

The Observational Threshold of Horizontal Gaze Nystagmus

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Abstract

Laboratory studies of field sobriety tests, which were conducted during the 1970s, identified horizontal gaze nystagmus (HGN) as a sensitive and reliable marker of alcohol at BACs of 0.10% and above (Burns & Moskowitz, 1977; Tharp, Burns, Moskowitz, 1981). In a more recent study, McKnight, Langston, Lange, and McKnight (1995) found that HGN remains a valid field sobriety test at 0.08% BAC. The observational threshold of HGN, however, has not been established.

A study was undertaken to further examine HGN at 0.08% BAC and to determine the lowest BAC at which its signs appear reliably. Measurements of the angle of gaze (AOG) at the onset of nystagmus were obtained with 48 subjects, who had been given alcohol to produce peak BACs in the range 0.02% - 0.12%. Observations were made with the EM/1, an instrument which displays a magnified video image of subjects' eyes.

The obtained data provide further evidence of the reliability of HGN as an index of the presence of alcohol at 0.08%. Further study will be required to establish a BAC threshold for HGN.

Introduction

Laboratory research identified three tests, horizontal gaze nystagmus (HGN), walk-and-turn (WAT) and the one-leg stand (OLS), as the best battery of sobriety tests for law enforcement use (Burns & Moskowitz, 1977; Tharp, Burns, Moskowitz, 1981). Currently, officers throughout the United States are trained to administer those tests, which are identified as the Standardized Field Sobriety Tests or SFSTs.

Recent field studies examined the decisions made by SFST-trained police officers when they were restricted to using only those three tests at roadside (Burns & Anderson, 1995; Burns & Dioquino, 1996; Stuster & Burns, 1998). The studies, which were conducted in three different states (Colorado, Florida, California), found that more than 90 percent of the officers' arrest decisions at all test sites were correct, as confirmed by the results of the analysis of breath or blood specimens.

Although instructions for standardized test administration specify that all three tests should be used, police officers report that they rely heavily on HGN, a jerking movement of the eyeball which occurs when the gaze follows the lateral movement of a stimulus (typically a pen, pencil or penlight). Officers are trained to observe three HGN signs: 1) whether a suspect's eyes follow a moving stimulus smoothly, 2) whether there is a distinct jerking of the eye at the position of maximum deviation, and 3) the angle-of-gaze (AOG) at which jerking first occurs.

In defending drivers who have been charged with driving-under-the-influence (DUI), attorneys often challenge the validity and reliability of HGN as an index of alcohol. Data are available to respond to such challenges when the defendant's BAC is 0.08% or higher. Research, however, has not addressed the question of the BAC threshold. Has an officer erred, for example, if he reports the observation of HGN signs at BACs lower than 0.08%? The alcohol level at which the signs first become visible, and whether they occur at the same BAC in all individuals and on all occasions is not known.

An officer instructs the suspect to follow the movement of the stimulus in the lateral plane and observes the eyes for the three signs. Since variability in the reported occurrence of the signs could be attributable to observational errors, as well as to actual differences in their occurrence, this experiment used an EM/1 instrument to minimize observer error.

Method

When an SFST-trained police officer believes a driver may be under the influence of alcohol or another nystagmus-producing substance, he examines the suspect's eyes for three HGN signs. In this experiment, however, subjects' (Ss) eyes were examined only for the angle of gaze (AOG) at the onset of the jerking movement. The two other signs, lack of smooth pursuit and distinct jerking at maximum deviation, were not examined.

Subjects

Newspaper ads recruited Ss for an alcohol experiment. Applicants were enrolled only if a screening interview revealed that they had no significant health problems, were alcohol users, and were not abusers of alcohol and other drugs. Forty-eight men and women, ages 21 - 54 years, met study criteria. AOG measurements were obtained during a single alcohol-treatment session.

Alcohol Treatment

When a S arrived at the test site between 1700 and 2030 hours, his or her BAC was measured with a breath-sampling Intoxilyzer 5000. Instructions were given for the eye examination, and AOG measurements were obtained prior to administration of alcohol treatments. The S then was given the first of the three alcohol beverages, which were to be consumed evenly over a 30-min period. Alcohol doses were based on estimates of Ss' body water as a percentage of body weight adjusted for gender, age, frame size and body composition (Frisch, 1988). To insure that alcohol was not given to a pregnant woman, all female Ss were given urine pregnancy tests prior to alcohol administration.

The beverage was one part 80 proof vodka and 1.5 part orange juice. The drinks were given at 10-min intervals, and Ss were monitored continuously during the drinking, absorption, and post-absorption periods. At the conclusion of the drinking and absorption periods and immediately prior to the eye examinations, BACs were measured. The Intoxilyzer readout was shielded from Ss' view, and they remained blind to alcohol treatment and their BACs until the conclusion of the session.

Apparatus

AOG measurements were made with a computer-based EM/1, an Eye Observation System designed specifically for use by law enforcement. The system's infrared illumination allows measurements to be made as the S looks into a viewport at a visual field which is completely dark except for a stimulus light. The viewport eliminates visual distractions which might influence eye movements, and the S's head position is fixed. As a S's eyes follow the stimulus light, the experimenter views a magnified image of the eye on a computer monitor, which also displays the metrics for AOG and pupil size.

For this experiment, after Ss were seated and the height of the viewport had been adjusted appropriately, they were instructed to follow the movement of the light with their eyes only. The experimenter who operated the EM/1 also operated the Intoxilyzer and, therefore, was aware of Ss' BACs. A second experimenter, who was blind to Ss' BACs, observed the image of Ss' eyes on the screen and signaled the onset of jerking. All of the examinations were videotaped.

Results

Police officers are trained to score one point for each HGN sign observed in each eye for a possible six points total score. For the AOG sign, one point is scored for each eye if jerking is observed prior to a 45° gaze. The criterion score for arrest is four points total. The scoring for AOG should be kept in mind in reviewing the data summarized in Table 1.

TABLE 1
HGN Onset Angle-of-Gaze, by BAC

| BAC Groups | <u>Ss</u> (number) | BAC (%), mean (range) | Angle of Gaze, Left Eye, mean (range) | Angle of Gaze, Right Eye, mean (range) |
|-------------------|---------------------------|------------------------------|--|---|
| 1 | 9 | 0.111 (0.100 - 0.125) | 40 (37 - 41) | 40 (37 - 40) |
| 2 | 13 | 0.089 (0.080 - 0.099) | 40 (37 - 44) | 40 (37 - 48) |
| 3 | 9 | 0.061 (0.040 - 0.075) | 44 (40 - 49) | 44 (40 - 51) |
| 4 | 12 | 0.046 (0.021 - 0.067) | none detected | none detected |
| Total | 43 | 0.088 | 41 | 41 |

Five Ss were given placebo beverages. No AOG was detected in any pre-dose examination or with any post-dose zero BAC. That is, false alarms defined as a measured AOG in the absence of alcohol did not occur.

The measurements obtained with 43 Ss with positive BACs are summarized in Table 1. Groups 1 and 2 include 22 Ss at 0.08% BACs and higher. The measured AOGs correctly reflect those levels of alcohol and would correctly support DUI arrests. The mean angles for the groups, as well as the mean for two eyes for all Ss, were less than 45°. A single deviant measurement was a right-eye AOG at 48° for a S, whose BAC was 0.080%.

The data for nine Ss at a mean BAC of 0.061% requires closer scrutiny (Group 3). Although the mean AOG of 44° for the group meets the arrest criterion, the BACs of all the Ss were below 0.08%. Thus, this AOG appears to be a false alarm since the lower legal limit for driving in the United States is 0.080% BAC. Although a single HGN sign or a single test from the SFST battery does not support an arrest, further analysis of this finding was undertaken. It was found that the mean AOG for three Ss at 0.040%, 0.065%, and 0.075% was just over 40°, which does meet the prior-to-45° criterion. On the other hand, a mean AOG of 45.5° does not meet the criterion by a small margin for the remaining six Ss whose BACs ranged from 0.055% to 0.073%.

As can be seen for Group 4, 12 Ss at 0.046% BAC displayed no AOG, although a distinct jerking was seen at maximum deviation in three Ss. It is important also to note that no AOG could be determined for one S in this group whose BAC was 0.067%. The data allow no firm conclusion for a BAC range of approximately 0.040% to 0.079%.

Discussion

These data provide additional evidence that AOG is a reliable index of alcohol at BACs of 0.080% and higher. A single HGN sign is insufficient evidence for arrest, but together with the two other signs, AOG provides valid information and supports police officers' use of nystagmus as part of the roadside examination of suspected impaired drivers. These data do not, however, identify the BAC threshold for the angle of gaze measure. Additional research at BACs in the range 0.040% - 0.079% is needed.

The instrument used in this experiment, an EM/1, facilitated and standardized the observation and measurement of AOG. Similarly controlled study of all three signs of HGN is strongly recommended and can be expected to provide data which are needed by law enforcement officers, prosecutors, and the courts.

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