HORIZONTAL GAZE NYSTAGMUS

In our study we investigated the validity of the horizontal gaze nystagmus test currently in use as a field sobriety testing method by many state police departments. We looked at smooth pursuits and end-point nystagmus in an attempt to record these movements and compare them with subjective measurements. We were unable to record end-point nystagmus due to inadequate instrumentation however, we did record pursuit eye movements. Therefore, we were unable to substantiate the relationship between blood alcohol concentration and the onset of horizontal gaze nystagmus.

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INTRODUCTION/BACKGROUND

HORIZONTAL GAZE NYSTAGMUS... these three words have been popping up in journals and newspapers all over the country. Alcohol induced horizontal gaze nystagmus has become a hot topic not only for optometrists but for the general public too. Everyone wants to know how it works, if it works and why it works!

The purpose of our study was to investigate the validity of the horizontal gaze nystagmus test (HGNT) currently in use as a field sobriety testing method by many state police departments. We attempted this by recording eye movements and comparing them with subjective measurements.

Typically, when the eyes attempt to track a slow moving object, they use smooth pursuit and quick saccadic eye movements. The smooth pursuit system has a latency of 125 msec and responds to the velocity of a target. The saccadic system, on the other hand, has a latency of 225 msec and responds to the position of the target. However, both systems are affected by the introduction of alcohol into the body. Smooth tracking seems to be affected by an increase in the amount of processing time required to generate an eye movement; while saccadic tracking is affected by a decrease in velocity and an increase in latency time. Alcohol affects both of these systems by acting on their sites of origin: the paramedian pontine reticular formation and the flocculus of the cerebellum.5 After relatively low levels of alcohol induction, smooth pursuits begin to depend on saccades to keep the eyes locked on to the moving target. The jerky movements that result are called nystagmus and are totally involuntary. Although many people will exhibit nystagmus when looking in extreme positions of gaze, intoxication results in an end-point nystagmus occurring at smaller angles of lateral deviation. The effects of alcohol on smooth pursuits and end-point nystagmus is the foundation upon which the HGNT was based.

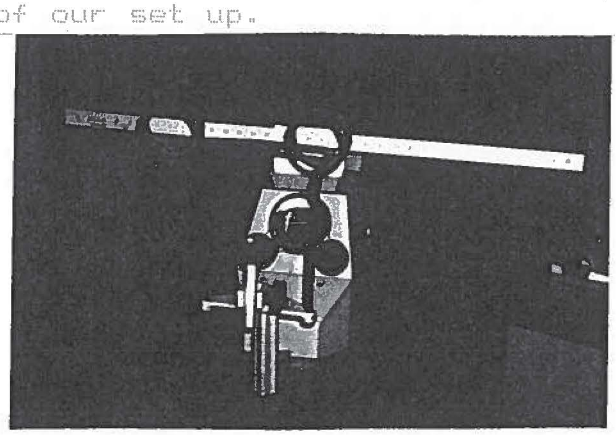
In 1983, the National Highway Traffic Safety Administration (NHTSA) developed a standardized test battery for police officers to determine a suspected drunk driver's blood alcohol concentration (BAC). Due to the ineffectiveness of random tests being used by the various police departments, officers were mainly arresting drivers with BACs in the 0.15-0.19% range. As a result, many drivers with BACs between 0.10% and 0.14% were not being picked up even though they were legally drunk.1 It should be noted that a BAC of 0.10% and above is considered legally intoxicated by most states. Therefore, the NHTSA test battery was developed to pick up drivers with lower BACs which are over the legal limit. The Administration developed three tests which included the one leg stand, the walk and turn, and the horizontal gaze nystagmus test. Of the three, the HGNT was determined to be the most sensitive in predicting BACs. The expected accuracy of the HGNT when used alone is 78%. When used in conjunction with the walk and turn test, the accuracy rises to 82%. The walk and turn and the one leg stand tests have individual accuracies of 68% and 65% respectively.2

The procedure used to test the HGN is as follows. A stimulus (penlight, finger, etc.) is held approximately 15 inches in front of a subject's face, slightly above eye level. The stimulus is then moved laterally in one plane as the subject is instructed to follow it with his eyes while keeping his head still. As the stimulus is moved, the officer checks one eye and then the other for smooth or jerky pursuits. Next the stimulus is moved to each eye's maximum angle of deviation while any distinct jerkiness is noted. Last of all, the stimulus is moved slowly from one side to the other as the angle of onset of HGN is noted. An onset angle of 40 degrees corresponds with a BAC of 0.10%. While an onset angle of 30 degrees corresponds with a BAC of 0.20%.

METHODS OF TESTING

All of our testing was administered at the State Police Academy in Lansing, Michigan during a field sobriety training session.

Our equipment included a model 106 eye trac which we modified to measure and record horizontal eye movements. Below is a photograph of our set up.



Attached to the fixation plate was a yardstick which had been marked at 10 degree intervals for the determination of the onset of HGN. This was fixed slightly above eye level. A linear rather than angular measure was used because it resembled testing conditions used by the officers used when they administered the test.

We used ten subjects for our study, all of which were volunteers chosen by the Michigan Department of State Police. The subjects were required to follow certain rules and guidelines in order to participate. These rules are listed on page seven. The subjects were brought to a predetermined alcohol level on the basis of the following equation:

#ml= (400)(BAC)(body weight-lbs.)/ % alcohol

The BACs of the ten subjects varied from 0.08% to 0.147%. The subjects were allowed to chose their alcoholic beverage and then were required to consume it in 60 minutes. Fifteen minutes after drinking stopped, a portable breath tester (PBT) was used to determine the BAC. This fifteen minute time lapse was required for the alcoholic residue to leave the mouth. Our testing immediately followed PBT testing. Once drinking was discontinued, the PBT was administered at approximately one hour intervals.

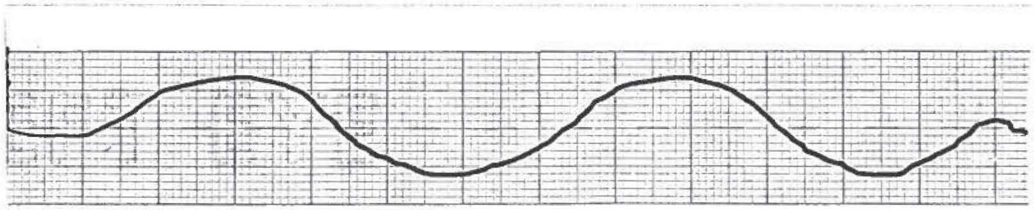
Our testing consisted of measuring end point nystagmus both objectively and sujectively at various time intervals. We also recorded the smoothness of pursuit eye movements for the left eye at these same time intervals.

To record the pursuits, the subject fixated the tip of an ink pen which was smoothly drawn across the face of the yard stick to the right and left. The limits of the movement were set at 40 degrees on either side of central fixation.

Next a fixation target was moved in 5 degree increments to calibrate the eye trac for each patient. After calibration, the fixation target was slowly moved to the limits of gaze for the right eye. The point at which nystagmus occurred was automatically recorded on the eye trac tape. At the same time the eye trac was recording the eye movements, we subjectively estimated the onset angle of nystagmus.

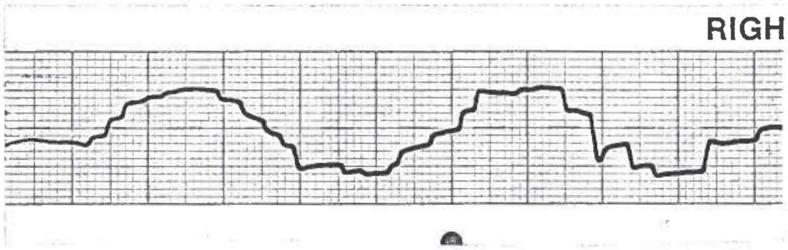
DATA

We noted from our results that in most cases, recordings of pursuits were smooth before the consumption of alcohol. The following sample of an eye trac tape demonstrates this.



Before alcohol consumption began, we subjectively noted jerky pursuit movements in two of the subjects. The breakdown of pursuits for the remaining eight subjects was found to occur as early as one hour and fifteen minutes after drinking began and as late as two hours and twenty-seven minutes. One of the subjects never subjectively showed a breakdown. The chart on page eight shows the actual time intervals for each subject and the type of pursuit movements elicited.

Our objective data, for the most part, agreed with that found subjectively. The instrument detected the onset of jerky pursuit sooner than we did subjectively. In contrast to our observations, three of the subjects showed jerky pursuits before alcoholic consumption began. The remaining seven subjects showed the breakdown as early as twenty minutes after alcohol induction and as late as two hours and four minutes. The chart on page nine shows the actual times involved. Below is an example of jerky pursuit eye movements as recorded by the eye trac.



In attempting to record the onset of HGN, we discovered the limitations the eye trac imposed. Due to inherent problems with calibration and the limitations in tracking large eye excursions, the data collected were deemed inaccurate. An eye trac has a range of approximately 10 degrees on either side of central fixation. Whereas, the eye movements we were attempting to record ranged from 30 to 50 degrees. Therefore, we have no objective measures of HGN to compare with our subjective findings. We could however, compare our subjective estimates of HGN with BACs. This comparison was only made with five of the subjects rather than all ten. We found that in eleven of the thirteen readings taken, we would correctly have identified a subject as being legally intoxicated solely on the basis of the HGNT.

ANALYSIS

Through trial and error, we determined the eye trac to be an excellent instrument for the recording of pursuit eye movements. However, it was inadequate for the measurement and recording of end point nystagmus. Therefore, we were unable to substantiate the relationship between BAC and the onset of horizontal gaze nystagmus. An infrared eye monitor, which was unavailable to us at the time of our study could possibly give the validation we seek. However, that will be the subject of another study.

Analysis of our pursuit eye movement data showed the eye trac as being slightly more sensitive than the human eye in detecting jerky eye movements. However, the eye was remarkably accurate. Out of the 40 readings taken, subjective and objective data failed to match only six times. This is an accuracy rate of 85%. In comparing our subjective measures of legal intoxiaction with those from the PBT, our accuracy rate was also 85%.

CONCLUSION

Much more research could be done in this area if the proper instrumentation could be acquired. The effects of varying the stimulus distance should be looked at more closely. Also the eye movements of the chronic drinker versus the occasional drinker could be compared. Clinically, the information from this research could be applied in the examination of patients. I used my knowledge of alcohol induced horizontal nystagmus as a clue in determining whether a patient of mine had red eyes from an extended wear contact lens versus intoxication. I also feel it is important for us to realize the difference between a pathologically related nystagmus and an alcohol/drug related one.

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Regulations and Conditions

1. Subjects must not drink any alcoholic beverage within a 24 hour period before the experimental session.
2. Subjects must not take any stimulus, depressants or tranquilizers within a 24 hour period before the experimental session.
3. No one can be a subject for this experiment while taking any prescribed medication.
4. Anyone who is alcoholic, or who has had serious personal problems with the use of alcohol cannot be a subject.
5. Only that amount of alcohol required to reach a predetermined blood alcohol concentration will be administered. No additional alcohol will be allowed.
6. Subjects will not be required to finish the alcohol dose if they feel they cannot or do not want to drink it all.
7. Subjects will not be required to finish the experimental session if they feel they cannnot or do not want to continue.
8. All subjects whether they complete the experiment or not must have a blood alcohol concentration below 0.05% before they are allowed to leave supervision of the experimenter.

J= jerky pursuit eye movements
S= smooth pursuit eye mo

SUBJECT	TIME INTERVAL	SUBJECTIVE ANALYSIS	OBJECTIVE ANALYSIS
1.	0	J	J
	1 hr. 23 min.	J	J
	58 min.	J	J
	1 hr. 18 min.	J	J
2.	0	S	S
	1 hr. 13 min.	S	J
	1 hr. 14 min.	J	J
	1 hr. 12 min.	S	J
3.	0	S	S
	1 hr. 23 min.	J	J
	56 min.	J	J
	1 hr. 14 min.	J	J
4.	0	J	J
	1 hr. 39 min.	J	J
	43 min.	J	J
	1 hr. 17 min.	J	J
5.	0	S	J
	1 hr. 20 min.	J	J
	52 min.	J	J
	1 hr. 20 min.	J	J
6.	0	S	S
	1 hr. 36 min.	J	J
	52 min.	J	J
	1 hr. 2 min.	J	J
7.	0	S	S
	21 min.	S	J
	2 hr. 26 min.	S	S
	36 min.	S	S
8.	0	S	S
	1 hr. 15 min.	J	J
	59 min.	J	J
	1 hr. 2 min.	S	J
9.	0	S	S
	20 min.	S	J
	1 hr. 44 min.	J	J
	1 hr. 20 min.	J	J
10.	0	S	S
	1 hr. 4 min.	S	S
	1 hr.	J	J
	1 hr. 33 min.	J	J

SUBJECT	TIME INTERVAL	SUBJECTIVE DETERMINATION OF LEGAL INTOXICATION	BAC
6.	1 hr. 15 min.	N	0.043
	1 hr. 13 min.	Y	0.122
7.	21 min.	N	0.147
	2 hrs. 26 min.	N	0.100
8.	1 hr. 15 min.	N	0.084
	59 min.	Y	0.109
	1 hr. 2 min.	N	0.099
9.	20 min.	N	0.800
	1 hr. 44 min.	Y	0.131
	1 hr. 20 min.	Y	0.125
10.	1 hr. 14 min.	N	0.050
	1 hr.	Y	0.138
	1 hr. 33 min.	Y	0.125