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The Effects of 8 Weeks of Gyro Training on Some Parameters Determining the Balance of Air Force Pilots

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Abstract: The present study investigated the effect of eight weeks of training with a gyroscope on identifying the body position in space, the semi-dynamic balance on the ground, and Huber's device score. Two groups of 30 Air Force (IRIAF) pilots with an average age of 27 years, height of 178, and weight of 80 kg were randomly assigned to two training and control groups. The training group was exposed to eight weeks of training with the gyroscope device. The pre-test and post-test of the two groups were compared using videography, star test, and Huber's score using the statistical method of repeated measurement. In the gyro test, there was no significant difference in the detection angle of the body position in the air in any groups before and after the test. However, an increase in rotation speed was observed in the training group. In Huber's test, there was no significant change in the control group before and after. However, in the training group, an improvement in the score was observed, especially in the non-superior limb, as well as a decrease in the difference in the score between the two hands. Stars were not observed in any groups before or after the test. According to the results, it can be concluded that despite the non-significance of the difference in the subjects' ejection angle and position identification in the training group, it occurred simultaneously as the rotation speed increased.

Keywords: Balance, Gyroscope, Gyro test, Position Identification.

1. Introduction

If we want to talk about physical-motor fitness and cognitive-scientific skills simultaneously in a job, piloting is one of the first jobs that comes to mind. At the beginning of the pilot's recruitment, screening is done with a particular care, and generally, pilots with minor physical abnormalities and the highest perceptual-motor skills are selected; after going through highly advanced scientific and physical-motor courses, they are ready to fly in an extended period. To control the plane, It is essential to have a series of information and a precise sense of your position and its relationship with the horizon. Pilots use senses such as middle ear fluid, muscle proprioception, and visual control, which control balance and recognize the body's position in space. They are collectively called the sense of flight.

The movement of fluid in the middle ear provides information about the body's position in space, referred to as the vestibular sense. In this regard, we can refer to the middle ear illusion is that when the airplane is flying and it tilted to one side around its longitudinal axis, and the middle ear fluid gradually reaches a stable state without shaking, giving the pilot the feeling that it is perpendicular to the horizon. If the lack of movement of the middle ear fluid induces this feeling into error, and if this problem is not compensated, the plane will approach the ground from the direction it tends to, and the probability of it hitting the ground will increase moment by moment. This is the state where the proprioception of the muscles can act as an auxiliary sense.

In air shows and battles, we see many movement maneuvers by the plane, which may happen in any of its three movement axes. As the plane rotates from all sides, the pattern of applying gravity to the pilot's body changes, and these movements will apply an impulse to the person's body. To continue controlling the plane, the pilot has to react and make decisions while bearing these pressures. Enduring these pressures requires special exercises and preparations involving balance-related senses, including muscle proprioception and vestibular and visual control. Also, damage to the spine during an emergency exit (Ejection) has been reported, and with faster muscle reaction, especially the trunk stabilizing muscles, we can see more muscle support and, as a result, reduce the amount of damage.

Inverted Ejection occurs when the fighter jet is rotating in its transverse or longitudinal axis, and Ejection should be done when the bottom of the plane faces the sky. In this case, the initial speed that should have thrown the pilot upwards throws him toward the ground, and the initial speed and the acceleration of gravity are combined and cause a disaster. If it is possible to improve the pilot's sense of positioning relative to the horizon, we can see a reduction in the risk of inverted Ejection.

1.1 Gyro Swing History

Gyro swing is a sports and recreational device initially designed and built for pilot training in Australia, for the first time in July 1964. After that, the construction of this device began in the world of aviation and aerospace community very soon, creating a sense of weightlessness and improved balance and orientation in pilots and astronauts. The U.S. Air Force, the American Space Agency (NASA), the Russian Space Agency, and Lufthansa use this device effectively in their astronaut and pilot training programs. Most European astronauts whom the space agency of Russia has trained have used this device to practice weightlessness and maintain balance and orientation.

In this device, the user can directly determine the device's speed and direction of movement by slightly shifting his body weight. This device consists of three inner, middle, and outer rings. Since the movement of the device is started by the rider, every rider determines the way of movement and the speed of movement according to his needs. Therefore, no two riders will have the same experience; even one rider cannot have the same movement.

The direction of movement is constantly changing. In this way, the speed and direction of rotation of the inner ring in which the work rider is located is under the control of the work rider to a greater extent. However, this ring has 360 degrees of freedom of rotation in the middle ring, which is under the control of the rider to a lesser extent. The center is also located in the outer ring with 360 degrees of freedom of rotation; the direction of movement and rotation is entirely outside the will and control of the rider and changes unpredictably from moment to moment. Therefore, you will never tire of it because there are always maneuvers and movements you have never experienced. These movements happen naturally and unexpectedly. Its rhythmic movements provide a scarce opportunity for the rider's body in a three-dimensional space of effort.

Contrary to its appearance, this device is not where you close your eyes and surrender to the machine's movements. If the rotation of the inner ring of this device is controlled by the conscious movements of the rider's body, it will not cause dizziness and nausea in any way. Just like a bicycle, whose stability is provided by the balance and weight of the rider's body, here, too, the rotational movements and balance of the three-dimensional movement of the device are provided by the change in the location of the body's center of mass. This is the only known sports device that can move in three dimensions and in a direction whose power is provided only by the rider's weight.

This device is an excellent and safe device for athletes, and it can even be used to develop the body and increase the physical fitness of the blind. Training with this device increases the athlete's self-confidence in a new way that he has never experienced before. In addition to muscle strengthening, training with this device creates a completely new and unexperienced feeling, which increases the ability to maintain balance, a sense of direction, and alertness and reduces nervous disorders. This device can even work effectively in the rehabilitation of the physiotherapy course.

1.2 An Overview of Anatomy and Physiology

The skull covers and protects the brain and its surrounding structures and connects different muscles responsible for controlling the head and jaw movements. Eight skull bones include: occipital bone, frontal bone, two occipital bones, two temporal bones, sphenoid bone and ethmoid bone. Some of these bones contain sinuses (cavities lined with mucous membranes connected to the nasal cavity). The ears are placed on both sides of the skull almost at the level of the eyes.

Body balance is determined by the coordination of body muscles and joints (proprioceptive system), eyes (vision system), and labyrinth (vestibular system). These areas send information about balance to the brain (cerebral system) for coordination and perception in the cerebral cortex. The brain receives the blood it needs from the cardiovascular system. A problem in each of them, such as atherosclerosis or visual impairment, can cause a disturbance in balance. The inner ear's vestibular system provides feedback related to the movements and position of the head and body in space.

1.3 How Can Using a Gyroscope Be a Sport?

To provide balance against unpredictable three-dimensional movements, all the body's muscles are uniformly involved and consume energy; therefore, the rider consumes energy unconsciously and reflexively without feeling tired. This energy consumption takes place through the body's muscles, which ultimately leads to the strengthening of all muscles and the consumption of fats.

Even if it looks like the rider is not doing anything or making an effort, the rider is doing an intense isometric activity. The position of the center of mass of the rider's body in space constantly changes in relation to the pull of gravity. Therefore, the amount of resistance that different muscle groups show to overcome the gravitational force is also constantly changing, and this means that the rider's body, at one moment, is forced to contract a series of muscles. In the next moment, when the position of the body's center of mass has changed, it relaxes the previous muscles. It contracts a new group of muscles accordingly, meaning energy consumption and isometric exercise or standing.

The higher the movement speed and the greater the rider's body weight, the more muscle energy spent to maintain balance will be the same feeling of fatigue in the arms and burning in the abdominal muscles as after the swimming exercise. Sit down, and you will have the same panting as after jogging. Depending on the rider's speed, you can go from a fun light stretching exercise to an intense aerobic activity to reach the optimal heart rate with this machine. The device's three-dimensional movement provides conditions for athletes to improve their physical fitness, regardless of their specialty.

Exercising with this device relieves the pain in this area of the body by creating tension in the lower back and strengthening its muscles simultaneously. Medical studies show how this is possible. The reflexive behavior of the body to maintain balance increases the ability to balance and coordinate the body parts, and its safe feeling of excitement relaxes the nerves. The benefits of inversion therapy are numerous, and the most important of them is reducing stress and minimizing the effects of aging resulting from uneven sitting and standing habits.

The earth's gravity causes pressure on the spine and all body parts. During the day, even if we do not do intense physical work and observe all the health principles regarding the correct way of walking, standing, and sitting the earth's gravity affects our body vertically throughout the day, and the stress accumulated during the day causes fatigue. Now, if we add the double pressure caused by improper sitting and standing to the above factor, the fatigue and stress feel beyond the tolerance threshold. During exercise with this device, when inverted due to the applied tension, which is the opposite of the forces applied to the body during the day, a large amount of compressive stress applied during the day is released, and the person feels relaxed. The emotions created by the endocrine glands, such as the pituitary and thyroid, are stimulated. By stimulating the lymphatic flow, lymphatic drainage prevents the formation of toxic substances and strengthens and better responds to the body's immune system. It increases the flow of oxygen-rich blood in the brain, reduces mental fatigue, and eliminates headaches.

Any exercise reduces stress in people, but repetitive and one-sided daily activity is the leading cause of stress. Gyro swing makes it possible to do stretching exercises and strengthen muscles. In this sense, it is unique because it is the only device that can simultaneously exert both tension and tension on a person's muscles. In the present study, we will examine the effect of training with a gyroscope on some parameters affecting the balance of IRIAF pilots.

The main goals of this research are to determine:

- the effect of 8 weeks of gyro swing training on some balance parameters of IRIAF pilots.
- the effect of 8 weeks of gyro swing training on identifying the body position in the space of IRIAF pilots.
- It determines the effect of 8 weeks of gyro swing training on the static and dynamic balance of IRIAF pilots.
- It determines the effect of 8 weeks of gyro swing training on the force input pattern in the left and right upper limbs of IRIAF pilots.

2. Materials and Methods

The current research is analytical and interventional:

Statistical population: Army Air Force pilots

- Statistical sample: 30 pilots will be randomly selected for the training group, and 30 will be selected as the control group.
- Measuring tools, devices, and software
- Equipment: marker, scale object, high-speed camera, vertical camera tripod, 25-meter meter, gyroscope equipped with lamp and switch, Huber device, gyroscope, and Huber
- software: Excel 2007, SPSS19, skill spectator

Due to the military nature of the plan and the existence of information protection restrictions, some information is omitted, including: Statistics of equipment - people - disclosure of events.

2.1. Participants

The study included 60 male pilots. The average age, height, and weight of all pilots were 27 years, 182.8 cm, and 80.1 kg, respectively. Table No. 1 shows the basic information related to these pilots by the investigated groups. The t-student statistical test showed no significant difference between the two groups given the exercise and the control in terms of basic variables (P.V.> 0.05).

Table 1. Descriptive characteristics of basic variables of the pilots

group	Number of participants	variable	mean ±standard deviation
practice	30	**age**	**26.6±1.9**
control	30		**27.4±2.1**
practice	30	**height**	**181.7±2.1**
control	30		**183.8±2.4**
practice	30	**weight**	**79.5±1.7**
control	30		**80.6±1.9**

2.2 Measuring tools, devices, and software

2.2.1 Videography

The primary common method used to record and study sports movements is videography. Cinematography (cine film cameras) and analog cameras are rarely used today. Motion analysis systems that automatically follow skin markers are increasingly used in biomechanics laboratories. These systems are more expensive than video analysis systems, and working with them is much more complicated; they also require a more professional user and cannot be used under sunlight.

For these reasons, the critical strength of videography is that it enables the researcher to investigate sports movements not only in the controlled environment of the laboratory but also in a field of competition (Payton, 2009). This also minimizes possible interference with the skills of the person performing. In videography, data is digitized by the researcher. Some video analysis systems that can follow markers in two dimensions save much time for researchers.

We ask the subject to stand on the machine and hold the button on the machine handle corresponding to the lamp on the top. After that, we asked him to start turning, and when he felt that his height was perpendicular to the ground, he turned on the lamp. Repeat this 12 times while spinning. We record events with two cameras perpendicular to the device at a frame rate of 300 fps. By extracting information from the video, we will calculate the angle of the person's height relative to the horizon line when the lamp is on by the software. The bisector angle of the measured angle relative to the horizon symbolizes identifying the body's position in space.

2.2.2 Star Test

We ask the subject to stand in the middle of a star shape in the form of 8 lines at an angle of 45 degrees to each other, and in a state where his balance is preserved, reach his free foot to the end of all eight lines. Reaching the foot to a point further from the line has a higher score for the subject. This test is performed with eyes open and closed, and this work will aim to estimate the visual sense of the subject's balance.

The SEBT test was used to evaluate dynamic balance. According to the test's standard protocol, eight directions with an angle of 45 degrees to each other were drawn as stars on the ground. In order to perform this test, the actual length of the leg was measured, i.e. from the anterior superior iliac spine to the inner ankle. After the examiner had given the necessary explanations about how to perform the test, each subject practiced the test six times to learn how to perform it. Before the test, the superior leg of the subjects was determined so that if the right leg were superior, the test would be done counter-clockwise, and if the left leg were superior, the test would be done clockwise.

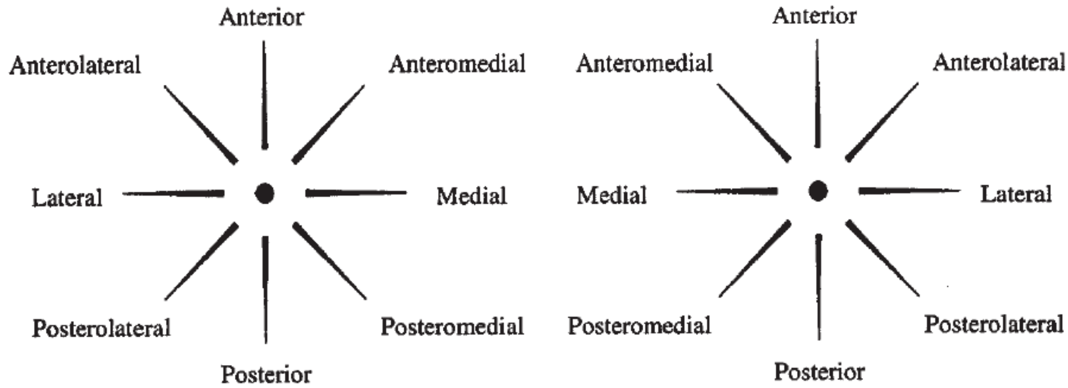

Figure (1). Overview of the SEBT The subject stands with one foot in the center of the star with the dominant foot and does not move the foot from the center of the star until making an error does not lean or fall on the reaching foot, with the other foot in the direction The experimenter determined randomly, performed the reaching action and returned to the normal position on both legs. The distance from the free foot's point of contact to the star's center is the reaching distance (Figure). Each subject performed each of the directions three times, and finally, standing on the right foot and standing on the left foot, the average of them was calculated according to the length of the foot in cm. Then, it was multiplied by 0.22 to get the reach distance as a percentage of the leg length. (32)

3. Result

Descriptive statistics were used to calculate the average and standard deviation of the subject's age, height, and weight, as well as the angle of the body position in space, the subject's range of motion in space by the gyroscope, Huber's test score and their reaching distance in eight SEBT directions. Also, to determine the significance of the difference in the angle of the body position in space, the subject's range of motion in space, the Huber test score, and the reach distance in each group before and after eight weeks of training with the gyroscope device, from the analysis of variance test (repeated measurement design) at a significant level. 0.05 was used.

Table 2 gives the average index and standard deviation of other variables examined in this study (the angle of body position in space, the subject's range of motion in space by the gyroscope device, Huber's test score, and their reaching distance in eight SEBT directions) separately for the compared groups, as well as before and after eight weeks of training with the Gyro swing machine.

Table 2. Descriptive characteristics of the studied variables in IRIAF pilots

variable	Review * time	** group	Number	Scope of privilege	± Mean standard deviation
the angle location Body At Space At X view	before training	practice	30	43-0	**0.14±21.4**
		Control	30	1-42	**12.5±18.8**
	after training	practice	30	6-38	**9.6±20.2**
		Control	30	5-39	**10.5±19.4**
the angle location Body At Space At Y view	before training	practice	30	1-41	**11.1±18.6**
		Control	30	8-24	**6.2±15.3**
	after training	practice	30	8-29	**1.7±6.6**
		Control	30	6-26	**6.1±14.7**
Domain move subject At Space At X view	before training	practice	30	9-28	**6.3±19.0**
		Control	30	8-31	**7.2±20.1**
	after training	practice	30	13-36	**5.8±27.4**
		Control	30	30-8	**5.6±19.5**
Domain move subject At Space At Y view	before training	practice	30	8-32	**6.5±16.4**
		Control	30	8-24	**4.3±17.4**
	after training	practice	30	14-36	**6.6±25.4**
		Control	30	8-33	**5.5±18.4**
Huber's score in the upper limb	before training	practice	30	17-10	**2.2±13.2**
		Control	30	17-10	**1.2±12.9**
	after training	practice	30	25-13	**13.1±18.8**
		Control	30	17-10	**2.2±13.1**
non-superior Huber score in the limb	before training	practice	30	5-13	**2.3±9.2**
		Control	30	6-13	**2.2±8.9**
	after training	practice	30	24-10	**3.4±17.4**
		Control	30	6-13	**2.2±9.1**
Huber score difference between superior and non-superior limbs	before training	practice	30	-11-1	**0.3±1.4-**
		Control	30	-11-2	**0.3±1.3-**
	after training	practice	30	-10-8	**5.5±1.4-**
		Control	30	-10-2	**0.4±3.1**
Star Test Score	before training	practice	30	101-72	**7.4±0.88**
		Control	30	104-70	**2.8±89.6**
	after training	practice	30	103-62	**11.5±90.4**
		Control	30	107-62	**11.9±90.6**

*Before 8 weeks of training with the Gyro swing device - after training
**Group: Practiced with gyroscope and control device

4. Discussion and Conclusion:

According to the information extracted from the videography on the gyroscope and its statistical analysis in the control and training groups, no significant difference was observed in the body angle of the pilots before and after eight weeks of training. At first glance, this lack of change in body angle shows the growing device to be ineffective. It is in line with Michael McBeth's 2012 research on the ineffectiveness of short-term exercises (9 weeks) and the need for long-term exercises with growth. On the other hand, the significant difference in the range of angular movement indicates an increase in

the range of movement of the pilots in the training group. In contrast, no significant change was observed in the control group.
The time the lamp is on, which is the symbol of the pilot's Ejection in the present study, was the same in all the subjects. The mentioned point confirms the hypothesis in this article that the training group obtained the results without change in the recognition of the angle of the standing position at a higher speed. According to the speed-accuracy law, it was expected that if there is no progress by increasing the speed of the gyroscope, the identification of the body position in space would face more errors; however, this error was not observed. As a result, not reducing the score while increasing speed is considered a form of progress. The discrepancy with Mcbeth's 2012 research is probably rooted in his measurement method, which detects the body's position in a fixed state.

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تأثیر ۸ هفته آموزش ژیروسکوپ بر برخی پارامترهای تعیین کننده تعادل خلبانان نیروی هوایی

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چکیده: این تحقیق به بررسی اثرات تمرین با ژیروسکوپ بر شناسایی وضعیت بدن در فضا، تعادل نیمه پویا در زمین و عملکرد دستگاه هوبر می‌پردازد. دو گروه ۳۰ نفره از خلبانان نیروی هوایی (IRIAF) با میانگین سنی ۲۷ سال، قد ۱۷۸ و وزن ۸۰ کیلوگرم به طور تصادفی به دو گروه آزمایش و کنترل تقسیم شدند. گروه آزمایش به مدت هشت هفته تمرین با دستگاه ژیروسکوپ انجام دادند. ارزیابی‌های پیش و پس از آزمون شامل فیلمبرداری، آزمون ستاره و امتیاز دستگاه هوبر با روش‌های آماری مقایسه شدند. نتایج نشان داد که در آزمون ژیروسکوپی، هیچ تفاوت معنی‌داری در تشخیص وضعیت بدن در هوا بین دو گروه قبل و بعد از آزمون مشاهده نشد، اما افزایش سرعت چرخش در گروه آزمایش مشاهده شد. در مقابل، در آزمون هوبر، هیچ تغییر معنی‌داری در گروه کنترل قبل و بعد از آزمون مشاهده نشد، اما در گروه آزمایش بهبودی در امتیاز، به‌ویژه در اندام غیر برتر و کاهش اختلاف امتیاز بین دو دست مشاهده شد. همچنین، هیچ تغییری در آزمون ستاره در هیچ‌یک از گروه‌ها قبل و بعد از آزمون مشاهده نشد. براساس نتایج، می‌توان نتیجه گرفت که در این تحقیق، علیرغم نبود تفاوت معنادار در تشخیص وضعیت بدن، افزایش سرعت چرخش در گروه تمرین رخ داده است.

واژه‌های کلیدی: تعادل، ژیروسکوپ، تست ژیروسکوپ، شناسایی موقعیت.