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B. Cheung
W.T. Wong
L.J. Holbrook

DEFENCE AND CIVIL
INSTITUTE OF ENVIRONMENTAL MEDICINE

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RECOMMENDATIONS TO IMPLEMENT GYRO-IPT (HELICOPTER CONFIGURATION) FOR DISORIENTATION TRAINING AT CFSAT

B. Cheung
W.T. Wong
L.J. Holbrook

Defence and Civil Institute of Environmental Medicine
1133 Sheppard Avenue West, P.O. Box 2000
Toronto, Ontario
Canada M3M 3B9

DEPARTMENT OF NATIONAL DEFENCE – CANADA

Executive Summary

With the acquisition of the GYRO IPT (ETC) at the Canadian Forces School of Aeromedical Training (CFSAT), a further evaluation was completed on the helicopter configuration of the device and how the disorientation profiles specific to the helicopter might be implemented into existing undergraduate pilot training syllabus.

The GYRO IPT is the most recent version of the GYRO-1 series of flight simulators. It features upgrades on the pitch and roll motion capability and options for data acquisition and medical monitoring. The major advantage of the device is its interactive closed-loop (pilot-in-the-loop) feature that forces the trainee to relate any demonstration to actual flight situations. In summary, the motion capability of the GYRO-IPT is able to elicit the type of vestibular illusions that are related to the inadequacy of the semicircular canals system (incapable of detecting constant velocity motion).

Due to the limited pitch (± 15 degrees) and roll (± 30 degrees) capability and the lack of planetary rotation, otolith-mediated illusions cannot be demonstrated by the GYRO-IPT. The device reasonably demonstrates most of the visual illusion profiles such as leans, autokinesis, distance and depth perception, and false horizon. Improvements in the demonstration of nystagmus leading to loss of visual acuity, and reducing the size of the instrument display console are required to enhance some these demonstrations. The timely implementation of the GYRO-IPT into current spatial disorientation lectures will be crucial to effective flight training.

Introduction

The GYRO-IPT (Integrated Physiological Trainer) manufactured by ETC of Southampton, N.J. is a flight simulator designed to demonstrate selected spatial disorientation (SD) illusions. With the recent acquisition of the device at CFSAT (Canadian Forces School of Aeromedical Training), the appropriate and timely implementation of this device is highly desirable in order to realize its potential. Issues regarding the fixed wing configuration have been dealt with in a previous technical memorandum (Cheung and Wong 1998). The objectives of the current technical memorandum are: (A) evaluation of the helicopter illusions generated by the GYRO-IPT and (B) recommendations for implementation of GYRO-IPT to helicopter SD training in the CF.

A. Evaluation of GYRO-IPT

The GYRO-IPT is the latest version in the series of GYRO-1 flight simulators with upgrades on the pitch and roll motion capability. The major advantage is purported to be its closed-loop feature that forces the trainee to relate any demonstration to actual flight situations. According to the manufacturer, this device can simulate the following illusions for fixed and rotary wing aircraft:

Fixed Wing	Rotary Wing
1f. Coriolis	1r. Coriolis
2f. Somatogyral Illusion	2r. Leans
3f. Graveyard Spin/Spiral	3r. Nystagmus
4f. Oculogyral Illusion	4r. Autokinesis
5f. Leans	5r. Black Hole
6f. Nystagmus	6r. Distance Depth Perception
7f. Autokinesis	7r. Flicker Vertigo
8f. Black Hole	8r. False Horizon-Night
9f. Dark Takeoff	
10f. False Horizon	
11f. Runway Width	
12f. Up-slope Runway	

DCIEM was provided with a GYRO-IPT by ETC in January 1999 for our evaluation. Our main objective was to integrate the GYRO-IPT into the current rotary wing pilot training program.

The manufacturer has given Dr. Cheung and Capt. Wong numerous demonstrations on the device in the past year. Capt. Holbrook, a current Griffon reserve helicopter pilot from Borden, assisted us in evaluating the GYRO-IPT at DCIEM on Jan. 25-26. Our observations and comments are reported as follows and are intended as positive feedback to facilitate the implementation of this device into the Canadian Forces helicopter flight training program.

The motion capability of the GYRO-IPT is able to elicit the type of vestibular illusions that are related to the inadequacy of the semicircular canals system (incapable of detecting constant velocity motion). Therefore, it effectively demonstrates most of the listed disorientation illusions with the following areas that require further attention and in some cases the explanation of the illusion should be elaborated to achieve effective training.

Cyclic and Collective Handling Pressure

It appears that excessive force is required to operate the cyclic laterally; it is not natural to have it spring-loaded to the central position. The simulation of returning to wings level from a banking manoeuvre is too sensitive. There is a tendency for the helicopter to oscillate after achieving wings level. This sensitivity should be reduced. The rudder pedals are too stiff in the helicopter configuration and the yaw trim should be corrected so that there is no immediate left turn motion at the beginning of each helicopter illusion profile. Finally, the location of the collective is too high in the cockpit. It should be lowered at least 6 inches. We would suggest that (i) ETC be contacted again to rectify the problem, and (ii) if time permits, trainees be given ample amount of time to become familiar with the control characteristics of the device before being exposed to the various types of disorientation illusions.

1r. Coriolis Illusion

The Coriolis illusion or Coriolis cross-coupling effect is demonstrated effectively. Even if it is not directly responsible for spatial disorientation in flight, it is an important exercise to demonstrate the fallibility of the vestibular system as orientation cues. In the extreme case, it could provoke symptoms of motion sickness.

Coriolis illusion or Coriolis cross-coupling effect is a common perceptual illusion that causes almost as much confusion in its discussion as in its experience. It is compounded by the results of frequent unpleasant motion sickness symptoms. Therefore the demonstration should be accompanied by careful explanation as to the imperfect integration of the inputs from the semicircular canals and conflicts with the otolith systems during such movements. At the very least the correct consequences of the demonstration should be given during debriefing. The sensations of discomfort and development of motion sickness symptoms resulting from these cross-coupled angular accelerations are most likely attributable to the conflict between the semicircular canals and the non-confirming otolith cues rather than to the unexpected cross-coupled angular acceleration signal acting on the canals themselves.

The Coriolis illusion should be demonstrated again prior to instrument flight; the idea to impart on pilots is that the vestibular sense cannot be trusted-the most important lesson of all for instrument flying.

2r. Leans

The GYRO–IPT introduces the leans (false sensation of bank) effectively during a simulated coordinated bank turn with a sub-threshold roll motion. However, the demonstration is effective without the deletion of the attitude indicator (AI). This portion of the demonstration should be altered since deleting the AI is an unrealistic flight scenario. Trainees should be made aware that there is more than one form of this illusion, although the common cause is the result of unperceived error in roll attitude. Three other forms have been identified:

- (i) Pilots allow the helicopter to bank at a rate below threshold roll detection (0.5-5 degrees/s).
- (ii) A supra-threshold change in the roll attitude (a sudden gust) followed by a sub-threshold return to the level position.
- (iii) An innate directional asymmetry in the pilot's ability to detect changes in roll attitude has also been cited as one of the causes of leans.

3r. Nystagmus

The listing of "Nystagmus" as an illusion is erroneous. Nystagmus is an involuntary eye movement. It is a normal physiological response to sustained angular acceleration and deceleration acting on the semicircular canals. This characteristic jerky movement of the eyes is observed at the start and end of a period of rotation. It is a reflex that maintains visual fixation on stationary points while the body rotates. When rotation starts, the eyes move slowly in a direction opposite to the direction of rotation. When the limit of this movement is reached, the eyes quickly snap back to a new fixation point and then again move slowly in the other direction. The slow component is initiated by the impulse from the semicircular canals; the quick component is triggered in the brain stem. Nystagmus is frequently horizontal (i.e. the eyes move in the horizontal plane); but it can also be vertical during pitch rotation, or torsional during roll rotation.

Nystagmus is demonstrated in the GYRO-IPT by performing two prolonged banking maneuvers followed by a leveling maneuver. A sub-threshold spin is maintained throughout the demonstration resulting in nystagmus once the pilot levels the GYRO-IPT. Some of the pilots reported nystamus however, they were able to read the altimeter accurately. At the same time, we were not able to observe nystgamus from the pilots' image through the video monitor. The above discrepancy could be due to the fact that although nystagmus in some cases might have been provoked, the resulting eye velocity was less than 3°/s. A velocity of 3°/s is the minimal velocity that could disrupt image stability in the retina in order to reduce visual acuity. We suggest that the spin rate is increased and the pilot instructed to perform a 45° bank turn to enhance the possibility loss of visual acuity.

4r. Autokinesis

It should be emphasized that there should be no light leaking into the cockpit during this demonstration. In the unit provided by ETC, we observed that there is light leak into the cockpit around the door seals. As a result, there was a glare on the cockpit view screen. This problem needs to be corrected for the demonstration to be effective, and the mirror at the top left portion of the cockpit may require repositioning. Our test pilot could not see the light in the mirror with his right eye from his vantage point. The narrative should also be corrected to direct the pilot to the target light in the "Top left corner of the cockpit, above the view screen."

5r. Black Hole Approach

An analogy should also be made after this demonstration that in the Canadian climate, an atmospheric whiteout and blowing snow whiteout approach can be as difficult as a blackout approach for essentially the same reason (which is the lack of sufficient ambient visual orientation cues.)

The area of the instrument console display is too large. In order to keep the display directly in front of the pilot he/she must look over the cockpit console and as a result it becomes impossible to maintain the proper glide path. In order to view the NATO "T" landing zone as instructed by the program, one needs to manoeuvre to the side and look off to the side of the cockpit console which is against training doctrine. Reducing the size of the instrument panel could solve this problem. In addition, prior to landing the scenario should change from night to daylight to show the pilot exactly how low he/she is on the approach path.

6r. Distance and Depth Perception

The demonstration was effective, however, it could be improved by automatically switching from a night situation to a daylight situation at the moment the narrator says "Did you come dangerously close..." This change would illustrate convincingly how close the illusion has brought the pilot to the "mountain surrounding the town" as narrated.

7r. Flicker Vertigo

The demonstration would be satisfactory with the following changes. A narrative should be inserted at the beginning of the profile instructing the pilot to: "Taxi for runway 36 by making a right turn at the next intersection." This would clear any confusion with regard to how and where the pilot should proceed at the beginning of the demonstration. By reducing the flicker frequency, the apparent sensation of motion would be enhanced.

8r. False Horizon-Night

The false horizon indicates the condition where the horizon perceived through ambient vision is not really horizontal. A typical example to illustrate the false horizon is when a pilot misperceives the lights at night from a town on a sloping hillside. The pilot should begin the scenario on a heading of 205° vice 215° to more effectively use the town's lights in demonstrating this illusion. In addition the scenario should change from night to daylight when the narrator states "Do you note a discrepancy with your AI..." to convincingly illustrate the sloping lights on the terrain.

B. Recommendations to implement GYRO-IPT to disorientation training at CFSAT

Currently, the Canadian Forces pilot training curriculum is separated into 3 distinct stages:

- Stage 1. Primary Flying Training at Portage la Prairie,
- Stage 2. Basic Jet Training at Moose Jaw, and
- Stage 3. Advanced Jet at Moose Jaw, Multi-engine and Helicopter training at Portage la Prairie.

After the third stage, a pilot is wings-qualified and assigned to an operational squadron.

Timing of SD training is one of the important factors in achieving the effectiveness of the training program and to fully utilize the potential of any training devices. This issue has been previously discussed in DCIEM report 98-R-32 (Cheung 1998) and DCIEM report 98-TM-59 (Cheung and Wong 1998). If SD training is too far in advance of flight training, students might forget important material concerning SD before they get the chance to experience SD in flight. It is suggested that training of any nature is more effective if distributed over several sessions. Therefore, "reviewing" SD is more effective during the basic helicopter-training phase at Portage la Prairie. We are aware of the possible restriction that might be imposed by fiscal restraints, but the possibility of a future SD-related accident will be more costly.

During Basic Helicopter Training in Portage la Prairie

A comprehensive course on helicopter SD including the following demonstrations should be given.

1. **Coriolis**
2. **Leans**
3. **Autokinesis**
4. **Black Hole Approach**
5. **Distance Depth Perception**
6. **Flicker Vertigo**
7. **False Horizon-Night**

References

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2. Cheung, B. Recommendations to enhance spatial disorientation training for the Canadian Forces. DCIEM, 98-R-32, 1998.

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