

# Analysis of Physiological and Psychological Factors Influencing Pilots in Flight Emergency

Liu Tao<sup>1</sup>, Li Yonggang<sup>1</sup>

<sup>1</sup>School of Basic Sciences for Aviation, Naval Aeronautical University, Yantai, Shandong, 264001, China  
274198316@qq.com

**Abstract:** In this paper, a series of research methods such as document literature, questionnaire survey and mathematical statistics are used to analyze the physiological and psychological factors affecting the pilot's flight characteristics. With that, the factors that affect the physiological and psychological characteristics of pilots during special flight situations have been identified, including three categories: individual mental characteristics, flight psychological quality, emergency flight psychological quality, and 12 important factors, including self-confidence, flight motivation, attention ability, thinking ability, judgment and decision-making ability, and spatial orientation ability. This paper aims to provide some theoretical and practical support for flight training safety.

**Keywords:** pilot; flight emergency; influencing factors

## 1. Introduction

Flight emergency has a comprehensive impact on the physiological and psychological well-being of pilots, and it can trigger adaptive responses and comprehensive thinking activities in pilots' physiological and psychological well-being. Normal flight emergency training, or sudden flight emergencies during flight, can instinctively trigger certain psychological stress reactions in pilots. However, with the further complicated development of flight emergency, the pilot will produce excessive stress response, and the pilot's body will appear physiological and psychological disorders. In severe cases, pilots can become overly nervous. Once the pilot's psychological adjustment ability is lacking, it will directly affect the special situation handling actions, ultimately leading to flight accidents.

## 2. The Effects of Flight Emergency on Pilots' Physiology and Psychology

### 2.1. Hyper-stress

In flight, an activity of high intelligence and high operational skills, moderate psychological stress is conducive to the normal play of pilots' flight skills. Moderate psychological stress can better mobilize the pilots' thinking, energy and physical strength to complete flight training and flight tasks. The impact of flight emergency on psychological stress levels is mainly determined by the degree to which flight emergency stimulates pilots, such as the level, intensity, and duration of psychological stimulation, the way pilots respond to stimulation information, the accuracy of information acquisition, and individual factors such as the way pilots handle flight emergency. Second, the influence depends on the adaptability and sensitivity of the pilot's physiological and psychological system. Third, the effect depends on the pilot's will quality ability; Fourthly, this impact comes from the pilots' knowledge, experience, and skills in handling flight emergencies. Excessive stress at the psychological level will seriously affect the pilot's special situation handling ability, and cause adverse effects on the pilot's thinking ability, control ability and reaction ability, which is also the main incentive leading to flight accidents.

### 2.2. Disorder of Operational Actions

The accuracy of emergency dealing operation is highly relevant to the pilot's comprehensive judgment and handling of flight emergency. In the case of psychological strain and limited thinking

ability, the accuracy and adaptability of the way pilots deal with special circumstances will be greatly affected. When the special situation worsens further, it may even cause pilots to operate blindly, and more seriously, it may cause pilots to experience operational disability, leading to flight accidents.

### ***2.3. Induced Flight Fatigue***

When energy begins to occur, pilots have a higher level of mental reserve and are able to maintain a normal and stable psychological state and carry out energy management. However, with the continuous flight emergency, pilots are in a state of high tension for a long time, a large amount of mental reserves are consumed, and the disposal ability is gradually decreased. Finally, the pilots' mental reserves are exhausted, inducing flight fatigue and resulting in flight accidents.

### ***2.4. Reduced Pilot's Emergency Dealing Ability***

When dealing with emergency situations, the workload of pilots will sharply increase, and their thinking and operational abilities will be affected to varying degrees. With the continuous development of flight emergency and the severity of the situation, the negative psychological reactions of pilots will become more apparent. Therefore, the improvement of flight emergency physiological and psychological adjustment ability has become an important part of flight emergency training. According to the investigation and analysis of the past flight accidents, 50 ~ 70% are caused by human factors, most of which are due to human operation errors, mistakes, forgetting, omissions, information discrimination errors and handling errors.<sup>[1]</sup>

### ***2.5. Judgment and Decision Difficulties***

Generally speaking, in the normal working and living state of human beings, the physiological and psychological indicators of the body are in a relatively stable state. However, once there is a sudden change in the surrounding environment, new and high-intensity stimuli will be generated to the human psychology, and the physiological and psychological indicators of the body will inevitably fluctuate. The larger and more sudden the environmental change, the stronger the stimulation, and the greater the changes in physiological and psychological indicators. In flight, when emergency occurs, the sudden change of the environment will produce new and strong stimulation to the pilot's physiology and psychology, which directly leads to difficulties in judgment and decision-making. This negative situation is directly reflected in the inability to correctly judge the information of flight emergency, and it is difficult to immediately judge the correct and favorable information for emergency treatment. After an emergency occurred, the pilot felt that there was insufficient information on the danger situation and time for troubleshooting, and did not have similar handling experience and experience. When a pilot faces a direct danger to human-machine safety emergency and exceeds their ability to handle the emergency, they will unconsciously exacerbate their tension. Due to individual differences in pilots, the level of tension caused by the same emergency varies, and the same level of tension has different effects on the handling of emergency situations.

## **3. Research Objects and Methods**

### ***3.1. Research Object***

In order to ensure the scientificity and pertinence of the research, this study mainly focuses on the expert education system engaged in the teaching and training of flight physiology and psychology and pilots.

### ***3.2. Research Methods***

#### ***3.2.1. Literature Review***

Based on the research objectives and ideas, a large number of literature materials on flight safety, aviation psychology, flight psychology, flight emergency, flight physiology training, and other aspects were consulted through CNKI network database resources, laying a solid theoretical research foundation for the research.

### 3.2.2. Questionnaire Survey

Based on literature data collection and expert interviews, this paper designed an Expert Questionnaire on Physiological and Psychological Factors Affecting Pilots' flight emergency in accordance with the requirements of sociology for questionnaire design, and tested the reliability and validity of the questionnaire,  $R=0.93, P < 0.01$ , indicating high reliability of the questionnaire. Such a design fully meets the requirements of the survey.

### 3.2.3. Mathematical Statistics

In the study, SPSS statistical software was used to make a statistical analysis of the obtained survey data.

## 4. Analysis of Physiological and Psychological Factors Influencing Pilot Flight Emergency

After multiple rounds of expert surveys, two rounds of surveys were conducted on the "Expert Survey Questionnaire on Physiological and Psychological Factors Influencing Pilot Flight Emergency". Statistical analysis was conducted based on the final results, and the most important indicators of emergency physiological and psychological abilities were selected. Based on the interrelationships between them, the flight emergency physiological and psychological ability indicator system was determined to include 3 primary indicators and 12 secondary indicators, thus constructing the flight emergency physiological and psychological ability indicator system (see Table 1). Finally, the factors influencing the physiological and psychological abilities of flight emergency were identified.

Table 1: Emergency Physiological and Psychological Ability Indicator System

No.	Primary index	Secondary index
1	a individual mental characteristics	A1 Confidence; A2 Flight motivation; A3 Ability to cope with setbacks; A4 Willpower;
2	b flight psychological quality	B1 Attention ability; B2 Thinking ability; B3 Perception ability; B4 Emotional regulation ability;
3	c emergency flight psychological qualities	C1 Judgment and decision-making ability; C2 Spatial orientation ability; C3 Stress resistance ability; C4 Control action quality;

### 4.1. Individual Mental Characteristics

#### 4.1.1. Confidence

Confidence, as a person's confidence in his own ability based on his experience in the process of achieving various goals, is the expectation of success in future activities.<sup>[2]</sup> Confidence plays a very positive role in the generation and improvement of pilot flight skills. Pilots with appropriate self-confidence can not only establish a correct understanding of success and failure, but also effectively stimulate their potential and deal with flight emergency and dangerous situations more effectively. Effective self-confidence is a personality psychological quality that pilots should possess, a necessary condition for being competent in the flight profession, and a necessary psychological quality for pilots to face failures and setbacks, overcome shortcomings and mistakes. Therefore, the confidence of pilots will inevitably become an important psychological quality that pilots must equip as standard.

#### 4.1.2. Flight Motivation

Motivation is a kind of psychological tendency or motivation that stimulates and maintains the behavior of an individual and makes it move towards a certain goal.<sup>[2]</sup> Due to the occupational characteristics of flight activities with high complexity, heavy safety responsibility and high safety risk, especially the difficulty and particularity of mastering flight emergency disposal technology, higher technical requirements are put forward than normal flight training tasks and skills. During flight, pilots should not make any mistakes, and any erroneous process or action may trigger flight accidents. Therefore, to become a skilled pilot, it is impossible to achieve it without a persistent pursuit of flight

motivation.

#### **4.1.3. Frustration Coping Capability**

Pilots will inevitably suffer setbacks and failures in flight training, life feelings and other aspects. In terms of psychology, setbacks and failures will inevitably lead to psychological fluctuations and feelings of loss among pilots. Will psychological fluctuations or feelings of loss affect flight? This is one of the psychological issues that pilots must face. Therefore, it is necessary to explore how pilots resist setbacks, overcome difficulties, challenge failures, correctly face setbacks, correctly understand themselves, evaluate self-value, find a new starting point and positioning, improve the ability to cope with setbacks, so as to surpass themselves, pursue excellence, and obtain new motivation, which is also one of the important psychological qualities that should be cultivated in the flying profession.

#### **4.1.4. Willpower**

Will refers to the mental process by which a person consciously determines the purpose and governs his actions in order to achieve a predetermined purpose.<sup>[2]</sup> Willpower refers to the ability of pilots to mobilize their emotions, regulate their behavior, actively overcome difficulties in flight, ensure flight safety, and complete flight tasks. Excellent willpower is an extremely important psychological quality for pilots, mainly reflected in a high degree of action consciousness, flexible thinking adaptability, decisiveness in decision-making, and fearlessness in the face of danger. Outstanding self-control and scientific awareness of flight are the core characteristics of the pilot's will quality.

### **4.2. Flight Psychological Quality**

#### **4.2.1. Attention**

Attention refers to the selective concentration and direction of certain objects during psychological activities, which is an important guarantee for pilots to complete flight tasks. During flight, the pilot pays attention to objects or information related to the flight situation and flight control of the aircraft. For example, during the take-off phase of the aircraft, the pilot should not only pay attention to the position relationship between the nose and the ground line. Moreover, they must keep an eye on the operation process and actions, pay close attention to the working state of the aircraft engine, and the pilot pays attention to the various instruments in the cockpit, whether the aircraft status changes normally, and the movement of other aircraft or objects. Therefore, it can be said that the ability of pilots to pay attention to allocation is very important for pilots to accurately observe data and judge flight dynamics.

#### **4.2.2. Thinking Ability**

Thinking refers to the indirect reflection of objective reality by the human brain.<sup>[3]</sup> Due to the characteristics of flight, such as tight time, changing situations and complex maneuvering, pilots' thinking ability must adapt to complex and changeable requirements. In normal flight conditions, the pilot is generally able to handle normal flight operations quickly and nimbly. However, the ability of pilots to calmly think, accurately judge and decisively deal with emergencies is often reduced. In flight emergency, the characteristics of various, complex and rapidly changing information determine that pilots need to adopt new methods and strategies to creatively solve problems. Therefore, only with a composite thinking ability that combines agility, effectiveness, continuity, and creativity can pilots adapt to the objective requirements of flight activities.

#### **4.2.3. Perception**

Flying can be said to be a very complex activity. Throughout the entire flight process, various types of information stimuli affect the pilot's perception at any time. During flight activities, pilots can only collect various aspects of flight information in a timely, accurate, and comprehensive manner if their various sensory organs function normally. For example, in the take-off and landing phase, the pilot needs to quickly and accurately perceive changes in the aircraft's altitude, speed, attitude and direction in a short period of time. Pilots must be equipped with strong space perception, time perception, motion perception and balance perception, otherwise they cannot accurately grasp the flight situation, determine the flight state and aircraft position. Only when the perception of various stable and unstable information is clear and accurate, the pilot can implement the correct maneuvering actions.

#### **4.2.4. Ability to Regulate Emotions**

The particularity of flight activities determines the emotional instability of pilots during the flight

process. The stability of emotions during flight plays an important role in the pilot's flight technology and emergency response ability. Excellent emotional stability and adaptability play an important role in ensuring the pilot's skill level. Once pilots experience psychological and emotional imbalances, they often experience phenomena such as restricted operational actions, slow reactions, reduced attention range, and an increase in errors, forgetfulness, and missed actions. In particular, when pilots encounter special situations in the air, if their emotions are excessively tense, they may even develop fear. This situation can make their thinking and judgment slow, with mild cases experiencing accident symptoms and severe cases leading to flight accidents.

### **4.3. Emergency Psychological Ability**

#### **4.3.1. Judgment and Decision-making Ability**

In flight emergency, the pilot must quickly anticipate various possibilities, make correct decisions in a very short time, and quickly make correct operational flight actions, so as to reasonably handle the flight emergency. "Perception - judgment - decision - disposal" constitutes the information processing system of the human body. The core of information processing lies in judgment. The information obtained through perception and knowledge and experience are compared, analyzed and recognized, so as to further make correct judgment and issue instructions for disposal operations. During flight, if there is a judgment error, it is likely to pose a threat to flight safety. Judgment and decision-making ability and situational awareness serve as the most important psychological qualities of shipborne pilots.

#### **4.3.2. Spatial Orientation Ability**

Spatial orientation refers to a perceptual process in which pilots integrate and process input external spatial information and their own information through their brains during flight, in order to obtain the aircraft's posture, spatial position, location, and direction of motion. Pilots urgently need to be equipped with good spatial orientation ability, which can always maintain correct judgment of flight direction, state, and trajectory under various complex flight conditions, in order to complete training tasks and ensure flight safety.

#### **4.3.3. Stress Resistance Ability**

The stress reaction will cause a series of physiological and psychological reactions of pilots. If these reactions are not effectively regulated for a long time, it is easy to show psychological pathological reactions, such as fear of flight, mood swings, anxiety, insomnia, depression and other negative psychological states, thus exerting a significant impact on learning, life and work. A series of studies have shown that if the stress level exceeds the pilot's ability to cope, operational performance will decline dramatically, resulting in problems such as perceptual and thinking disorders, conical contraction of attention span, and the production of motor omissions and errors. Therefore, it is of great significance to improve the ability of pilots to cope with stress.

#### **4.3.4. Control Action Quality**

Flight control is a process of processing information in a limited amount of time under extremely complex conditions, which is completed through a series of actions, which requires the pilot's reaction time to be fast, the direction, amplitude, speed, and strength of the action to adapt to changes in the flight state at that time, and calls for coordination and continuous execution of hands and feet. Therefore, the control action performed by the pilot is the necessary psychological quality to complete the flight activity. The pilot's good control ability mainly includes quick and flexible reaction time, high accuracy of control amount, good coordination of hand and foot movements, correct and coherent action program, and scientific use of time to implement actions.

## **5. Conclusion**

Through the analysis of physiological and psychological factors affecting pilots' flight emergency, this paper determined the main factors affecting pilots' flight emergency, including:

- (1) Individual mental characteristics: confidence, flight motivation, resilience to setbacks, willpower;
- (2) Flight psychological quality: attention ability, think, perceive, and regulate emotions;

(3) Emergency flight psychological qualities: judgment and decision-making ability, spatial orientation ability, stress resistance ability, and manipulation action quality.

### References

- [1] Liang Bin, Wang Shengda. *Military Flight Psychology [M]*. Beijing: Blue Sky Publishing House, March 2019
- [2] Yang Xia. *Flight Psychological Education and Training [M]*, Beijing Institute of Technology Press, 2008, 3
- [3] Hao Xueqin. *The impact of personality and stress on flight safety [J]*. *Ergonomics*. 2007, 1