DETECTION OF IMPAIRED DRIVERS THROUGH
MEASUREMENT OF SPEED AND ALIGNMENT

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Do impaired drivers drive any differently than sober drivers? Is there any way a police officer can, by observing the passing flow of traffic, identify impaired drivers? This problem has intrigued traffic safety researchers for a number of years. Damkot (1977) attempted to identify unobtrusive measures which would differentiate sober and impaired drivers by assessing vehicle speed, lateral placement, lateral placement variation (weaving), speed deceleration and stopping accuracy. He found that only speed deceleration differentiated significantly between the sober and the impaired driver. However these findings should be considered as tentative since Damkot (personal communication) indicated that there were a number of equipment problems. In addition, Damkot (1977) reported only analyses of central tendency whereas other researchers (Bragg and Wilson, 1979) identified the major differences between sober and impaired drivers were in the analyses of the variability. (i.e. extreme scores).
Bragg and Wilson (1979) found that drivers with a Blood Alcohol Concentration (B.A.C.) greater than 50 mg% were significantly less capable of aligning their vehicles than were sober drivers. Given the success of this research and the problems associated with Damkot's study the possibility that speed and lateral placement might successfully be used to identify impaired drivers remained an issue worthy of further investigation and the present study was designed to determine if impaired drivers could be identified through the application of unobtrusive measures of speed, lateral placement, and weaving.

**METHOD**

**SUBJECTS:** This study was done in conjunction with roadside survey of impaired drivers conducted by the Ministry of Transportation and Communication and the Attorney General's Office of the Province of Ontario. Subjects consisted of 460 drivers who passed through the observation sites and who were stopped and breath-tested. These drivers were selected randomly from the traffic flow once an interviewer was available.

**SITES:**

Site selection for the roadside survey used the 1974 National Roadside Survey (Smith, Wolynetz & Wiggins 1976) site plan in an attempt to replicate the earlier survey. The present study investigated the relationship between speed/alignment and alcohol impairment used a sub-sample of twenty two survey sites. Sites used in this study were:

(1) within 100Km of Metropolitan Toronto
(2) on Rural Highways or Major Arterials

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in a location where the speed and lateral placement assessment could be made before the drivers were aware of the survey crew. Therefore, the sites used in this study were not randomly selected but were selected to assess the effectiveness of the device under optimal conditions.

This lack of randomness does not affect the internal validity of the findings only the generality of the findings to sites different from those used in this study.

TIME:

Measurements were conducted in May and June 1979 on Wednesday through Saturday nights between the hours 9:00 P.M. and 3:00 A.M. Only 1 1/2 hours were spent at any one site and two sites were surveyed each night, either from 9:00 P.M. - 10:30 P.M. and 12:00 P.M. - 1:30 A.M. or from 10:30 P.M. - 12:00 P.M. and 1:30 A.M. - 3:00 A.M.

MEASUREMENT OF SPEED AND LATERAL PLACEMENT:

Speed and lateral placement were measured by a pneumatic tube device (Bragg and Wilson 1979). The device has two parallel pneumatic tubes perpendicular to the flow of traffic for the measurement of speed and two pneumatic tubes aligned in a "V" pattern with the point of the "V" pointing in the direction of traffic flow and at the midpoint of the traffic lane for measurement of lateral placement. The devices assess the time lag between contact with the two tubes and calculates the speed in kilometers per hour and the lateral placement of the vehicle in centimeters right or left of the midpoint of the lane.

In this study two devices were laid out 30 metres apart (See Figure I). With the two devices
Figure 1: Layout of Devices
measurements can be taken twice on speed and alignment, therefore, speed changes and alignment changes can be determined by examining differences between the first and second measures.

IDENTIFICATION OF THE VEHICLE:

Two observers were located in an unmarked vehicle parked unobtrusively downstream, off the roadway (usually in a driveway) from the speed and alignment device. Once a vehicle had passed over the device, the last 3 numbers of the licence number were radioed to the police officer directing traffic at the survey site. The officer then confirmed that the vehicle had been stopped. The interviewer who obtained the breath sample also recorded the last three digits of the licence number for later matching of the BAC and speed/alignment data.

MEASUREMENT OF B.A.C.:

All drivers stopped in the roadside survey were asked to provide a breath sample. This was taken with an A.L.E.R.T. J-130 unit with a digital attachment in order to obtain exact BAC reading. The units were calibrated before each night of testing, and were kept on battery charge when not in use.

RESULTS AND DISCUSSION

B.A.C. and speed/alignment data were obtained for 460 drivers, of these 32 (7.0%) were legally impaired (80 mg% or greater) 28 (6.1%) had a B.A.C. between 50 and 79 mg% and 400 (86.9%) had a B.A.C. less than 49 mg%. There was no significant difference between the proportion of impaired drivers in this sample and in the total survey sample (N = 9923) X (2) = 0.19 p = 0.92.

SPEED AND ALIGNMENT MEASURES:

Lateral placement is known to vary from site to site as a function of such factors as lane width (Jarol,
Similarly, site speeds will vary as a function of such factors as road curvature, rise and roadside structures (Case, Hulbert, Mount and Brenner, 1953). Consequently, to correct for site location factors a deviation score was derived for both the speed and alignment measures. This consisted of subtracting the mean site score from the raw score, a correction which decreases the effect of extreme scores such that subsequent analyses represent conservative tests.

Since Bragg and Wilson (1979) found the extreme speed and alignment scores to be predictive of impairment, a second measure was derived using the absolute deviation score (disregarding the direction of the deviation for both speed and alignment). Additional difference measures were derived by alignment). Additional difference measures were derived by subtracting the adjusted speed and alignment deviation scores on the second device from the respective measures on the first device. With these difference scores, acceleration/deceleration and lateral drift can be assessed. A discriminant analysis was conducted on the speed and alignment deviation scores; the speed and alignment absolute deviation scores; the speed and alignment deviation difference score and the posted site speed limit in order to determine which measure or combination of measures best differentiated drivers with respect to B.A.C. The discriminant analysis (See Table 1 & 2) indicated that only absolute alignment deviation on the second alignment device significantly discriminated the three B.A.C. groups: (1) 0-49 mg%; (2) 50-79 mg% and (3) 80 + mg%. This discriminant function $X^2(6) = 16.99$ $p = .009$ correctly classifies 49.35% of the cases or more importantly increases the identification of impaired drivers 1.88 times over the rate of identifying impaired individuals by randomly stopping drivers (see Table 2). In other words if a police officer were to randomly stop
### Table 1
**Summary of Discriminant Analysis**

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable</th>
<th>F to Enter</th>
<th>Rao's V</th>
<th>Change in Rao's V</th>
<th>Sig. of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Absolute Deviation</td>
<td>2.92</td>
<td>5.83</td>
<td>5.83</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Alignment 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Absolute Deviation</td>
<td>2.81</td>
<td>11.46</td>
<td>5.62</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>Speed 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Absolute Deviation</td>
<td>2.82</td>
<td>17.20</td>
<td>5.74</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Speed 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discriminant Function</th>
<th>Eigenvalue</th>
<th>Relative Percentage</th>
<th>Canonical Correlation</th>
<th>Chi-Square</th>
<th>DF</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.03</td>
<td>68.0</td>
<td>0.158</td>
<td>16.99</td>
<td>6</td>
<td>0.009</td>
</tr>
<tr>
<td>2</td>
<td>0.01</td>
<td>31.98</td>
<td>0.109</td>
<td>5.46</td>
<td>2</td>
<td>0.065</td>
</tr>
</tbody>
</table>
TABLE 2

PERCENT OF DRIVERS AT THREE LEVELS OF B.A.C. THAT WOULD BE STOPPED USING RANDOM TESTING COMPARED WITH STOPPING ONLY INDIVIDUALS WHO FAILED THE TEST

<table>
<thead>
<tr>
<th>BAC</th>
<th>Percent of Drivers Tested</th>
<th>Percent of Drivers who Failed</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>86.9</td>
<td>78.6</td>
<td>- 8.3%</td>
</tr>
<tr>
<td>50-79</td>
<td>6.1</td>
<td>8.0</td>
<td>+ 1.9%</td>
</tr>
<tr>
<td>80+</td>
<td>7.0</td>
<td>13.0</td>
<td>+ 6.0%</td>
</tr>
</tbody>
</table>

TABLE 3

Mean Alignment in Centimeters for Sober Drinking and Impaired Drivers.

Impairment

<table>
<thead>
<tr>
<th>Impairment</th>
<th>0-49 mg%</th>
<th>50-79 mg%</th>
<th>80+ mg%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment 1</td>
<td>*L 22.8cm</td>
<td>L 18.15 cm</td>
<td>L 24.55</td>
</tr>
<tr>
<td>Alignment 2</td>
<td>L 16.92 cm</td>
<td>L 20.25</td>
<td>L 30.17</td>
</tr>
</tbody>
</table>

* L means left of lane center
and breath test drivers he would find 6.9% of the people stopped would be impaired. Using this device, he would find 13% or 1.88 times as many people stopped would be impaired - a significant improvement in police efficiency.

Examination of the mean alignment scores (See Table 3) for each impairment group illustrates what is occurring when a driver encounters this device. As the driver encounters the first speed and alignment device, he will feel the rumble of his tires crossing the tubes and sober and impaired drivers react differently to this unexpected vibration - sober drivers move to the right on the average while impaired drivers move to the left. This is reflected in alignment scores on the second device. Figure 2 shows the alignment deviation scores on device II for each of three B.A.C. groups. As can be seen, the percentage of the impaired group (80 mg% or more) exceeds the percentage of the sober group at deviations greater than 30 cm from the site mean. If a "fail" criteria were established for any vehicle having an alignment deviation greater than 30 cms either left or right of the site mean alignment then 52% of the impaired group and 36% of the 50 - 79 mg% group would be detected while only 17% of the 15 - 49 mg% group and 25% of the 0 - 14% group would fail. Because these groups differ in size this would translate into 26% of those drivers "failing" while having a B.A.C. greater than 50 mg% where random stopping of drivers would find only 12.5% of those stopped to exceed 50 mg%. In fact, current police practice, requires a two stage process (1) determining whether the driver has been drinking and (2) obtaining a breath test. This two stage process resulted in a detection rate of 2.54 in 1000 drivers stopped in Saskatchewan (Shiels 1978) and a 6.4/1000 driver detection rate of drivers stopped in the Etibocoke "R.I.D.E" program (Vingilis, Salutin and Chan 1979). If failure on the device evaluated in this
study was deemed to be sufficient evidence to require a breath test then the difficult task of determining whether a person had been drinking would be eliminated and the efficiency of a police officer would rise from between .00254 and .0064 to .258 or a 40 to 101 fold increase in police efficiency.

An even greater increase in police efficiency would accrue if the device was used as a performance test where the driver had to actively align his vehicle. While the results of research on the device as a performance test (Bragg and Wilson 1979) are not directly comparable because the levels of impairment and the proportion of impaired drivers were not equivalent to actual levels of impairment on the road, the results did indicate that speed and lateral placement measures used as a performance test virtually eliminated the need to stop sober drivers.

In summary, the results of this study indicate that the introduction of an unexpected stimulus, in this case 1 centimeter diameter pneumatic tubes, evoked driving reactions that differed significantly for impaired and sober drivers. In addition to providing further evidence of the utility for police of the speed/alignment device in the detection of impaired drivers, these results suggest a whole avenue of research to determine the unexpected event which will maximally differentiate, safely, between impaired and sober drivers.
REFERENCES

Bragg, B.W.E. and Wilson, W.T.

Evaluation of a Performance Test to Detect Impaired Drivers; Accident Analysis and Prevention (In press)

Case, H.W., Hubert, S.F., Mount, G.E., and Brenner, R., 1953


Damkot, D.K.

On-the-Road Driving Behavior and Breath Alcohol Concentration: Department of Transport 1977 HS-802-264

Jarol, M.H.


Shields, A.C.

Police Checks for Impaired Driving at Six Saskatchewan Locations Transportation Agency of Saskatchewan (1978)

Smith, G.A. Wolynetz, M.S. and Wiggins, T.R.I.

A National Roadside Survey of the Blood Alcohol Concentrations in nighttime Canadian Drivers. Department of Transport 1976 TP 1311

1352
Triggs, T.J. and Wisdom, P.H.


Vingilis, E., Salutin, L., and Chan, G.

R.I.D.E: A Driving while Impaired Countermeasure Program, One year evaluation Addition Research Foundation 1979