

The Horizontal Gaze Nystagmus (HGN) Test

Karl Citek, OD, PhD, FAAO
Professor of Optometry
Pacific University College of Optometry
Forest Grove, Oregon
(503) 352-2126
citekk1@pacificu.edu

I. Purpose of the Standardized Field Sobriety Tests (SFSTs)

- A. SFSTs are *screening tests* that allow an officer to articulate *probable cause* to arrest a driver whom s/he suspects of being impaired.
- B. Most officers do **not** conduct SFSTs on drivers for whom they do not have *reasonable suspicion* of impairment at the initial contact of a traffic stop. Therefore, sober drivers who may have eye movement or balance problems typically will **not** be mistaken as intoxicated since there would be no reason for an officer to conduct SFSTs, unless the officer suspects impairment/intoxication for other reasons.
- C. SFSTs *correlate to physical impairment caused by intoxication*. However, because there literally are too many factors to consider, they do **not**, and never were intended to, correlate to *driving impairment*. Yet, they quickly and efficiently assess physical and mental skills *similar* to those necessary in order to safely operate a motor vehicle.

II. Sequelae of intoxication

- A. In terms of physical signs and physiological indicators, intoxication affects the functioning of the Central Nervous System (CNS), specifically, parts of the brainstem and cerebellum.
- B. Functions potentially affected by intoxication
 - 1. Eye movements and/or pupil responses, depending on the intoxicant(s)
 - 2. Speech
 - 3. Gross and fine motor skills, e.g., movement of one limb and movement of fingers, respectively
 - 4. Coordinated motor skills, e.g., walking (deficit is termed *gait ataxia*)
- C. Even to this day, we do not know the precise mechanism by which alcohol and many drugs actually cause these changes; that doesn't mean they don't happen!

III. HGN Health Questions

A. Glasses or contact lenses?

1. Suspect's spectacles are removed to allow the officer an unobstructed view of the suspect's eyes. The suspect's possible inability to see the stimulus **clearly** does not invalidate the test.
2. Suspect's contact lenses (CLs) are kept in place, since the suspect is not asked to make any eye movements that he/she would not normally make. About 10% of CL wearers use *gas permeable* (rigid) lenses, the remainder use soft lenses. All CLs potentially reduce nystagmus, regardless of its origin or cause, probably via a biofeedback mechanism.

B. Blind in one eye, or other eye problems?

1. Pilot studies show that *monocular* (one-eyed) individuals show the expected clues in the remaining eye.
2. Individuals with one blind eye, or one eye with severely reduced vision (e.g., significant *amblyopia*), show the expected clues for all tests in which the good eye can see the stimulus (usually everything except Distinct & Sustained Nystagmus at Maximum Deviation [see below] for the non-seeing eye).

C. Any eye or head injuries or other medical problems?

1. *Cerebral vascular accident* (CVA or *stroke*), *hypoglycemia* (insulin shock) in diabetes, heart attack, etc., should be evident as impairment but not intoxication to a properly-trained officer.
2. *Vestibular system* or *joint/muscle* problems that could affect balance.

D. Other possible factors

1. *Sleep deprivation* does **not** cause or exacerbate any clues/indicators on any SFST in the absence of intoxication (research study by Citek et al. 2011).
2. There is no evidence that anxiety, time of day, slight differences in weather conditions, etc. can cause or exacerbate any clues/indicators on any SFST in the absence of intoxication.

IV. Horizontal Gaze Nystagmus (HGN) Test

A. Pre-Test Checks

1. Check for equal pupil sizes

- a. Up to 35% of normal, sober individuals have a difference in pupil sizes of 0.5 mm or more, but fewer than about 10% have a difference of 1.0 mm or more.
- b. Most people with any difference in pupil sizes are aware of it.
- c. Recent onset, or no prior knowledge, can indicate a recent head injury or stroke.

2. Check for equal tracking & “resting nystagmus”

- a. Checks that eyes can move together and have full range of motion.
- b. Unequal tracking indicates presence of *strabismus* (misalignment of the eyes) or other neurological problem.
- c. *Nystagmus in primary gaze* (“resting nystagmus”) most commonly is a medical condition, but, when other obvious physical and physiological indicators of drug use are apparent, could indicate intoxication by PCP.

B. Sub-tests are conducted in the order in which they are expected to appear with increasing levels of intoxication.

1. Lack of Smooth Pursuit

- a. About 10% of normal, sober individuals have lack of smooth pursuit, but they will not be tested at a traffic stop unless the officer suspects impairment.
- b. Research repeatedly has shown that normal, sober individuals should be able to follow a stimulus moving across the visual field at a speed of about 30 degrees per second, such that it will take the officer about 2 seconds (± 0.5 second) to move a stimulus from center to either side, and about 4 seconds (± 1 second) to move it from one side to the other.
- c. If smooth pursuit eye movements are not present, for whatever reason, the individual must make *saccades* (a.k.a. *saccadic* eye movements), which is the expected finding for this test, or move the entire head.
- d. Lack of Smooth Pursuit can be evident at BACs as low as .02-.03, making this an effective indicator for Commercial Drivers (.04 Federal per se limit) and Minors (.02 or zero tolerance, depending on jurisdiction) when other physical and physiological evidence of intoxication is present.

e. Moving or positioning the stimulus inappropriately can affect the observation of clues:

- i. If the officer moves the stimulus *too quickly*, s/he could induce Lack of Smooth Pursuit but will more likely **miss** observing the clue.
- ii. If the officer holds the stimulus *closer than* 12 inches, s/he will be more likely to observe Lack of Smooth Pursuit but will be at an unsafe close distance to the suspect.
- iii. If the officer holds the stimulus *further than* 15 inches, s/he may have difficulty observing the suspect's eyes and will no longer have proper control of the suspect.

2. Distinct & Sustained Nystagmus at Maximum Deviation

- a. Distinguished from *endpoint* nystagmus (EN), which is a phenomenon exhibited by 50-60% of normal, sober individuals.
 - i. EN usually is of small amplitude; therefore, not *distinct*; and
 - ii. EN usually dissipates within 1-2 sec; therefore, not *sustained*.
- b. Direction of nystagmus (given by the direction of the fast phase of the eye movement) is always in the direction of gaze.

3. Onset of Nystagmus Prior to 45 Degrees

- a. Referred to as *gaze-evoked*, *gaze-induced*, or simply *gaze* nystagmus if it is neurological in origin. However, if it is of neurological origin, the earlier clues generally will NOT be present, nor will other physical evidence of intoxication.
- b. Stimulus is moved from center to the side at about half the speed of the check for Lack of Smooth Pursuit, about 10-15 degrees per second, such that it would take about 4 seconds to reach 45 degrees.
- c. 45 degrees may be estimated from the position of the stimulus with respect to the suspect's shoulder.
 - i. For persons of average body build, distance from center to edge of shoulder is about 10 (± 1) inches.
 - ii. If the stimulus is held 12-15 inches from the eyes, the officer typically can go several inches beyond the edge of the shoulder and still be within 45 degrees.

- d. Research repeatedly has shown that the angle of onset of nystagmus (AON) *estimates* BAC, if alcohol is the only intoxicant, by the approximate formula referred to as Tharp's equation,

$$\text{BAC} \approx (50 - \text{AON}) / 100$$

- i. This formula is most accurate for BACs between .10 and .20.
- ii. AON = 45 degrees actually correlates with BAC of .08.
- iii. BAC > .20 can show "immediate" AON and/or other very definite and obvious signs of intoxication.
- iv. Even though officers likely will not be able to testify to this assessment, they are taught that a small AON without a concomitant high BAC indicates the presence of drugs other than or in addition to alcohol.

4. Scoring

- a. One point for the presence of each of three indicators in each eye, for a maximum of 6 points.
- b. At low to moderate BAC levels (< .08), about 10% of subjects show an odd number of clues, likely due to a slight, clinically-insignificant left-right asymmetry.
- c. Results are not expected to vary or change with one's experience with alcohol or drugs. However, some individuals show all 6 clues at BACs below .08 (without the presence of other intoxicants that also could affect the eyes), while others show fewer than 4 (or even zero) clues at BACs above .10.

V. Vertical Gaze Nystagmus (VGN) Test

- A. Originally part of the Drug Recognition Expert (DRE, a.k.a. Drug Evaluation and Classification Program, DECP) protocol, the VGN Test was added to the SFST protocol in 2002.
- B. To be conducted after the HGN Test, but not part of the HGN Test or scoring.
- C. Expect to observe distinct & sustained *vertical* nystagmus in maximum upgaze.
- D. Unlike the HGN Test clues, presence of vertical nystagmus does vary with one's experience with alcohol or drugs.

- E. Presence indicates a high level of intoxication for that individual, regardless of the actual BAC or amount of drug(s) in the body.
- F. If the officer does not conduct the VGN Test, this does not invalidate the findings on the HGN Test.

VI. (Non-)Effects of Environmental Conditions

- A. HGN and VGN tests, and others, can be properly performed with suspects standing, seated, or lying down.
- B. *Positional alcohol nystagmus* occurs only when the head is tipped or tilted significantly away from “upright.”
- C. *Caloric nystagmus* is nearly impossible to induce in a moving vehicle.
- D. Rotation can induce nystagmus, but it will be inconsistent with how the officer conducts the tests and what s/he expects to observe if intoxication were the cause.
- E. Movement of objects in the visual field (e.g., heavy traffic, freight train) can cause *optokinetic nystagmus* but only if the suspect pays active attention to those objects.

VII. Conclusions

- A. HGN/VGN (and other SFSTs) are *screening tests* of *divided attention* that correlate to *impairment caused by intoxication*.
- B. SFSTs do **not** “prove” intoxication. However, if an officer observes performance on SFSTs that s/he knows to be *consistent* with that of an intoxicated individual (from prior training and observation of other subjects), then the officer will make the proper decision to arrest and request a confirmatory chemical sample (breath, blood, urine, saliva).