Original Article

Ground based Spatial Disorientation Counter Measure training: An approach to training for Indian Air Force

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ABSTRACT

Indian Air Force (IAF) addresses Spatial Disorientation Counter Measure (SDCM) training with an accepted multi-pronged approach of education, training and research. Physiological training, using a spatial disorientation simulator, Airfox DISO®, is one of the SDCM strategies employed by the IAF. Such ground based training aims to provide an understanding amongst pilots about the physiology of orientation, its limitation in aviation, in turn helping them understand their susceptibility to spatial disorientation (SD), and demonstration of common illusions to help in early recognition of SD. Though, the training practices include a combination of didactics and demonstration; there is learning of the SD trainers as well, with the shared experiences, feedback and interactions with the pilots undergoing the SDCM training. Such training, therefore, is an ongoing 'teaching learning' process. The healthy, meaningful and mutually beneficial interaction, between the SD trainers and the pilots, helps in evolving the training practices. With a view to evaluate the ongoing 2 day SD training course for fighter pilots, this study was undertaken to define and plan the future SDCM training of the IAF aircrew. The data for the study was obtained from the selected analysis of the post-course written feedback; and interaction, formal and informal, with the aircrew undergoing training. The post-course feedback pertaining to this study was available from 105 pilots. The trainee pilots suggested procedural modifications (59.04%), modifications in the layout of display and control in DISO (22.85%) and various training, trainee, course content and course conduct related issues (18.09%). Based on the varied data and the inputs, ground based SDCM training schedule is proposed for the ab-intio to the operational pilots, as per the growth in their professional career. The need for refresher training and modifications in in-flight SD training is emphasized. This paper outlines the strategy for long term exploitation of the SD simulator for an enhanced SDCM training value for the IAF pilots.

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Key words: Spatial Disorientation (SD), spatial disorientation counter measure (SDCM), spatial disorientation simulator, ground based SD training, 'teaching learning' process

Ground based Spatial Disorientation Counter Measure (SDCM) training aims to augment an experience based understanding amongst pilots to enable early recognition of spatial disorientation (SD) and initiate appropriate corrective actions [1]. Such training is meant to increase pilots' awareness about limitations of the physiological orientation mechanism in flight; increasing their awareness of conditions predisposing to SD; demonstration and experience of common in-flight illusions; thereby enhancing their trust in instruments and ability to initiate corrective actions.

Indian Air Force (IAF) acquired an SD simulator, Airfox DISO® [2], in 2004. DISO, with its 6 degrees of freedom (DOF) motion system, with a generic aircraft mock-up, provides a safe, realistic and real-time ground based disorientation training to the aircrew. Though not a flight training device, DISO provides the necessary environment to ensure that the pilot undergoing SD training experiences the cockpit work load situation akin to actual flight, including normal flying, circuit approach

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and landing; roller take-offs, letdowns, and simulated emergencies. DISO also offers facility to change the out-of-window (OTW) views with respect to visibility, cloud cover, time of day, topology, runway and environmental lightings. The common illusions that can be demonstrated are [2]: Coriolis illusion, Somatogyral illusion, Oculogyral illusion, Graveyard spin, The leans, Nystagmus, Auto kinesis, Black hole approach, Dark take-off, False horizon, Size distance illusion, Flicker vertigo, Height depth perception.

Since its acquisition, DISO based ground training SD courses for the fighter and helicopter pilots have been conducted for 5 and 2 days duration, respectively. The course curriculum [3] included brief didactics and demonstration of illusions, starting in free flight mode before pilots are exposed to host of passive and active illusions. Debrief with recorded visuals or print out of flight profile is used for reinforcing the training objectives. Others witnessing the real time training also make an impression about the disorientation experienced by the pilot being trained.

A preliminary study on DISO training based on pilots feedback (n = 178) provided valuable insight into the gains of training [3]. This study reported an improved awareness of SD amongst aircrew (88%), with the realism of simulator being rated good to excellent (85%). Majority (90-97%) of them admitted that the training reinforced their trust in instruments and ability to initiate corrective actions. This study also commented on the need for training of ab-initio pilots (31%) and after trifurcation of trainee pilots into fighter, helicopter and transport stream (38%). An overwhelming 90% advocated the need for refresher training. The fighter aircrew interestingly desired that the duration of training be reduced from 5 days to 3 days (71%) or even 2 days (11%).

The findings of this preliminary study [3] with the need for providing the benefits of ground based SDCM training [1] to the maximum number of aircrew led to an in-house review of the course curriculum in 2006. This resulted in designing a modified shortened 2 day SD course for the fighter pilots, with the total duration curtailed from 5 days to 2 days by reducing the didactics element for the group and limiting the simulator flying to 90 min for each pilot. The aim of the 2 day SD course is to help indoctrinate as large a number of aircrew as possible in the shortest possible period; besides to help individual aircrew understands the basics of orientation and SD with demonstration of the illusions in the safety of the ground based simulation [2]. The objective of this short duration course continues to be "to enhance awareness of illusions by demonstration in DISO"; and it is expected that this training shall help the aircrew to develop watchful expectancy for the effects of the SD phenomenon in flight [1]. During training, it is reinforced that pilots must learn to disregard bodily sensations and they must 'believe in instruments' and 'make instruments read right, as per the phase of flight'.

After successful completion of one year of the modified 2 day SD course, there was a need to evaluate the training goals of the ground based SDCM training and to plan the courses as per the felt needs of the aircrew. This study aims at defining the future training needs of ground based SDCM training of the IAF aircrew.

Material and Methods

Each pilot, undergoing the DISO course, gives a written post-course 'aircrew feedback' in a standard format. The feedback consists of various SD, and DISO training related aspects, including: any change in their awareness about SD (before and after the course); realism of simulation in DISO and transfer of learning to actual flight conditions;

subjective discomfort, including motion sickness, during training; illusions experienced during their career; and suggestions for improvement in training. At the end of this feedback, they were requested to offer their suggestions for modifications in the conduct of training, including inclusion of any flight profiles for SD demonstration. For the purpose of this study on defining the future ground based SDCM training, the structured part of the written feedback pertaining to the experiences during DISO training was not considered. In addition, there were semi-structured interview with the pilots, mostly supervisors, about the need and conduct of SDCM training. Certain training needs e.g. in-flight demonstration of recovery from unusual attitude, although not a part of the ground based SDCM or the 'aircrew feedback', but which enhance the SDCM training strategies for aviation safety, were also discussed in depth with current Qualified Flying Instructors (QFI) and flying supervisors, who had undergone the DISO training.

This study included the feedback from fighter pilots (n = 288) who had undergone training in one calendar year (Jun 2006 – May 2007) after the 2 day SD course commenced in 2006. In view of the combination of 'aircrew feedback' and semi-structured interview, statistical analysis was not possible in this study.

Results

The 'aircrew feedback', which included the voluntary inputs offered by the pilots pertaining to the modification of training were received from 105 pilots (36.45%), out of a total of 288 pilots trained during the calendar year of 2 day SD training (Fig 1).

The major suggestions for future ground based SD training pertain to procedural modifications (n = 62, 59.04%) and layout of display and control in DISO (n = 24, 22.85%). Remaining 18.09% (n = 19) feedback was related to various training, trainee, course content and course conduct related issues. Salient points from the feedback received from the pilots (table 1) included: need for profiles akin to real IMC conditions; modifications in the training schedule; absence of Russian symbology of displays; and mandatory training, including refresher, for all aircrew.

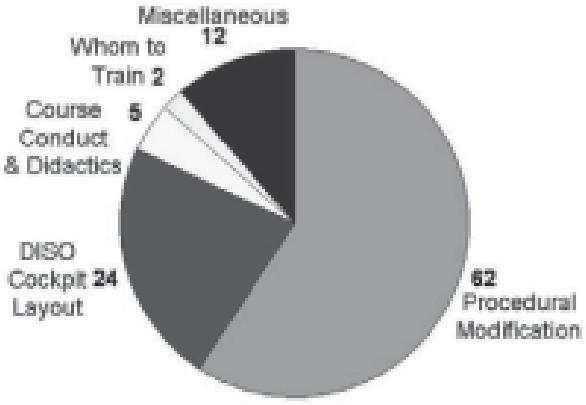

Figure 1: Post-course feedback, including suggestions, from Pilots (n = 105; 36.45% of 288 pilots)

Discussion

Conducting the short duration SD course for more than a year helped SD trainers discover that such training is an ongoing 'teaching learning' process. Though, the teaching practices in SD training involve combination of didactics and demonstration [1, 4, 5]; SD trainers, too, constantly continue to imbibe lessons from the pilots undergoing training in DISO. The meaningful and mutually beneficial interaction with the pilots undergoing DISO training helped in evolving training practices, The hypothetical model of the 'teaching learning process' at Figure 2 illustrates the importance of feedback – verbal and written. The valuable information emerging from the personal experiences, aircrew feedback and interactions with the pilots during the SD training helped the authors define the future training needs of ground based SDCM training of the IAF aircrew.

Table 1: Varied inputs of the Pilots who underwent DISO training - The learning process

System	Suggestion
Procedural modifications (n = 62)	
	(a) Terrain, weather specific and night flying profiles as in real flying conditions (n = 44)
	(b) Modification in training schedule, increasing the duration of training, as well as by splitting the sessions as per different profiles, e.g. landing illusions, active illusions during flying in clouds etc. (n = 7)
	(c) Pilots to be encouraged to recover on instruments, overcoming body sensations while taking correct actions - to reinforce the dictum 'believe in instruments' (n = 6)
	(d) Exaggerated experience of certain profiles without instruments e.g. false horizon with cloud bank ≥ 10-15°; pulling out from dives; and sudden turns or pitch up (n = 5)
Displays and Controls of DISO(n = 24)	
	(a) Displays should be analogous to the Russian fleet of fighter ac, and inclusion of TSI (n = 12)
	(b) Feel of the control inputs be as close as that of an aircraft, including active trim and auto-pilot (n = 7)
	(c) Need for increased field of view, akin to bubble canopy (n = 5)
Miscellaneous(n = 12)	
	(a) Integration of DISO training with compatible procedure trainer facility for better assimilation of experiencing disorientation and following correct procedures for recovery. Recommended that DISO be made available at all the flying units (n = 5)
	(b) Lack of G forces does not give the same feeling as in flight; if possible the feel of G forces must be included to make it more realistic (n = 4)
	(c) Need for studying human behaviour and responses under SD (n = 1)
	(d) Demonstration of recorded profile of disorientation accidents (n = 1)
	(e) One pilot with instructional experience be attached during SD training at IAM (n = 1)
Course content and conduct (n = 5)	
	(a) Number of hours of lectures be increased to cover in greater details the mechanics/teaching about how various illusions occur, and debrief after demonstration of various illusion (n = 4)
	(b) Audio-visual debrief of each illusion demonstrated (n = 1)
Whom to train (n = 2)	
	(a) SD training, including refresher courses, is a must for all aviators irrespective of experience

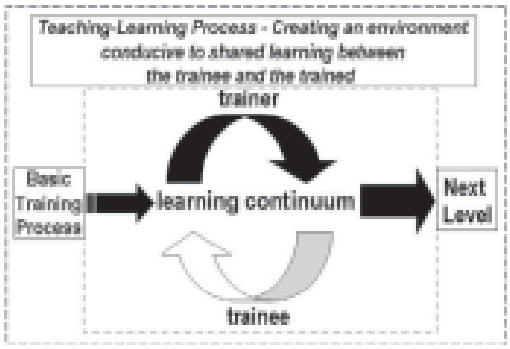

Figure 2: Hypothetical model of 'teaching learning' process

There has been an overwhelmingly positive response to the ongoing DISO training. This re-emphasizes the usefulness of ground based SDCM training in helping pilots understand their physiological limitations during various phases and meteorological conditions of flight. The existing 2 day DISO course for the IAF pilots is required to be taken to the next level once almost all the squadron pilots have been trained at least once. The reason is that the present 2 day SD course has the limitation of "enhanced awareness of illusions by demonstration so that aircrew develops watchful expectancy for the SD phenomenon in flight" [1]. Such training, thus, can sensitize the pilots to their physiological limitations only - hence it is needed that the existing SD training is redefined.

This need has become all the more important in view of certain developments, both in aeromedical training and operational preparedness. First, there has been an amalgamation of various aeromedical courses for the IAF aircrew into a comprehensive Operational training in Aerospace Medicine (OPTRAM). Second, IAF is in the process of acquiring two more DISO simulators, to be located elsewhere. Third, acquisition of air-to-air refuellers and use of night vision devices has provided the IAF with all weather, all terrain, day and night operational capabilities with increased geographical reach. This focuses on the need to educate the aircrew in SDCM since "without an understanding of the nature and effects of SD, the aviator is poorly equipped to deal with the problem when it is encountered" [1].

Therefore, the 2 day DISO course shall hereafter be a part of OPTRAM; and the other two DISOs need to undertake operational training of aircrew, with defined aims and objectives. Broadly, the future training, utilizing the DISO simulators for ground based SDCM training, shall aim to fulfill the following objectives as defined by Braithwaite et al [1]:-

(a) Spatial orientation mechanism in flight; limitation of sensory organs

(b) Conditions conducive to SD

(c) Onset and manifestations of SD and its mechanism

(d) Coping strategies against SD, including under stressful conditions

A broad outline, with the proposed schedule for the target clientele for ground based SDCM is discussed hereafter (Table 2) [7]. The first – 'SD Indoctrination' - is proposed for the ab-initio pilots at Air Force Academy, with an aim to introduce them to the mechanism of orientation and limitation of sensory organs by didactics and demonstration of passive illusions. Next 'stream specific' indoctrination for the pilots of fighter, helicopter and transport stream shall aim at revision of orientation mechanism, defining conditions conducive to SD and making them aware of illusions by demonstration, so that aircrew develop watchful expectancy for the SD phenomenon in flight. This is meant for pilots during their stage III flying training phase. The third phase of indoctrination shall be part of the OPTRAM course, as per the aircraft stream, to aim at demonstration of illusions to help aircrew understand the onset and manifestations of SD and its mechanism. The subsequent proposed courses, refresher and terrain specific, primarily aim at helping pilots evolve coping strategies against SD in different settings, as per their areas of operations and under stressful conditions, akin to battle inoculation, the enemy being SD.

A vital suggestion that emerged from interaction with QFIs and flying supervisors is to integrate DISO training with the conventional instrument flying curriculum, with its three components: full panel, limited panel and recovery from unusual attitude. In such a case, DISO training can be redefined, especially for Stage III and IV trainee pilots as per the suggested format, where once the trainee pilot has been put into an illusionary situation in DISO, (s-)he must spell out and take correct actions as per his (her) training syllabus, under supervision of the available QFI, who must debrief the trainee pilot immediately after the situation. This is for better transfer of simulator based learning for application in actual flight. In addition, during such SD training, psycho-physiological monitoring of the trainee pilot may be undertaken to assess the stress levels. This monitoring may be useful for debriefing the 'high strung' pilots or those whose psycho-physiological responses are found to be exaggerated beyond the

Table 2: Proposed programme for Spatial Disorientation training [7]

IndoctrinationProgramme	Proposed schedule
SD indoctrination	Ab-initio pilots; during stage I flying, before night flying and aerobatic flying; DISO based experience of passive illusion only
Stream specific indoctrination	Pilots from all three streams; before commencing stage III trainingMix of didactics and DISO based illusions.
Ops aircraft indoctrination course	All squadron fighter and helicopter aircrew; Course content similar to the existing DISO course.
Refresher course	All squadron fighter and helicopter aircrew; once in three years, or after break in flying more than six month. Planned navigational flight, with a pre-determined course for a specific duration, with online psycho-physiological monitoring, unexpectedly exposing the pilot to illusions.
Terrain specific training	All squadron fighter and helicopter aircrew; whenever pilots move from one geographical location to another.Terrain specific DISO training is to be planned, since the varying terrain of Indian subcontinent increases the probability of SD. Hence there is need for such training, to be tailor made for terrain specific training to sensitize the pilots to terrain specific visual cues, or rather the lack of it e.g. desert, snow and sea. This is to help pilots be better prepared for coping with terrain specific illusions, and learn to anticipate the probable season specific pitfalls and prepare for the same. *[Note*: *The present simulator lacks compatible digital imagery]*

normal in such situations. This can be a part of debrief by the SD trainer - an Aviation Medicine (Av Med) Specialist. Such an effort is likely to be rewarding since it is aimed at younger, learning trainee pilots, who shall not only be sensitized to SD but shall have feedback about their stress coping strategies. Development and validation of such programme shall require team approach between a group of thinking QFIs, SD trainers, neuro-physiologists and cognitive psychologists.

Needless to say, ground based training shall succeed only if followed by in-flight instrument flying (IF) and night flying (NF) [1]. The IAF has a strong tradition of IF and NF during all stages of flying training and operational flying. To further contribute to this tradition, team approach, with the participation of the Av Med specialist along with the squadron commander and the flight commander, is advocated to help evolve preventive strategies against SD. Squadron Av Med specialists are advised to actively take lectures on SD and preventive strategies, especially during IF and NF phases. In case any pilot experiences SD during such phases, (s-)he must be encouraged to share his (her) experience with the supervisors and Av Med specialist, where the Av Med specialist debriefs on the probable cause of SD and its dynamics; and the correct actions expected out of the pilot being discussed by the flight commander/QFI. An audio and video archive of such debrief sessions can be planned at each squadron for its learning value and future use by other pilots. Such a practice must be encouraged and implemented for the benefit of all the squadron pilots.

Conclusion

It is essential to mention that the success of DISO training is not just indoctrinating about SD. Instead, it is the willingness of the pilots to share their past experiences in an open and frank

atmosphere during the DISO course. They have also reduced their experiences to writing for the larger benefit of not just the SD trainers but also help the trainers develop better understanding about the practical experiences of their aviator colleagues. The proposed SD training programme for the IAF aircrew is to help aircrew understand the basics of SD and their bodily limitations under safe conditions of ground based simulation, reinforcing the lessons in air under supervision later. This shared approach of preventive strategies against SD between aircrew and aviation medicine fraternity shall help enhance overall flight safety.

Conflict of interest: None

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Appendix

SD SIMULATOR INDOCTRINATION : AIRCREW FEED BACK

Name _____

Rank _____ Ser No. _____ Age _____

Unit _____ Flg Hrs: TOTAL _____

Current Ac_____ Six months _____

Aircraft current _____ Aircraft flown_____

_____

Course at IAM _____ Date _____

I. Please Mark each question in a scale of 1 - 5 as follows :
1-POOR, 2-SATISFACTORY, 3-GOOD, 4-VERYGOOD, 5-EXCELLENT

a. What was your SD awareness prior to SD Training: [ ]
b. What is your awareness of SD after the Training: [ ]
c. What is the extent of realism of the illusions vis a vis actual flying : [ ]
d. What is the extent of the realism of the controls and displays to your actual flying: [ ]
e. To what extent the trg can be tranferred to the actual flying environment: [ ]
f. How realistic is the lead-in and scenario of the illusions: [ ]
g. To what extent is the SD simulator a cost effective trg tool: [ ]
h. How do you rate the overall benefit of the SD simulator training in the following:
Recognition of being disorientated: [ ] Ability to initiate corrective action: [ ]
Trust in instruments: [ ] Recovery from unusual attitudes: [ ]
Recognition of in-flight circumstances that could lead to SD: [ ]
j. How do you rate the quality of SD training imparted: [ ]

II. Please mark each question in a scale of 1 - 5 as follows: 1-NIL, 2-SLIGHT, 3-MILD, 4-SIGNIFICANT, 5-SEVERE

a. Did you feel any motion sickness during the trg: [ ]

If yes, then which illusion you felt it _____ and to what extent: [ ]

What did you feel _____

b. Did you feel any difficulty in body-balance at the end of the session: [ ]

If yes, then how long did it last _____

c. Did you have any other abnormal feelings at end of session: [ ]

If yes, then what was the feeling _____

d. What was the severity of the illusions in the simulator: [ ] i.e feeling of illusion

Which illusion was most severe _____

e. Were you disorientated at any time: [ ] i.e. conflict situation

If yes, then which illusion was most disorientating _____

III. Did you experience an illusion in-flight in your career till now? Yes / No. No. of Episodes [ ]

a. If yes, please describe it with respect to: Type of illusion / feelings, aircraft, sortie

weather/visibility, time of day, mode of recognition of illusion *(Use Back page*)

b. To what extent was it disorientating to have led to an accident:

Mild [ ] Moderate [ ] Severe [ ]

c. What recovery procedure did you / will you adopt when under SD:

Auto Pilot [ ] Instruments [ ] Regain VMC [ ] Hand over controls [ ]

IV. a. Did you benefit from SD training at IAM: Yes / No

b. What should be the ideal duration of SD training: 1/ 2/ 3 days

c. Do you consider training for: Ab initio trainees / After trifurcation/ after every 05 / 10 yrs

d. Do you think refresher training is required on SD: Yes / No

e. If yes, what should be the periodicity of re- training:

V. Any suggestions on modification/inclusion of any flight profiles for SD demonstration on Sim?