

CHAPTER 15- AVIATION PSYCHOLOGY

1 INTRODUCTION

The performance of aviators requires certain cognitive, psychomotor and interpersonal capabilities in order to perform operational tasks in a reliable way especially during high workload and stress. These capabilities may decrease to such a critical level that safe flight operation is no longer warranted. However, a reduction in pilot capability is never easily detected or demonstrated. The majority of accidents in aviation is caused by human error not by physical incapacitation or technical failures. People may become unsafe for various reasons; low mental or psychomotor problems or accelerated ageing, to name a few. Such personal conditions are not usually classified by psychiatric and neurological standards as disqualifying criteria. They have to be assessed by a psychological evaluation.

2 INDICATION

A psychological evaluation should be considered when the AMS receives information which evokes doubts concerning the mental fitness or personality of a particular individual. Sources for this information can be accidents or incidents, problems in training or proficiency checks, delinquency or knowledge relevant to the safe exercise of the privileges of the applicable licences. The evaluation shall be part of, or complementary to, a specialist psychiatric or neurological examination.

3 TESTING FACILITIES

Only psychologists acceptable to the AMS or organisations which employ psychologists acceptable to the AMS are allowed to perform the psychological evaluation.

4 PSYCHOLOGICAL CRITERIA

The complete psychological evaluation includes a collection of biographical data, the administration of aptitudes as well as personality tests and a psychological interview. The following aspects will be investigated:

- a *Biography*
 - i General life history
 - ii Family
 - iii Education
 - iv Socio-economic status
 - v Training progress and occupational situation
 - vi Critical behavioural incidents
 - vii Diseases and accidents
 - viii Delinquency

- b *Operational aptitudes*
 - i Logical reasoning
 - ii Mental arithmetic
 - iii Memory function
 - iv Attention
 - v Perception
 - vi Spatial comprehension
 - vii Psychomotor function
 - viii Multiple task abilities

- c *Personality factors*
 - i Motivation and, for Class 1, work orientation
 - ii Decision making
 - iii Social capability
 - iv Stress coping

Definitions of aptitudes and personality factors as well as recommendations for the use of adequate test methods are further elaborated below.

5 OPERATIONAL APTITUDES

5.1 General considerations

The general demands on pilots (applicants for, or holders of a Class 1 medical certificate) require operational aptitudes like cognitive and psychomotor capabilities. The complexity of the tasks and the time stress inherent to flight deck operations necessitate an accurate and fast task performance. Therefore it is recommended, when feasible, to apply tests with tight time constraints.

An adequate performance in the aptitude categories listed below is regarded as essential.

5.2 Logical reasoning

a Definition

The ability to find rules and to apply them in various task situations using verbal, mathematical and other abstract material.

b Description

Reasoning is a cognitive process which refers to finding general rules or analogies on the basis of observed instances and using them to make judgements. Test items may include syllogisms or judgements like 'A does not preclude B': BA (true or false).

5.3 **Mental arithmetic**

a *Definition*

The ability to mentally operate with numbers and to solve simple and more complex computational problems.

b *Description*

Mental arithmetic requires the practical and effective use of algorithms and working memory. Typical test items include mentally performing basic calculations and solving more complex arithmetical problems.

5.4 **Memory function**

a *Definition*

The ability to memorise and retrieve from memory visually and/or verbally coded information.

b *Description*

The use of memory refers to holding a detailed record of sensory information for a relatively brief period of time, after which forgetting will occur unless special efforts are made to retain the information, as by rehearsal, long enough to permit identification and classification of sensory information and response with corresponding behavioural actions.

Memory function testing may include visual and/or auditory tests for working memory, tolerance against interference by required responses, memory for instructions.

5.5 **Attention**

Important aspects of attention are concentration, vigilance, divided attention and selective attention.

a *Concentration*

i *Definition*

The ability to direct attention for a long time to a task in order to attain a stable performance.

ii *Description*

Concentration refers to a high degree of continuous and focused attention which requires a high degree of effort. Fluctuations in concentration are reflected in the selective aspects of task performance (tunnelling, distraction). Tasks of concentration may include both monotonous tasks and tasks of varying difficulty, as well as of long duration.

b *Vigilance*

i *Definition*

The ability to maintain a state of readiness for a long time in order to detect and respond to certain specified, infrequently occurring events in a stream of events which have to be neglected.

ii *Description*

In vigilance tests the subject has to pay attention to all the events, most of which do not need a response. Good vigilance is reflected by a high probability of detecting a signal, a low errors rate and a high speed of response.

c *Divided attention*

i Definition

The ability to direct attention to different tasks simultaneously in an efficient and effective way.

ii Description

The subject has to perform several tasks at the same time by setting priority and switching attention quickly and effectively between tasks (time sharing, see also multiple task abilities).

d *Selective attention*

i Definition

The ability to direct attention selectively to one of several sources of information by switching the focus of attention.

ii Description

Tests of selective attention may include measuring the ability to discriminate among various sources of sensory information and attend to one without being distracted by irrelevant information.

5.6 **Perception**

The ability to perceive information, auditory and visual, in an effective and efficient way. Relevant aspects of perception are: perceptual speed and perceptual closure.

a *Perceptual speed*

i Definition

The ability to perceive information quickly and accurately, simple as well as complex material.

ii Description

Perceptual speed can be assessed by e.g. tachistoscopic instrument reading tests.

b *Perceptual closure*

i Definition

The ability to recognise incomplete forms, i.e. to form 'Gestalts' from Description incomplete material (synthesis).

5.7 **Spatial comprehension**

Two aspects of spatial comprehension should be assessed which can be designated by the classical psychological terms '*Visualisation*' and '*Spatial Orientation*'.

a *Visualisation*

i Definition

The ability to construct an appropriate mental image of two or three-dimensional spatial patterns and to manipulate or to transform these images into other visual arrangements.

ii Description

One indicator of good visualisation is the capability of rotating mental images, e.g. the capability of identifying given spatial patterns, even if these patterns are presented at various orientations in the picture plane.

5.8 Psychomotor function

Two aspects of psychomotor function should be assessed, namely, psychomotor co-ordination and choice reaction time.

a *Psychomotor co-ordination*

i Definition

Psychomotor co-ordination can be defined as the capability to co-ordinate the movement of arms, hands and feet in response to visual stimuli.

ii Description

Usually tests of psychomotor co-ordination involve some kind of display-control tasks, where the subject has to control a dynamic system by means of appropriate (joystick) and/or pedal inputs.

b *Choice reaction time*

i Definition

Choice reaction time can be defined as the interval between the onset of a stimulus (taken from a set of different stimuli) and the subjects correct response.

ii Description

In contrast to simple reaction time, choice reaction time is measured in tasks, where the presented stimulus is randomly chosen from a set of different stimuli each of which is associated with a certain response. In order to vary the degree of cognitive control associated with response choice, the assessment of choice reaction time should include a comparison of those for (spatial) compatible and incompatible stimulus-response mappings. Stimulus response compatibility in this sense is given when the spatial arrangement of stimuli is required (e.g. light on the left requires response with the left hand). Furthermore the possibility of speed-accuracy trade-offs should be taken into account by a recording of error rates.

5.9 Multiple task abilities

a *Definition*

Multiple task abilities (time sharing abilities) can be defined as abilities which are needed in situations where at least two independent tasks have to be performed simultaneously.

b *Description*

Multiple task abilities include:

- i effective timing of responses,
- ii rapid inter task switching,

- iii parallel information processing,
- iv adequate allocation of processing resources according to task priorities.

Usually a high level of multiple task abilities is reflected in relatively low performance decrements (compared with single task performance) in the tasks to be performed simultaneously, and relatively small performance trade-offs between these tasks under multiple task conditions. In order to assess multiple task abilities, multiple tasks should be used which consist of at least dual tasks that are similar with respect to their demands on response related resources (e.g. psychomotor tasks which are similar in their demands on response-related resources, or memory demanding tasks, which are similar in their demands on perceptive-cognitive resources).

6 PERSONALITY FACTORS

6.1 General considerations

The personality factors which are important for the psychological evaluation of pilot applicants or licence holders are presented below. Work orientation, social capabilities and stress coping have to be considered, particularly in respect of crew resource management and crew co-ordination. Most of these traits are well known and can be measured by conventional assessment tools (e.g. questionnaires). The concept behind this trait-oriented assessment is that relatively stable dispositions are influencing behaviour under various conditions in a typical way. Although there is no doubt that such dispositions do exist, there is even no doubt that actual behaviour is not only a function of these traits but also a complex dynamic process where the traits interact with a manifold of other aspects, e.g. actual individual needs or situational demands.

The trait structure itself can also be the reason for specific dependencies. Certain combinations of trait intensities can interact in the way of typical syndromes. Therefore, in applying the personality traits as evaluation criteria it has to be carefully considered that such complex psychological processes exist and might display critical information in addition to pure trait assessment. Often such information is revealed by behavioural observation and psychological interview which should follow psychometric testing.

6.2 Motivation and work orientation

a Definition

The disposition to develop, direct, regulate and maintain energy in order to reach an objective (despite obstacles or difficulties) while keeping up a positive attitude towards work, tasks and, in general, towards occupational demands.

b Description

Important indicators of this attitude are need of achievement, vitality, mobility, readiness to acquire new knowledge and skills and acceptance of responsibility.

i Need of achievement

A Definition

The aspiration to succeed in competition with some standards of excellence.

B Description

Achievement oriented individuals prefer challenging situations with moderate risks, like to get performance feedback, like to perform well and better (mastery)

and attribute successful performance to internal factors like personal effort and/or abilities.

ii Vitality

The positive attitude towards physical activities like sports, hiking, mountaineering.

iii Mobility

The readiness to accept and practise new activities, to move, to travel, to take risks.

iv Readiness to acquire new knowledge & skills

Readiness and open-mindedness to acquire new knowledge and skills which are necessary for the successful conduct of new tasks and responsibilities.

v Acceptance of responsibility

The readiness to accept formal roles, tasks and duties and to behave accordingly.

6.3 **Decision making**

a *Definition*

The capability to properly choose responses in complex situations where several reactions are possible.

b Description

Decision making is concerned with problem solving behaviour which only partially is based on knowledge and skills. Three different categories of decisions performed by humans can be distinguished.

i Choice of alternatives,

ii Decisions under uncertainty,

iii Decisions after diagnosing available information (e.g. from displays or from crew members).

The efficiency of decision making varies as a function of many different factors including appropriateness of the mental representation of the problem structure, adequate problem solving heuristics, correct estimation of probabilities of events, workload and practice. Personality factors such as flexibility, creativity and dominance are also important.

6.4 **Social capability**

a *Definition*

The capability to develop, maintain and enjoy contacts and relations with other persons.

b *Description*

In interpersonal and group activities social capability is manifested by team orientation, verbal and non-verbal expressivity, sensitivity and tolerance with respect to individual needs and cultural differences. Team orientation includes effective management of human resources, situational/group oriented leadership style, acceptance of group objectives, tasks and roles and striving towards consensus.

Well established personality traits which are related to social capability are explained below:

i Extroversion-Introversion

The need for affiliation and change paired with the disposition to communicate one's ideas, opinions and feelings in a manner that conforms to social forms.

Extreme extroverts possess a high requirement for the company with other people and social life. They quickly make and adapt to new friends which they keep in a loose fashion. They are extremely talkative, temperamental, quick-witted and skilled in social situations.

Extreme introverts do not mind being alone. They prefer small groups and have few but very close friends. They are taciturn, serious, reserved and inhibited in social situations.

ii Dominance/Assertiveness

Dominance refers to the need for appreciation and leadership.

High dominant people have an extreme need for appreciation and have a tendency to take on responsibility and leadership in any case paired with the disposition to impose their own goals, ideas and wishes on others.

Low dominant people have the tendency to submit themselves under the goals and leadership of others. Usually they stay passive and avoid taking on responsibility in social situations.

iii Empathy

The ability to understand and feel with the experiences and emotions of other persons.

iv Aggression

Aggression is characterised by a lack of self-control regarding hostile reactions which manifests itself in spontaneous as well as reactive aggressivity.

Reactive aggressivity refers to a disposition to defend oneself against unfairness and attacks.

6.5 Stress coping

Stress coping is the capability to cope with external and/or internal stressors in such a way that efforts can be effectively directed in order to maintain control and reach the objective. Contributing factors of stress coping are emotional stability, readiness to bear privations, flexibility and stress management.

a *Emotional stability*

i Definition

The disposition to control, regulate, moderate and express emotional reactions appropriately without interfering with an efficient performance and/or without impacting other people.

ii Description

Emotional stability is characterised by calm, thoughtful behaviour, even temper, constant mood, freedom from cares and from emotional problems like anxiety and irritability. It depends on factors like self acceptance, focus of control and defence mechanisms.

b *Readiness to bear privations*

i Definition

The disposition to accept, tolerate and adjust oneself to physical discomforts and/or psychological hardships.

ii Description

Physical discomfort, psychological hardship, lack of privacy, sleep deprivation and separation from family.

c *Stress management*

i Definition

The capability to develop and implement cognitive and behavioural strategies in order to master stressful situations.

ii Description

Stress management includes identification and evaluation of stresses and an active approach towards altering the sources of stress.

7 METHODOLOGICAL RECOMMENDATIONS

Because of the diversity of psychological methods (e.g. tests, questionnaires, observer ratings, interview data, biographical data) available for the assessment of the different criteria mentioned on the criteria list above, no tests, questionnaires or other methods have been recommended for the assessment of these criteria. However, general guidelines are described below for guidance and finding adequate assessment methods.

7.1 Tests and questionnaires

Whenever possible, standardised psychological tests and questionnaires which fulfil at least the following general requirements should be used for criteria assessment.

a *Reliability*

The stability (test-retest-reliability) or at least the internal consistency of tests/questionnaires has been proved (whenever possible with regard to an application in personnel selection).

b *Construct validity*

The extent to which a test-questionnaire measures the construct (aptitude, personality trait) it is intended to measure has been proved (whenever possible with regard to an application in personnel selection).

The test or questionnaire should clearly differentiate between the applications (ideally normal distribution of test scores) even in a highly pre-selected group like, e.g. holders of a pilot licence.

c *Norms*

In order to evaluate the test-questionnaire results of individual subjects, standard norms have to be available for the test-questionnaire. These norms should be derived from the distribution of test results in samples which are more similar in important characteristics (e.g. age, education, level etc.) to the group of applicants under discussion. For reasons of standardisation it is recommended to use STANINE scores as norms for all tests or questionnaire.

7.2 Rating scales and classification systems

In case that observer ratings are used for criteria assessment, it should be ensured that the observers are very well trained and that the inter-rater-reliability is high, i.e. that different observers agree about their evaluation of a certain behaviour shown by an applicant. As a rule, a high inter-rater-reliability can be achieved by using clearly defined rating scales and/or classification systems.

7.3 Sources of information

The whole test system used for the criteria assessment should be characterised by redundancy with regard to the sources of information used to assess the aptitudes/personality traits mentioned in the criteria list above. Whenever possible each of these aptitudes/personality traits should be assessed/tested on the basis of at least two independent sources of information (tests, questionnaires, observer ratings, interview-data, biographical data). This kind of cross validation is recommended in order to improve the overall reliability of the whole test system.

7.4 Decision rules

The decision about the classification of an applicant or holder of a Class 1 or Class 2 medical certificate should be based on the following general rules. However, in the case of clear deficiencies in operational aptitudes of already experienced pilots, it has to be considered whether or not personality characteristics can compensate for the resulting risks.

a *Operational aptitudes*

In order to be assessed as non-critical an examinee should not have a clear deficiency in any operational aptitude as compared with the norm group (see paragraph 7.1.c) above).

b *Personality factors*

An examinee must be evaluated (by a psychologist) as non-critical with regard to the main personality factors:

- motivation and work orientation
- social capabilities
- stress coping

This usually implies that the examinee is not assessed as an extreme case with regard to the normal range of variation in the contributing factors.