****
*** TX REPORT ***
****

TRANSMISSION OK

TX/RX NO	2471
CONNECTION TEL	18664222823
SUBADDRESS	
CONNECTION ID	
ST. TIME	11/10 11:02
USAGE T	02'53
PGS. SENT	17
RESULT	OK

Colorado Division of Highway Safety

DETECTING DUI's THROUGH THE USE OF NYSTAGMUS

Colorado Division of Highway Safety

DETECTING DUI's THROUGH THE USE OF NYSTAGMUS

A SUMMARY OF GAZE NYSTAGMUS AND HOW IT APPLIES TO DETECTING A PERSON WHO IS UNDER THE INFLUENCE OF ALCOHOL AND CERTAIN DRUGS

Coordinated and Prepared by:
Paul Helzer
Law Enforcement Coordinator
Division of Highway Safety
Colorado Department of Highways

NYSTAGMUS IS AN INVOLUNTARY JERKING MOVEMENT OF THE EYES. GAZE NYSTAGMUS REFERS TO A JERKING OF THE EYES AS THEY GAZE TO THE SIDE. MANY PEOPLE WILL EXHIBIT SOME NYSTAGMUS, OR JERKING, AS THEIR EYES TRACK TO THE EXTREME SIDE. HOWEVER, AS PEOPLE BECOME MORE INTOXICATED, THE ONSET OF THE NYSTAGMUS OCCURS AFTER FEWER DEGREES OF LATERAL DEVIATION, AND THE JERKING AT MORE EXTREME ANGLES BECOMES MORE DISTINCT.

CONTENTS

BACKGROUND

Traffic accident reports indicate that alcohol is involved in a large porportion of the fatal and injury accidents in Colorado. Current attempts to deter the drinking driver are directed at raising the perceived risk of arrest and punishment. Unfortunately there is a very low (1 out of 500) risk of arrest, and the public's perceived risk of arrest is also quite low (Beitel, G., Sharp, M., and Glauz, W.).

One factor that may contribute to the low probability of a DUI being arrested is the difficulty police officers have in detecting those drivers with blood alcohol concentrations (BACs) above .05% who are not obviously impaired. There is the additional problem of the alcoholic, who usually has a high BAC, but can "mask" the signs of intoxication through his drinking experience. Most police officers seem hesitant to arrest a driver unless the degree of impairment is high and obvious. It has been estimated (Beitel, Sharp and Glauz) that there are three times as many drivers on the road with BACs in the .10% to .14% range as in the .15% to .19% range. However, at least twice as many drivers are arrested who have a BAC in the .15% to .19% range as there are drivers arrested with BACs in the .10% to .14% range. The average DUI arrest in Colorado is .18% BAC, so this estimate seems to be valid for our State as well.

The low level of detection and apprehension of drivers with BACs only slightly above the illegal limit may be the result of the lack of effective and highly reliable detection techniques used by the officer in the field.

During a typical DUI stop, the police officer who has formed an initial suspicion that a driver is impaired by alcohol, will administer a series of simple maneuvers to the driver. These maneuvers serve to confirm (or not confirm) the initial suspicion and may provide probable cause to arrest the driver for a DUI related charge. The driver's performance on these maneuvers is a critical part of the evidence presented in court and administrative hearings to support the DUI charge. For many of these maneuvers, the relationship between performance and specific BAC levels has not been well documented, although they are a fairly good indication of impairment. What is needed is a procedure that is easy to administer, virtually seen in all people impaired by alcohol and is an involuntary action (that is to say the person does not know he is doing it and cannot "practice" passing it as in walking a line for example).

It might sound too good to be true, for police officers that is, but such a "test" does exist. Horizontal gaze nystagmus when properly administered by a trained police officer has proven to be accurate within .02% of the subject's actual blood alcohol concentration level. Traffic officers in Colorado that have been properly trained in using nystagmus are greatly increasing their detection level of intoxicated drivers. However, nystagmus is not intended to replace any of the roadside maneuvers but should be in addition to the four presently used. So, the properly trained officer would conduct the "roadside" in the following order:

1. Gaze nystagmus
2. Rhomberg
3. Alphabet
4. Walking a line
5. Finger to nose

After the officer evaluates the suspect on these five maneuvers he may have probable cause to arrest the driver for a DUI related charge and then may ask the suspect to submit to a chemical test of his blood or breath to determine the alcohol content within his system.

By accurately administering and evaluating gaze nystagmus, Rhomberg, alphabet, walking a line and finger to nose to a subject, trained officers can estimate BACs within an average of .02% of the chemical test readings. Administration procedures and precautions, training and mechanisms producing nystagmus are detailed in this publication.

TRAINING RECOMMENDATIONS

In order to gain favorable court acceptance and so that officers are confident in using nystagmus, the Division of Highway Safety recommends a minimum of 8 hours training by a qualified instructor. The goal of the training course should be designed to assist officers in detecting and apprehending alcohol impaired drivers, even with low BACs, through the use of nystagmus. The following objectives to reach this goal should be addressed:

1. The student will understand the magnitude of the DUI problem and the importance of aggressively enforcing the DUI laws.

2. The student will understand how to detect the DUI.

3. The student will understand how to administer the horizontal gaze nystagmus test and will show a proficiency within .02% BAC in the training exercises.

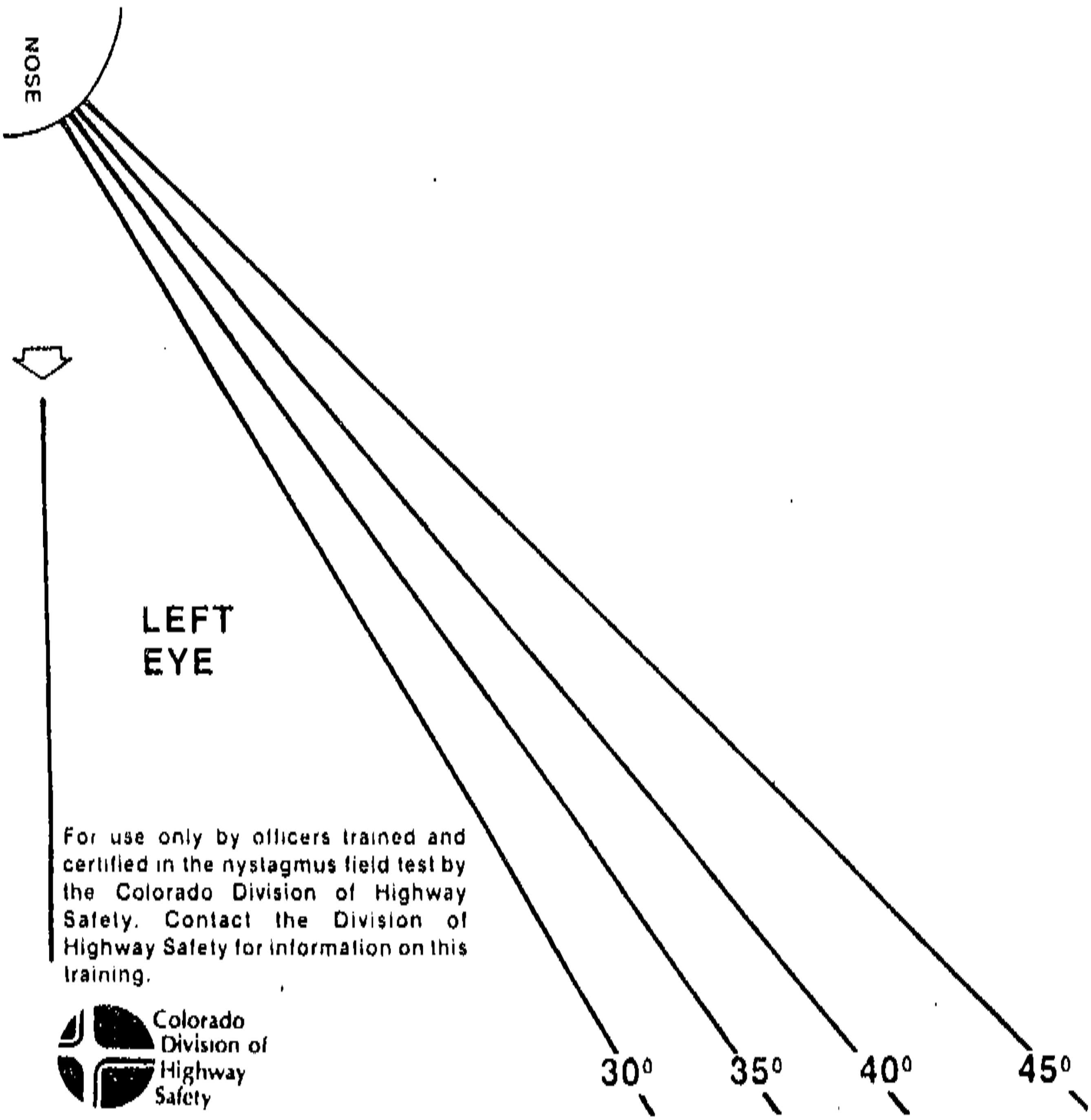
4. The student will understand the detection methods available for determining drug usage by drivers.

5. The student will understand the law pertaining to DUIs.

Once the student has successfully completed the classroom training, a certificate of training then may be issued. Since nystagmus, like other roadside maneuvers, is non evidentiary, and only used in developing probable cause, an officer need only to show that he was properly trained and is proficient in its usage. A continuing certification process should not be required by the courts.

Administering Nystagmus

Nystagmus is an involuntary jerking movement of the eyes that sometimes can be seen when the eyes are deviated to their lateral extremes. The jerking has a slow and fast phase, with the fast phase being in the direction of the gaze. A strong correlation exists between the BAC and the angle of onset of the nystagmus. At a BAC of .10%, nystagmus onset occurs at 40 degrees of lateral deviation. To correctly judge the angle of onset the officer should use a nystagmus measuring device similar to the one pictured below.



The following procedure should be followed when administering nystagmus:

First, eye glasses should be removed. The stimulus (object) should be placed slightly above the eyes in order to prevent squinting and approximately 8 to 10 inches from the subject's face. At night, if street lighting is inadequate, a flashlight is required to illuminate the face. In looking for the onset of nystagmus, it is recommended that the object be moved fairly slow (i.e., at about 10 degrees per second), but not too slowly, otherwise normal oscillation of the eyeball may be mistaken for nystagmus. The suspect should keep his head still. The officer should move the object twice to the left and twice to the right, looking at the eye on the side of the head to which he is moving the object. The officer should move the object to the side until the jerking starts, this is the angle of onset. Based upon laboratory research the trained officer should expect to see the following relationship between the BAC and the angle of onset:

45° = BAC of .05%
40° = BAC of .10%
35° = BAC of .15%
30° = BAC of .20%

The second movement in each direction should be faster (about 20 degrees per second) and the observer should note whether or not the suspect follows smoothly and how distinct the nystagmus is at the maximum lateral deviation. The breakdown of the smooth pursuit and greater amplitude of nystagmus at maximum deviation are also good signs of a BAC over .10%. Thus, the police officer has three eye signs to look for:

1. Onset of nystagmus.
2. The distinctness of nystagmus at maximum lateral deviation.
3. The breakdown of smooth pursuit eye movements.

About 3% of the population will show early onset nystagmus, and impaired balance, with no alcohol in their system. This nystagmus could be the result of drugs (usually barbiturates, antihistamines and phencyclidine) other than alcohol. Brain damage can also cause nystagmus, but this is easy to detect since the angle of onset should be different in each eye.

After completing the nystagmus test the police officer should continue the roadside with the Rhomberg, alphabet, walking a line and concluding with the finger to nose maneuver.

At this point, the officer should be able to make a good decision either to arrest or release the driver. He has observed his driving behavior (in most cases), his physical and mental condition in the vehicle, and observed his performance during the maneuvers. These factors taken together, constitute probable cause for arrest, or should influence the officer's decision to release him.

Conclusion

Because a number of complicated issues are involved in using and understanding nystagmus, it is recommended that it be used by properly trained officers only. The remainder of this document is a collection of various reports and studies concerning Nystagmus. It is hoped that this entire document will give the reader a better insight to nystagmus, but in no way should it be used to replace formal training.

APPENDICES

GAZE NYSTAGMUS AS A ROADSIDE SOBRIETY TEST

Van K. Tharp, Ph.D.*

Traffic officers in Southern California are beginning to use a new tool in roadside sobriety testing, one that could greatly increase the detection of intoxicated drivers. The tool is horizontal gaze nystagmus, which refers to a jerking of the eyes as they deviate to the side. The jerking has a slow and a fast phase, with the fast phase being in the direction of the gaze. The eyes of 50-60% of all individuals will show horizontal gaze nystagmus if they move to the lateral extremes of from 45 to 65 degrees, measured from the center of the nose. However, after a person has consumed alcohol, the onset of the gaze nystagmus occurs at a much smaller angle, depending upon the blood alcohol concentration (BAC). The relationship between the angle of onset of horizontal gaze nystagmus and the BAC is so precise that a properly trained police officer can estimate a driver's BAC at roadside within ± 0.02% of chemical test readings.

Tharp, Burns, and Moskowitz, in a contract for the National Highway Traffic and Safety Administration, have standardized the administration and scoring procedures of a field sobriety test battery designed to aid police officers in recognizing drivers with BACs over 0.10%. In a laboratory evaluation of this test battery, ten police officers administered the test battery to 296 volunteers with BACs ranging from 0 to 0.185%. The officers were able to classify better than 80% of these individuals with respect to a BAC of 0.10%. The most sensitive test in the battery was horizontal gaze nystagmus.

Roadside Procedures

Tharp *et al*. recommend the following procedures for police in using gaze nystagmus at roadside. The person being tested should remove all corrective lenses; glasses may impede an officer's view of the eyes and hard contact lenses tend to limit the lateral movement of the eyes (which might prohibit the recognition of borderline cases). The occurrence of nystagmus is not affected by visual acuity. The stimulus should be positioned above the eyes, in order to elevate them and reduce squinting, and about 15 inches away from the eyes. At night if the street lighting is not adequate, a penlight should be used to illuminate the face and eyes. The officer should move the stimulus at least twice in each direction, looking at the eye on the side of the head to which he is moving the stimulus. The suspect must keep his/her head still. The officer's flashlight makes a good chinrest for suspects who persist with head movements. The first movement in each direction should be slow (i.e., at about 10 degrees per second), while the second movement should be somewhat faster (i.e., at about 20 degrees per second).

*Southern California Research Institute, 6305 Arizona Place, Los Angeles, CA 90045.

Signs of Intoxication

The police officer should look for three signs of intoxication in the eyes: 1) the angle of onset of horizontal gaze nystagmus; 2) the amplitude of the nystagmus at the maximum lateral deviation; and 3) the ability of the eyes to follow smoothly.

1. Nystagmus Onset. Lehti reported a correlation of -0.76 between the angle of onset of horizontal gaze nystagmus (measured from the center of the nose in five degree increments) and the BAC of 56 arrested drivers at the time of arrest. Tharp et al. were able to confirm this correlation in several laboratory studies. In our own work the regression equation relating the angle of onset to the BAC was approximately:

Angle of Onset = 51 degrees - 105 (BAC as %)

Thus, at a BAC of 0.10% we would expect the angle of onset to be about 41 degrees; at 0.15% we would expect the angle of onset to be about 35 degrees; and at 0.20% we would expect the angle of onset to be about 30 degrees. Individuals with BACs above 0.20% frequently cannot even follow a moving object with their eyes.

During the first movement of the stimulus in each direction, the officer should look for the onset of nystagmus. When he first detects a slight jerking, he should stop moving the stimulus to make sure that the jerking continues. If the nystagmus stops, then the officer has not found the point of onset and he should continue his examination.

When the officer finds the onset point, he sould determine whether or not it occurs before 45 degrees with some of the conjunctive (i.e., the white of the eye) showing. The 45 degree angle was chosen as a criterion because it is close to the expected onset point for a BAC of 0.10% and because it is easy to estimate. The 45 degree angle splits the right angle that runs from the tip of the nose to the center of the head to the middle of the ear. Since some individuals cannot deviate their eyes more than 45 degrees, some white of the eye must show to ascertain that nystagmus is not occurring at the most extreme deviation for that individual.

2. Nystagmus at the Extremes. Nystagmus at the maximum lateral deviation becomes more distinct as the BAC increases. Tharp et al. found that this measure is fairly distinct in people with a BAC of 0.10%. Thus each movement of the stimulus by the police officer should continue to the extremes of the eye so that the maximum amount of nystagmus can be observed.

3. Smooth Pursuit Breakdown. Smooth pursuit eye movements are required to follow a moving object. This eye movement system is autonomic, and it is concerned primarily with matching the speed of the eye with the speed of the target. It appears to function in providing a stable image on the retina.

Wilkinson, Kim, and Purrell have shown that the smooth pursuit system is particularly vulnerable to the effects of alcohol. This eye movement system can normally track movement at up to 30 degrees per second. Alcohol, however, reduces the maximum tracking speed and, in sufficient concentration, eliminates smooth pursuit entirely.

Smooth pursuit eye movements should also be examined by a police officer at roadside, although this is the least reliable of the three signs. Tharp et al. recommend that the second movement of the stimulus in each direction be at about 20 degrees per second, while the officer looks for impaired smooth pursuit. The officer must be careful to move the stimulus smoothly to be sure that impaired pursuit is not due to his manner of moving the stimulus. What a police officer will see as the BAC increases is: 1) at a BAC of 0.08% - 0.10% impaired smooth pursuit will be characterized by smooth movements interrupted by small jerks or saccades; 2) at a BAC in the range of 0.15% to 0.20% the eye movements will be characterized by much bigger saccades; 3) at high BACs (e.g., above 0.25%) most people cannot track at all.

Precautions

Tharp et al. found that about three percent of the 296 volunteers in their laboratory study had sufficient horizontal gaze nystagmus when sober to be mistaken for a BAC in the 0.08 to 0.10% range. There are a number of causes of nystagmus other than alcohol which could account for these individuals.

1. Other Drugs. Horizontal gaze nystagmus is well documented as occurring with barbiturates with antihistamines, and with phencyclidine. A number of other drugs may also produce horizontal gaze nystagmus, especially other depressants and anticonvulsants, but most of the evidence on these drugs is contained in some clinical case reports in which the authors fail to define "nystagmus."

2. Brain Damage. Horizontal gaze nystagmus also occurs with some types of brain damage. Asymmetrical gaze nystagmus is more likely to result from brain damage than from drugs.

3. Illness. Certain types of diseases will produce horizontal gaze nystagmus. However, the medical literature is filled with case studies in which symptoms of "nystagmus" are reported with no mention of the type of measurements taken. Consequently, this literature is beyond the scope of this review.

4. Fatigue or Sleep Loss. Since police often arrest the suspected intoxicated driver after midnight, possible effects of fatigue or circadian rhythms on gaze nystagmus would be significant. Collins (personal communication) found no changes in gaze nystagmus after two nights of sleep loss, so fatigue alone does not appear to influence gaze nystagmus. However Moskowitz and Tharp have shown that the angle of onset of horizontal gaze nystagmus at a

BAC of 0.10% decreases by about five degrees when circadian rhythms reach their nadir. Consequently, police officers should adjust their criteria by about five degrees between midnight and 5 a.m.

6. Test Sensitivity. Most studies in which gaze nystagmus has been measured involve a "cutoff point" of 30 to 40 degrees. The cutoff point means the angle beyond which the investigator stops looking for nystagmus. The use of a cutoff point may explain the conclusion of many of these studies. For example, Aschan used a cutoff of 40 degrees and concluded that gaze nystagmus had a distinct threshold BAC of approximately 0.06%. Umeda and Sakata used a cutoff of 30 degrees and concluded that gaze nystagmus was one of the least sensitive eye measures of alcohol intoxication. These conclusions are not at all surprising in view of the data presented above that horizontal gaze nystagmus at a BAC of 0.10% will occur at about 41 degrees.

Aschan reported that gaze nystagmus is more evident with monocular fixation thatn with binocular fixation. He reported that subjects showing monocular gaze nystagmus at 20 degrees would not show binocular nystagmus until 40 degrees. Toglia reports that gaze nystagmus tends to be greater in the left eye upon gazing to the left and in the right eye upon gazing to the right. Tharp et al. believe that these two phenomena are the same and recommend that police officers only look at the eye in the direction of gaze.

Conclusions

In summary, a powerful tool is now available for police officers to use at roadside to determine the BAC of stopped drivers. By accurately judging the angle of onset of nystagmus, officers can learn to estimate BACs to within an average of 0.02% of chemical test readings. Administration procedures and precautions are detailed in this review.

ALCOHOL AND NYSTAGMUS - TECHNICALLY SPEAKING*

Nystagmus refers to a jerking of the eyes which may be pendular (equal on both sides) or asymmetric with a slow an fast phase (Toglia, 1976). Alcohol appears to influence a number of different kinds of nystagmus, including: positional nystagmus (Aschan, 1958; Goldberg, 1963), post-rotational nystagmus (Schroder, 1971b), caloric nystagmus (Schroeder, 1971a), optokinetic nystagmus (Schroeder, 1971a), gaze nystagmus (Aschan, 1958; Lehti, 1976).

If all of these forms of nystagmus are considered, then the literature on alcohol and nystagmus is quite large and somewhat contradictory. However, by studying the mechanisms producing nystagmus, the literature can easily be sorted.

Essentially, alcohol can influence nystagmus in two ways: (1) mechanically by acting on the vestibular system, and (2) neurologically.

1. Vestibular Mechanisms

In man, three semicircular canals, joined at right angles, are located in each inner ear. The canals are filled with fluid, called endolymph. A swelling or ampulla is located in each canal and contains the sensory transducer of the canal. Essentially, the cilia of a number of sensory cells project into a common gelatinous mass, the cupula. This cupula is hinged at one end, so that it can swing from side to side with the ampulla. In the upright position, the cupula forms an effective seal, preventing the leakage of endolymph past that point.

The semicurcular canals respond to angular acceleration, such as in a head movement, which causes the endolymph to lag behind the head movement (i.e., the fluid moves) and deflects the cupula. Deflection of the cupula discharges the sensory cells and provides the sensation of movement. With constant angular acceleration, the system provides accurate information for the first ten seconds or so and then underestimates the amount of acceleration. If the person is then held at a constant velocity, then the cupula catches up to the skull movement (i.e., it returns to normal position) and the sensation is one of slowing down and eventually (in about 20 seconds) of stopping. If the person is stopped, then he or she will sense a sudden acceleration in the opposite direction because the head is now slower than the endolymph, which causes the cupula to deflect in the opposite direction. If the person remains stopped, then the cupula returns to its level position giving a sensation of slowing down and stopping.

---

*Reprinted by the Division of Highway Safety from an original report completed by the Southern California Research Institute (Contract DOT-HS-8-01970).

Since the three semicircular canals in each ear are at right angles, we can sense angular acceleration in any direction. When visual information conflicts with the sensation of motion, one feels dizzy and may feel sick. However, the mere sensation of movement may produce illness in some individuals.

The vestibular system interacts with the visual system by producing alternating fast and slow eye movements (i.e., nystagmus) in addition to the sensation of movement. Nystagmus is produced because the eyes lag behind the angular acceleration, so a "brain center" makes periodic adjustments in order to maintain adequate foveal fixation. For example, one can move one's head back and forth and still maintain fixation.

Unfortunately, angular acceleration is not the only stimulus which will cause cupular deflection. The cupula and endolymph both have the same specific gravity. A very slight change in the specific gravity of either the fluid or the cupula may result in a cupular deflection, because the system becomes sensitive to gravity with certain head positions. Money and Miles (1975) claim that a change in the specific gravity of 3 parts in 100,000 will make the system sensitive to gravity.

Alcohol and some other drugs can alter the balance in specific gravity (Money and Miles, 1974; 1975). The base of the cupula has a rich blood supply. Foreign substances in the blood will diffuse rapidly into the cupula because of its proximity to the blood and alter the specific gravity of the cupula with respect to the endolymph. The direction of the nystagmus (i.e., the fast phase) will depend upon whether the drug makes the specific gravity of the cupula greater or less than that of the endolymph.

For example, within one hour after consuming alcohol a positional alcohol nystagmus (PAN) will occur. That is, if from supine position one rolls one's head to the side (i.e., so that the cupula is subject to gravity), a nystagmus, called PAN I, occurs in which the fast eye movements are down (e.g., Aschan and Bergsted, 1975). Approximately four hours after drinking, the nystagmus stops. This is probably because sufficient alcohol has defused into the endolymph so that its specific gravity equals that of the cupula. Finally, as alcohol is eliminated from the blood stream, the endolymph ends up with a greater concentration of alcohol than the cupula. At this point, a positional nystagmus occurs in which the fast eye movements are up (PAN II). PAN II may persist up to 20 hours after consuming alcohol -- long after alcohol has been eliminated from the bloodstream (Hill, Collins, and Schroeder, 1973). In fact under conditions of increased gravity, PAN II has been found up to 40 hours after drinking alcohol (Oosterveld, 1970). The change in specific gravity also explains why the presence of congeners in alcohol can increase the amount of positional nystagmus (Murphree, Price, Greenbert, 1966; Ryback and Dowd, 1970). Excellent reviews of the PAN phenomenon are contained in Aschan, Bergstedt, Goldberg, and Laurell (1956); Fregly, Bergstedt, and Graybiel (1967); Hill, Collins, and Schroeder (1973); Aschan and Bergstedt (1975); Aschan (1958); and Goldberg (1963).