# Probe into the Methods of Flight Training Based on Special Flight Environment

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## ABSTRACT

With the changing nature of modern warfare, warfighters have to equip with agile fighting skills and robust psychological qualities. Only by staying calm and being unruffled when facing complicated circumstances, can they give full play to the skills learned during training or save the plane in emergencies. This article is against such background to probe into the methods of flight training based on special flight environment. 10 participants were selected in this experiment. The FSX was used and a retired FT-6 was adapted as the cockpit, the training scheme had been set out. With respect to three certain special flight environments, tasks scenes had been selected from FSX. Meanwhile, the heart rate amplitude was recorded, and the scales of state anxiety conducted before and after training were investigated. By analyzing the 10 subjects' physiological and psychological data, the conclusions had been drawn as follows: (a) the effects of training reflected more on the relief of the psychological anxiety; (b) a decline in psychological levels of anxiety had more effect on task-performing efficiency; (c) in the special fight environment, a certain degree of physiological arousal combined with a decline of anxiety had made the participants complete the tasks more successfully.

**Keywords**: Special Flight Environment, Flight Simulator, Flight Training

## INTRODUCTION

The highly developed technologies used in modern military field not only make the modern war more destructive and cruel, but also produce greater impact on military psychology. Now military' psychological quality becomes an important part of fighting force (Liu PingZhong et al, 2006). Flight is one of the most complex types of labor in modern society. During flight, pilots must be in good physical and mental conditions (Yao JianMing, 2005). Various factors, such as long time flight, high stress condition, disordered circadian rhythm and lack of sleep, may make pilots in a fatigue status weakening their operational capacity, making poor judgment and developing flight illusion, and finally giving rise to flight accidents (Cao XueLiang et al, 2002).

Simulation training is one of the most popular and effective method for training pilots. Smode (1966) pointed out in the review that a) simulation training can actually reduce the hours of training, b) the effect of skills transfer in procedure is greater than that in operation and c) the effect of simulation training is directly proportional to the fidelity of the simulation equipment. Kerttu Huttunen (2011) et al used flight simulator to study the role of speech

prosody in cognitive load in aviation. The results suggested that the feature of speech prosody can show the pilots' status and provide support for flight training. In the study of Brett Moleswort et al (2006), they tried to test that after one week of simulation training, the feedback associated with performance can help pilots correct their behaviors in dealing with simulated dangers. Therefore, simulation training play a significant role in improving the ability of handling special issues of pilots.

When encountering emergences or engaging risky operations, pilots are in a state of high tension which will trigger a series physiological stress response. The response beyond the limitation of physiological compensation can affect pilot's operations and even the safety of flight. Obviously, the stress situation is too important to be ignored. Of these, special flight environments such as night flight, low-altitude flight and oversea flight are common stressors. However, very few studies are done focusing on the pilot's performance under special environment. This study is aiming to explore an effective method of simulation training with an emphasis of special environments which can relieve pilots' discomfort and fears in dealing with such stressors, therefore provide reference for improving capacities of air combats.

# MRTHOD

## Theory

### Special flight environment

Night flight refers to the flight activities that occur from half an hour before the sunset to half an hour before the sunrise of the next day. Low-altitude flight refers to the flight activities that are apart from ground or sea 100 meters. And extreme low-altitude flight refers to the flight activities that are apart from ground or sea between 10 to 100 meters. Oversea flight refers to flight activity that are off shore and over the sea. All of these special flight environment makes flight activities more difficult, and also cause great threats to flight safety. Based on these factors, this study was conducted on the background of the abovementioned special flight environments.

### Formation of flight skills

Flight skills refer to a reasonable combination of physical quality and psychological quality during the smooth completion of mission. And it is also the combination of mental skills and motor skills. Accuracy, speediness and adjusting to changing circumstances are its main characters. Flight skills are comprised of flight mental skills and flight motor skills, and the latter include reaction time. Pilots need to possess the ability of swift response to sensed stimulus. Operating in a correct, rapid and coordinate way, good ability of manipulation, sensitive awareness of the situation and the excellent judgments are the criteria of flight skills formation and skills proficiency (Zhang YuQing, 2008).

### Physiological and psychological indexes

In this study we choose heart rate level as the physiological index. It is known that in the mood of happy, anger, fear, sad and so forth the excitability of sympathetic nerve of human will increase, and so dose the heart rate. The study assumes that before simulation training stressors (special flight environments) can increase heart rate dramatically due to stress and fear. And after training, those dramatic responses can be relieved. In the experiment, heart rate recording was correspond with the relevant phase. From the original acquired data, we got the amplitude of (with the maximum minus the minimum) and average heart rate for each participant in each different phase. Considering individual differences, we mainly used the amplitude of the heart rate before and after simulation training to measure the effect of training method.

And we chose state anxiety level as the psychological index. Cattel and Spielberger proposed the concepts of State Anxiety and Trait Anxiety. The former describes an unpleasant emotional experience, such as tension, fear, anxiety and nervousness, accompanied by the hyperfunction of vegetative nervous system. It's usually temporary experiences. And the latter is used to describe a kind of tendency of anxiety in the personality and individual differences. It's relatively stable. Spielberger et al compiled the Inventory of State Anxiety(S-AI) including 20 items. Each item rates 4 grades: 1-none, 2-a little, 3-medium and 4-obvious. Participants need to circle the consistent options according to their exact experiences. All positive feeling related items are scored in a reverse order.

Accumulating each score of the items indicate the level of state anxiety, with the range from 20 to 80.

## Equipment

### Cabin

All the experiments were carried on in a retired FT-6's cabin (see Figure 1). Since all participants are male college students with no flight experience, it's necessary to modify the cabin with joystick and pedal. We also removed the former cushion including escape devices, then used thick sponge to refill the concave.


Figure.1. a shows the front view of the cabin; b shows the side view of the cabin; c shows the layout of the joysticks in the cabin.

### Joysticks

In this study we chose Saitek X52PRO joysticks. They can control the direction and throttle of the plane (see Figure.1.c).

### Software

The experiment was operated on the base of Microsoft Flight Simulator X. It included 10 tutorials in the Mission Mode. Since all the participants were novice, it was necessary for them to learn from the tutorials. We chose tutorial No.1-5 and No.8 with the intention of teaching players how to control the plane. We assumed that participants would possess the basic skills required for completion the subsequent two missions (landing on the sea and low-altitude flight) when they finished all the 6 tutorials.

### Methods for data acquisition

Heart rate was acquired using the electronic sphygmomanometer in a medical grade. The type is CONTEC 08A.The state anxiety level was acquired using S-ATI compiled by Spieberger et al.

## Participants

All the participants were male and aged between 21 and 24 with bachelor degree or above. And they all had a strong ability of learning.

## Method

The experiment includes four parts: the learning, pre-training, training and post-training phases.

Before learning phase, participants were asked to read the experiment instruction. Once the participants completely understood the experiment requirement, the experimenter explained the basic operations in details. In the learning phase, participants learned basic skills, such as taking off, landing, approaching airport and so forth. Before moving on to the next phase, participants needed to complete each tutorial, yet were not required to control the plane skillfully.

After learning phase, participants were required to complete two missions (landing on the sea and low-altitude flight). Landing on the sea was characterized by oversea flight. Low-altitude flight otherwise was characterized by both night and low-altitude flight. Before completing the missions, participants were ask to divide the former mission into two stages (aligning plane with the runway and landing) and the latter mission into three stages(passing through targets, aligning plane with the runway and landing). In order to avoid breaking the continuity of the

mission, the divisions were on psychological level. Heart rate were acquired during the missions per 10 seconds. And after completing the mission, participants completed the S-AIs corresponding to stages of each mission. In other words, they should complete two S-AIs for landing on the sea and three S-AIs for low-altitude flight.

During pre-training phase, participants needed to complete 1) landing on the sea; 2) low-altitude flight (before times up, passing through at least one floating target in the air and landing successfully). They had two chances, one for practice and the data were acquired during the second time.

During training phase, in order to gain proficiency, participants should practice each tutorial at least twice. Besides, they should practice the low-altitude mission specifically for another one hour as this mission involved complex skills.

During post-training phase, participants needed to complete 1) landing on the sea (having only one chance to practice); 2) low-altitude flight (after one hour training). And data were acquired at the same time for each mission.

### Data acquisition

Data were comprised of heart rate and scores of S-AIs in pre training and post-training phase. Since heart rate were recorded per 10 sec, the number of data points for each mission multiplied by 10 equaled the time for completing each mission. Thus, from each participants, we got 4 sets of heart rate and 10 sets of scores of S-AIs of all the 5 stages from pre-training and post-training respectively. In addition, we recorded the results of missions' completion ——landing successfully or not for both missions and the number of targets participants passed through in low-altitude flight mission. For landing on the sea, we used the time of completion to measure the efficiency because of the simplicity of this mission. For low-altitude flight, we cannot apply the same method as before to measure efficiency as the individual difference involved in the 3 minutes and 20 seconds of the flight routes. Therefore, we used the number of targets participants passed through and results of landing together to measure the efficiency.

## RESULTS AND DISCUSSION

### Efficiency of completion the missions

We observed performances of 10 participants in both pre-training and post-training phases. The results showed that the 80% of them improved during landing on the sea. This result could be attributed to the training of those 6 tutorials just before completing landing on the sea. It revealed that skills got from training could transfer to special environments and hence could improve mission efficiency, which also proved that training was effective. And during low-altitude flights, the results suggested that, based on number of target participants passed through, 100% of people got efficiency improved; and based on landing successfully or not, 90% of people got efficiency improved (since 1 person landed successfully both before and after training). It's critical to note that the safety of the aircraft and the pilots is always the most important in a real situation, so landing successfully weigh much more than number of targets passed through.

### Physiological and psychological results

We got data of heart rate amplitude changes of each participants at each stages in pre-training and post-training phases. During landing on the sea, 40% and 50% of people got alleviated heart rate amplitude at aligning plane with the runway and landing stages respectively. If judging from heart rate, we could not tell if training was effective and there was no rule to follow. During low-altitude flight, 30%, 60% and 30% of people got alleviated heart rate amplitude alleviated at passed through targets, aligning plane with the runway and landing stages respectively. It was observed that the training effect of maintaining relatively stable heart rate amplitude was not ideal. By contrast, however, participants were more likely to calm down at stage of aligning plane with the runway.

Besides, we got data of anxiety level at each stage in both pre-training and post-training phases. During landing on the sea, 100% and 80% of people whose anxiety alleviated at aligning plane with the runway and landing stages respectively. It was believed that the process from unfamiliar skills to practiced skills had certain effects to relieve psychological anxiety. In addition, according to the results of pared-samples Student's t test of pre-training and post-training phases at aligning plane with the runway and landing stages, the changes of anxiety between pre-training and post-training phases at aligning plane with the runway stage were significant ($P=0.000<0.05$). However, the changes of anxiety at landing stage were not significant ($P=0.106>0.05$). It was revealed from the statistics that

training had significant effect on relieving state anxiety at aligning plane with the runway stage, while the effect was not significant at landing stage. During low-altitude flight, 60%, 60% and 70% of people whose anxiety alleviated at passed through targets, aligning plane with the runway and landing stages respectively. According to the results of pared-samples Student's t test of pre-training and post-training phases at three different stages, the changes at passing through targets and aligning plane with the runway were not significant($P>0.05$), while at landing stage was significant($P=0.022<0.05$). According to statistics above, training had effective effect on anxiety at landing stage.

### Discussion

Concerning landing on the sea, only 2 participants spent more time to complete the missions after training. Integrating original psychological statistics with physical statistics, we found out that participants No.2 and No.10 got higher heart rate amplitude at landing stage compared with others. Although No.2's anxiety score decreased at both stage, he had the max heart rate amplification compared to pre-training. That's could be the reason for his low mission completion efficiency. As to No.10, why he was impossible to complete missions with high efficiency was possibly due to that both his heart rate amplitude and anxiety score increased. Moreover, at landing stage, No.8's anxiety score increased, while his heart rate amplitude reduced the most compared with others. In the end, his mission completion efficiency improved.

Therefore, for landing on the sea, it could be summarized that:

(1)If both anxiety score and heart rate amplitude decreased, generally the participants could complete missions efficiently. Thus, one way to be efficient was to make participants calm down, physically and psychologically.

(2)Many efficient participants got their heart rate amplitude increased while anxiety score decreased, which suggested that anxiety level played a more important role in mission completing efficiency.

(3)By analyzing original data, it was shown that the most efficient participants didn't get both physical and psychological level reduced, but got physical level increased and psychological level relieved. Thus, although psychological level played an important role, a certain degree of increased physiological arousal might work for high efficiency.

Firstly, during low-altitude flight, as a result of training, all participants could complete missions with higher efficiency. Secondly, it was shown that the percentage of people whose heart rate amplitude and anxiety score reduced were 30% and 60% respectively at stage of passing through targets; both 60% at stage of aligning plane with the runway; and 30% and 70%respectively at stage of landing. Thus, it was believed that training had much more effect on relieving psychological anxiety than physical one. Besides, the statistical results of the first two stages were not significant, which could be attributed to the strong randomness of the missions content involved in the two stages. The strong randomness referred to the situation that merely none of participants could complete task of passing through target on constant navigation course during each training phase, which gave rise to the different "starting point" of the next stage. Consequently, it's challenging for them to achieve psychological calmness when encountering different situation each time. Therefore, it resulted in the insignificance of statistical results. Although results were not significant at first two stages, as previously stated, the last stage was the most critical part. And it was believed that the significant result of the last stage could reflect the effectiveness of training to some extent.

Therefore, for low-altitude flight, it could be summarized that:

(1)By repeated training, it was relatively easy for the participants to achieve calmness on the psychological level.

(2)Since the anxiety level decreased for most of the participants, so training had effect on relieving state anxiety. Furthermore, because their mission completion efficiency increased, it was presumed that relieved anxiety played a significant role in increasing efficiency.

(2)It was revealed that high efficiency was the result of high-level physiological arousal combined with low-level state anxiety. High-level physiological arousal could make participants in stress state deal with emergency agilely, while low-level state anxiety could help them make responses and decisions sanely.

## CONCLUSIONS

This paper carried on a series of simulated training based on two types of special flight environment and reached the

following conclusions:

(1)Training had more effect on relieving state anxiety.

(2)Low-level state anxiety played a critical role in completing missions efficiently.

(3)In special flight environment, a certain high level of physiological arousal combined with low-level state anxiety could make participants complete missions successfully.

Above all, the training scheme set in this paper had a significant effect on improving mission completion efficiency and state anxiety level under special flight environment.

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