I-70 IN MARYLAND AS DETERMINED BY AN AUTOMATIC MONITORING STATION

	Number of Observations		Percentage over 65 mph			Percentage over 75 mph		
Vehicle Type	No Radar	Detectable Radar	No Radar	Detectable Radar	Percentage Difference	No Radar	Detectable Radar	Percentage Difference
Passenger Vehicles (20 ft. or less)	5,212	5,237	24.8	20.9	-16	2.8	1.6	-43
Straight Trucks (20-40 ft.)	158	169	17.7	14.8	-16	0.6	-0-	-100
Tractor-Trailers (40 ft. or more)	567	570	27.3	11.1	-59	0.7	0.2	-71
All Vehicles	5,937	5,976	24.8	19.8	-20	2.5	1.4	-44

TABLE 2

MEAN VEHICLE SPEEDS MEASURED WITH NONDETECTABLE AND DETECTABLE RADAR IN USE IN MARYLAND AND VIRGINIA

	Speed (mph)*		
	Nondetectable Radar	Detectable Radar	Difference
<u>Overall</u>			
Maryland	59.7	58.3	-1.4
Virginia	59.7	58.9	-0.8
<u>Interstates Only</u>			
Maryland	60.3	58.2	-2.1
Virginia	60.0	59.1	-0.9
<u>Vehicle Types</u>			
Passenger Cars	60.0	59.6	-0.4
Sports/Specialty Cars	61.4	59.5	-1.9
Light Trucks	59.6	58.8	-0.8
Straight Trucks	57.8	57.6	-0.2
Tractor-Trailers	59.9	57.7	-2.2

*Least squares mean.

the observed percentages of vehicles traveling over 65 and 70 mph under these radar conditions. As indicated in the tables, average speeds and the percentages of vehicles traveling over 65 and 70 mph were lower overall in both Maryland and Virginia when detectable radar was in operation. The declines in speeds tended to be somewhat greater in Maryland, where radar detectors are legal, than in Virginia. However, both mean speed declines (1.4 mph for Maryland and 0.8 mph for Virginia) were statistically significant, and the difference in the effect of detectable radar signals between the two states was only marginally significant ($p < 0.07$).

The effect of detectable radar on speeds varied by road type (for example, interstate vs. primary highway, four-lane vs. two-lane); when only interstate highways were considered, the effect was greater. Mean speeds dropped 2.1 mph on Maryland interstates and 0.9 mph on Virginia interstates with detectable radar in use; these reductions were statistically significant, as was the difference in the reductions between the two states.

Reductions in mean speeds across all sites in both states were largest for tractor-trailers and sports/specialty cars (2.2 and 1.9 mph, respectively) and negligible for straight trucks. Compared to other vehicle types, tractor-trailers showed the greatest reduction in the proportion traveling at speeds over 65 mph, and both tractor-trailers and sports/specialty cars showed the greatest reductions in the proportion traveling at speeds above 70 mph.

Speed Changes in Response to Detectable Radar

Table 4 lists total numbers of vehicles with initial speeds of at least 62 mph targeted in Maryland and Virginia, according to vehicle type and site location, and the percentages of such vehicles slowing down at least 5 mph in the presence of suddenly activated detectable radar. Eleven percent of the targeted vehicles, both in Maryland and in Virginia, slowed down by 5 mph indicating the likely presence of radar detectors. The percentages varied significantly by vehicle type; for example, 24 percent of tractor-trailers but only 6 percent of passenger cars slowed down by 5 mph when the radar was activated. The percentages of vehicles slowing down by at least 5 mph also varied significantly across the various sites but with no clear pattern by state or road type.

As initial speeds increased, the percentages of vehicles slowing at least 5 mph in the presence of detectable radar generally increased (figure 1). In the two states combined, over half of all tractor-trailers and more than one quarter of all vehicles initially traveling over 70 mph had speed reductions strongly suggesting use of radar detectors.

Vehicles traveling at or above 62 mph that slowed at least 5 mph in the presence of detectable radar were initially traveling faster by an average of 2 mph

TABLE 3

PERCENTAGES OF VEHICLES TRAVELING OVER 65 AND 70 MPH WITH NONDETECTABLE AND DETECTABLE RADAR IN USE IN MARYLAND AND VIRGINIA

	Percentage Over 65 mph			Percentage Over 70 mph		
	Nondetectable Radar	Detectable Radar	Percentage Difference	Nondetectable Radar	Detectable Radar	Percentage Difference
Overall						
Maryland	5.8	3.7	-36	1.1	0.8	-27
Virginia	7.0	5.4	-23	1.1	0.6	-45
Interstates Only						
Maryland	6.2	3.0	-52	0.9	0.5	-44
Virginia	7.7	4.7	-39	0.9	0.6	-33
Vehicle Types						
Passenger Cars	6.0	5.8	-3	1.1	0.7	-36
Sports/Specialty Cars	9.5	5.9	-38	1.7	0.4	-76
Light Trucks	4.5	5.1	+13	1.2	1.5	+25
Straight Trucks	3.5	1.6	-54	0.4	0.3	-25
Tractor-Trailers	8.1	2.2	-73	1.2	0.3	-75

than vehicles that did not slow as much. Also, the average reduction in speed was about 10 mph for the former group; there was no reduction for the latter group.

DISCUSSION

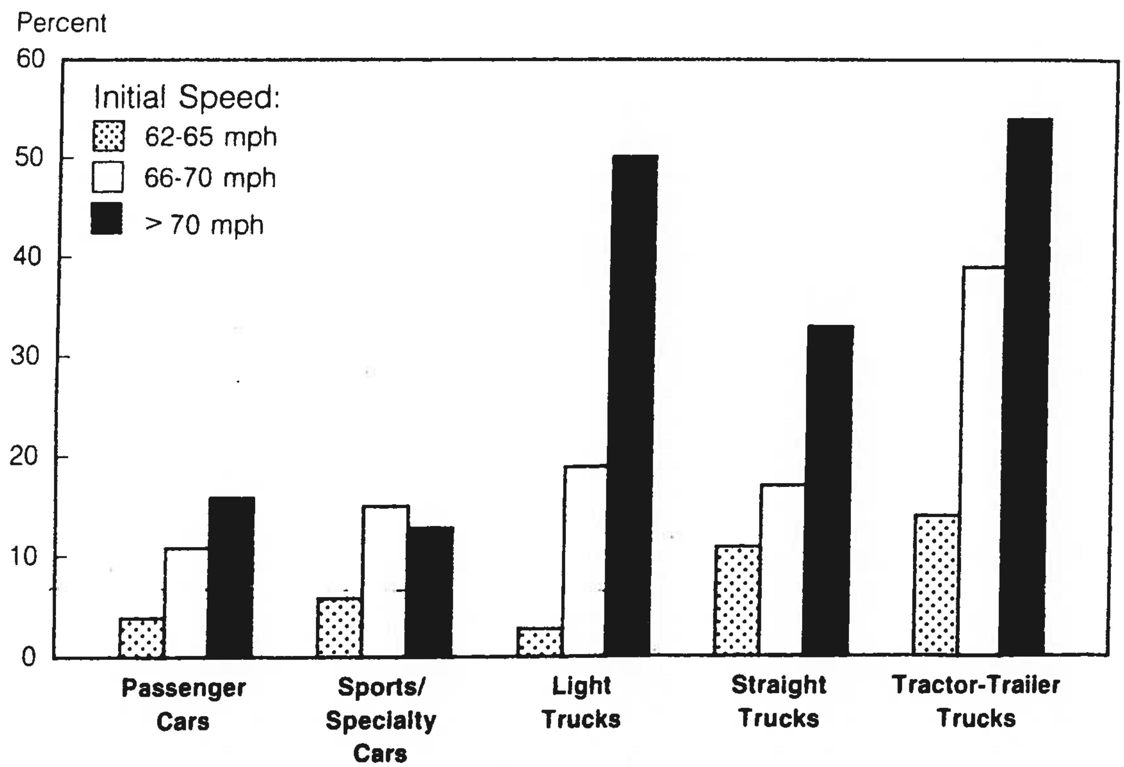
This study has shown that overall travel speeds are lower and the proportion of vehicles traveling at very high speeds are lower when hidden police radar units are operating. Tractor-trailers showed the greatest declines in average speed and in the proportion exceeding 65 mph in the presence of continuously operating detectable police radar. These results suggest that radar detectors are being widely used to elude police speed enforcement and that travel speeds on U.S. highways are faster than they would be in the absence of radar detectors.

The presence of suddenly activated detectable police radar caused sharp reductions in the speeds of more than one in 10 targeted vehicles initially traveling at or above 62 mph, and this effect was the most pronounced for tractor-trailer trucks. For all such targeted trucks initially traveling between 62 and 65 mph, 14 percent slowed down at least 5 mph when the detectable radar was activated. For those traveling between 66 and 70 mph, 39 percent slowed down; for those traveling over 70 mph, 54 percent did so.

The Maryland State Police collected data on the presence of radar detectors in trucks at Maryland truck stops and weigh stations in 1985 and 1986. They observed that 81 percent of 2,371 commercial vehicles at truck stops were equipped with some type of radar detector, but that of 14,462 trucks examined for radar detectors as they crossed the weigh station scales, 16 percent had radar detectors (Maryland State Police 1986). The wide variation in percentages of trucks with radar detectors may reflect the differing types of truck traffic represented at the two locations; that is, mostly long haul drivers at the truck stops and a mix of local and long haul trucks at the weigh stations. The truck traffic at the weigh stations may more closely match the truck population observed in this study and thus is closer to the present finding of 25 percent of tractor-trailers in Maryland and 22 percent in Virginia probably using radar detectors.

Among all vehicle types, it was found that those vehicles suddenly slowing at least 5 mph in the presence of police radar had, on average, greater initial

Figure 1
Percentage of Vehicles Slowing at least 5 mph in the Presence of Suddenly Activated Detectable Radar



speeds than vehicles that did not slow down as much. Although some radar detector manufacturers claim that detectors are used to control speeds, this result suggests that radar detectors provide motorists with confidence to drive faster in the absence of detectable radar signals.

The effects of Virginia's ban on radar detectors appear to be limited—the same proportion of speeding vehicles on all highways combined in either Maryland or Virginia reacted to police radar in ways strongly suggesting they had radar detectors. However, overall speeds were affected somewhat less in Virginia than in Maryland by the presence of detectable police radar.

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