Chapter 36
Study on Influencing Factors of Human to the Performance

Zhibing Pang, Honglei Li, Haitao Zhao, Kehua Zou and Cheng Jin

Abstract Aiming at effects of human in the performance, the influences to the performance are analyzed and researched from physiological and psychological two aspects in this paper. In terms of physiological factors, it is researched form five aspects: physical characteristics, auditory function, balance function, visual function, and physiological fatigue; in physiology respect, factors that effect the performance are dissected form three aspects: intelligence factors, will quality, and mental fatigue. Two categories of factors impacting on performance was positioned from the theoretical level, and all of these discussions provide certain reference values to select operators scientifically and quantize specific measures to improve the performance.

Keywords Performance · Physiological factors

36.1 Foreword

The research on operating performance of human is an important part of ergonomic research. There are many factors affecting operating performance, among them, human—the operator and user of weaponry—causes the complexity and randomness of operating effect and huge influence on operating performance due to inherent characteristics and attributes.

Z. Pang (✉) · H. Li · H. Zhao · K. Zou · C. Jin
Air Defence Forces Academy, Zhengzhou, China
e-mail: fkb_mme0s@163.com

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36.2 Influence of Physiological Factors of Operator on Operating Performance

The influence of physiological factors of operator on operating performance is mainly reflected in five aspects: physical characteristics, auditory function, balance function, visual function, and physiological fatigue.

36.2.1 Physical Characteristics

The physical characteristics of human main refer to physical quality of human, including strength, speed, endurance, agility, and flexibility.

Strength is the ability of human body to overcome resistance when muscle is working. The muscle contraction force is composed of the composition of contraction forces of muscles when completing a movement, coordination ability of muscle contraction, and mechanical efficiency of bone lever. Completion of any movement needs corresponding force, the basis of all activities.

Speed is reflection of comprehensive ability of human body like reaction speed, strength, flexibility, and other qualities, one of basic qualities. Speed quality depends on comprehensive development level of the flexibility and strength of central nerval system agility, speed, and endurance.

Endurance (or hardiness) refers to the ability of human body to resist fatigue after working for a long period. Fatigue is the necessary result of exercise or training. There is no overload recovery and organic function without fatigue. The course of endurance development is the course of keep generating fatigue, overcoming fatigue, and enhancing anti-fatigue ability.

Agility is very important in military battles and combat sports. Agility is the comprehensive reflection of various movement abilities of human body. Well-developed agility can not only help fast, accurately, harmoniously grasp techniques and exercise methods to fully effectively exert physical quality in the practice, but also prevent occurrence of accident.

Flexibility is determined by the many factors like scope of joint movement, stretch, and elasticity of muscles, ligaments, and tendons, and the coordination between intensity and relaxation of muscles. The factors influencing flexibility include age, sex, basic ability of muscle movement, state of bone lever, when exercise is stop every day, fatigue degree, etc.

36.2.2 Auditory Function

Sound can be heard only if it reaches the certain intensity. The min sound intensity is called auditory absolute threshold (auditory threshold); for a specific sound

signal, the auditory threshold refers to the min effective sound intensity value when sound can be differentiated in 50 % of total number of times.

The auditory threshold is in reverse proportion to the sentience, and the auditory absolute threshold is different with the change of frequency. People have the highest sentience for the sound within 1,000–4,000 Hz. Once sound is below this range, the sentience will drop fast with the reduction in frequency; once sound is higher than this range, the sentience will fast drop with rise of frequency. Therefore, sounds of different frequencies can give birth to the same loudness feeling only if they have different objective intensities.

Generally speaking, the auditory response duration of a human is 0.115–0.182 s. However, there is big individual difference of auditory absolute sentience. The jobs with high auditory requirements need the human with high auditory absolute sentience.

The hearing of human is influenced by many factors. The people who work in a high noise in a long period will decline in auditory sentience. Age is another important factor influencing auditory sentience. The sentience for alt is every easy to decay with the increase in the age. A child can hear the sound of 40,000 Hz when the drumhead vibration is very small down to 1/10 of diameter of a hydrogen atom. With increase in age, the high-frequency hearing drops at a speed of 100–200 Hz yearly. A young person can hear the sound of 20,000 Hz, but a mid-age person can only hear the sound below 16,000 Hz. Generally speaking, the high-frequency hearing is losing with increase in age remarkably for a man [1].

36.2.3 Balance Function

Another important function of human ear is the balance function of human body. The balance function mainly involves judging direction for human body and maintaining self-balance. The organs responsible for balance function are centralized in inner ear, including semicircular canals, elliptical capsule, and saccule. There are three semicircular canals which are perpendicular to each other, constituting three faces in the space. Canals accept external balance stimulation and send the balance central of the cerebral cortex via vestibular nerve to adjust and manage response to balance.

Well-functioned vestibule of inner ear is one of the basic conditions to produce motion sickness (seasickness, motion sickness, motion sickness). If vestibular function is lost, human body will lose ability to accept various stimulations caused by accelerated/decelerated movements; in other words, the adverse or overlimit stimulations, which can cause the motion sickness, have no effect on human body. For instance, we know some people have car sickness. However, even if they have vertigo, some of them have no carsick symptoms for the loss of vestibular function (ototoxic drugs poisoning, bilateral labyrinthectomy, repeated vertigo attacks, etc.). These people will not feel deceleration, shaking, bump, and other movements involving acceleration in the future, although carsick phenomenon will disappear.

36.2.4 Visual Function

Visual sense of human is caused by light stimulation. It has remarkable adaptability to the change of the intensity of the light. Eyes of human can adapt to the light from dozens of photons to 105 CD/m^2. But the degree of agility of human eyes to light is change with the change of brightness of surrounding environment. Generally, degree of agility is high in dark and low in light. Besides, the degree of agility of human eyes to light is change with the change of the time.

Visual adaption: The first and the foremost visual characteristics of the human is visual adaptability, divided into light adaptation and dark adaptability. Light adaptation refers to the process of visual sense change when human eyes turn from the dark to the light. Light adaptation process lasts for approximately 1 min. Dark adaptation refers to the process that visual sense is enhanced when human eyes turn from the light to the dark. Dark adaptation process is longer than light adaptation process. Studies show that eyes can adapt completely in 30 min or a longer duration from light to dark.

Features of eyeball movement: When seeing an object, people are customized to see from left to right, from top to bottom clockwise; besides, horizontal direction is prior to vertical direction, and the estimation on the dimension and proportion in horizontal direction are more accurate, faster, and more efficient than those in vertical direction. When deviating from visual center, in the same deviation condition, the order of observation is top on the left, top on the right, bottom on the left, and bottom on the right. When observing an object, two eyes are moving at the same time and the visual image will be obtained within 0.07–0.3 s at shortest and 0.17 s averagely; the movement angular speed can be identified only if it is higher than 1–2°. Eyes pay more attention to the profile in comparison with shape (contour effect); and more accept linear profile in comparison with curve profile. Eyes conduct flick in reading and approximately 3–7 viewpoints for a line of letters, approximately 250 ms for a viewpoint when skipping. All these features are very important for arrangement of observation work [2].

36.2.5 Physiological Fatigue

Physiological fatigue is the declining state of work ability caused by large intensity or long duration of movement during working. Biologically fatigue is a natural protective response. People need consumption of stored energy and resources during working and movement, so large intensity and long duration of movement will consume more energy. If energy consumption cannot be supplemented in time and people keep acting, organ will be affected adversely. Therefore, fatigue is a response to prevent physical and psychical overload of organ [3].

When people puts themselves into work after warm-up at the beginning, their activity capacity is brought into full play and task performance reaches the highest level. However, considerable energy and resources will be consumed in this phase; therefore, people will feel tired and cannot insist very long with dropping efficiency, slowed speed, and weakened strength. With continuation of operation, the fatigue is accumulated to interrupt in the work. If serious fatigue is caused frequently, chronic fatigue will form to damage physiologically and psychologically.

36.3 Influence of Psychological Factors Operator on Operating Performance

If we compare physiological factors of human to a complicated "hardware", the psychological factors of human is naturally the "software" of the complicated thing. Unreasonable structure and weak or incomplete function of the software will restrict the exertion of the hardware.

36.3.1 Intellectual Factors

Intellectual factors are one of the basic capacities of human as a whole, covering a lot of factors. In this paper, author just makes a research on the capacities affecting operation: capacities of memory, understanding, reaction, and concentration.

First of all, capacity of memory. According to the rule of generation of military skills, at the beginning of generation of military skills, learner shall make the actions in memory and then kept the memory based on understanding. The good memory is the inborn advantage of learning operation skills.

Secondly, capacity of understanding. Memory is not enough to form operation skills. The learner shall form understanding-based memory through keeping operation actions in mind. On the one hand, this can form deeper memory to automatize skill operation. Even if when the learner is stimulated by an accident, he or she can complete the operation task depending on firm understanding-based memory; on the other hand, the learner can develop more effective operation actions and process in repeated exercise only if he or she keep the operation actions in mind based on the understanding on the fundamentals and interrelation of actions.

Thirdly, capacity of reaction. The capacity of reaction of human is the central reflection of many capacities. For instance, in a digital signal display, the operator shall cover the digital signal information from the display to other information and then take corresponding actions. That requires operator to have better capacity of digital reaction. If a person has prominent capacity of reaction, he can immediately take countermeasures when receiving abnormal sign to ensure the timeliness of

military kill operation. By comparison, an operator with weak capacity of reaction has long duration of reaction after receiving abnormal sign and may loss the best opportunity of remedy sometimes.

Fourthly, capacity of concentration. When the operation duration is postponed, the influence on attention will appear. Without specific training, human has limited duration to focus on a single thing and concentration can also greatly impair capacity and energy himself or herself. If a person has been focused on a thing for a certain time, if he or she is forced to focus again, physiological fatigue will be caused. For some operation tasks in military operation, it is necessary to select those operators with long duration of concentration or conduct specific training for selected operators to enhance reliability of the implementation of operation tasks.

36.3.2 Willpower

Will is a kind of very complicated advanced psychological function, the active function of consciousness, the psychological process that a human consciously determines the aim and governs its actions to realize preset the aim. Self-consciousness, perseverance, decisiveness, and self-control are the four basic factors constituting a person's willpower, playing a very important role for operator to maintain efficient task performance in a fixed work environment in a long period.

Self-consciousness refers to that people have clear deep realization on the purpose and motive of action under control of correct belief and view to the world and are able to insist in principle in the activities. It is a character to ensure action can achieve given purpose. The operator with high self-consciousness has high realization and recognition on the work and is able to overcome various difficulties in operation consciously with firm determination to accomplish tasks, playing positive role in pushing for enhancement of task performance.

Decisiveness is a ready-witted character of a person who is good at distinguish right from wrong, able to make and implement decision duly reasonably. It is very important for an operator to make a prompt decision to fast reasonably treat various unexpected events on the basis of all-round consideration of various influencing factors in complicated changing situations [4].

Self-control refers to ability of people to consciously control and adjust the thought, emotion, and behavior. It is a character good at control ego. Such character can not only help operator eliminate interference in operation and firmly implement adopted decisions, but also depress the thought, emotion, and behavior inconsistent with the purpose of operation.

Perseverance refers to a character of people to overcome all difficulties and obstacles diligently in actions to complete established purpose. For an operator, perseverance is the premise to work and complete tough mission and the guarantee to overcome difficulties, remove interference, and resolutely complete task.

36.3.3 Physiological Fatigue

People may feel fatigue and some situations like inefficiency and error may happen in physiological fatigue. If physiological fatigue gets worse, the people will become indifferent and tired about work. Once physiological fatigue occurs, first of all, the work state will be affected and symptoms like distraction, slow thinking and act, bad mood and depression will appear so that people will feel tired about of the operation. Of course, he or she can continue work and maintain task performance by psychological control force in a certain period, but this cannot last long. If the situation cannot be changed, more serious physiological fatigue may appear and needs a longer period to recover. If operator cannot have a rest in such situation, some adverse consequences may occurs, including declining task performance first of all, increased operation errors, dropped quality, slowed work speed, and reduced output. Therefore, many people take change of work performance as an indicator of performance assessment. Sometimes work performance can maintained when fatigue develops to a certain extent mostly because of additional effort of the people. However, additional effort will cause more serious fatigue.

36.4 Conclusion

Human is complicated and uncertain in task performance. Due to physiological and psychological characters, human is easy to be affected by many factors so as to impact task performance [5]. This paper focuses on the qualitative research on the influence of operator on the task performance. The following research will intensify quantitative research by experimental analysis to realize scientization, digitalization, and computerization in the research on the influencing factor of human in task performance.

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