CULTIVATING THE BALANCE SENSE: A PRELUDE TO CLOUD FLYING.*

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As the war advanced, bombing by night and day and long-distance raids, made possible by the improvements in planes, assumed a steadily increasing importance. Bombing pilots had to be able to navigate their ship to a given objective, under cover of darkness, or through and above the clouds in daytime. Aviators find it difficult to fly in the clouds. Some men who fly safely in the open are totally unable to navigate in a cloud, and sometimes they go into a tail spin.

Lieut. Commander A. C. Read, United States Navy, of the *N-C4*, says in the personal account of his experience, as printed in the *Philadelphia Inquirer*:

"At 6:55 (a. m.) we passed over a merchant ship, and at 8 o'clock we saw our first indications of possible trouble, running through light lumps of fog. It cleared at 8:12, but at 9:27 we ran into more fog for a few minutes. At 9:45 the fog became thicker and then dense. The sun disappeared and we lost all sense of direction. The compass spinning indicated a steep bank and I had visions of a possible nose dive. Then the sun appeared and the blue sky once more, and we regained an even keel and put the plane on a course above the fog, flying between the fog and an upper layer of clouds. We caught occasional glimpses of the water, so we climbed to 3,200 feet, occasionally changing the course and the altitude to dodge the clouds and fog."

This is an intensely interesting report to me, and the method of instruction I am advocating may eliminate such fears. Analyzing the report we find that the compass spinning indicated a steep bank or tilt to one side. In other words, the aviator chosen for his superior skill to make this historic trip was unable when in the fog bank to perceive that the ship was off an even keel, and the spinning of the compass was what called Commander Read's attention to their faulty position. "I had visions of a possible nose dive." If the steep bank into which the *N-C4* was placed in the fog, had become more marked and the aviator, not perceiving it, had not ruddered into it properly, a side slip would have occurred, and this, if not stopped, might have resulted in a tail spin. These heavy boats do not spin easily. They are more likely to dive. You will notice

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that it was only when the sun appeared that the ship was righted and that the danger was sufficient to cause them to change their course and to climb to a higher altitude in order to have a chance to maneuver in case of an accident. "We lost all sense of direction." The direction could easily have been maintained by the compass. It was the balance sense that was confused, also. Many men have told me there is a tendency to nose up (climb upward) in a cloud, and it is a common practice to listen to the engine to hear if it is laboring with the strain of climbing, and to the purr of the wires to judge whether speed is being gathered by an inclination downward. The same difficulties apply to night flying, if the stars and moon are obscured and the aviator cannot see the ground. Any technique that would even partly remedy this danger would be a distinct advance.

In ordinary daylight flying an aviator keeps his ship in position by his sense of sight, his balance sense, his muscle sense, and deep sensibility tracts. He gets some information from the wind through his tactile sense and the engine and wires through his sense of hearing. The most important of these, by far, are sight and balance. On a dark starless and moonless night and in a cloud sight is cut off. In a cloud the feel of the wind on the face is also lessened. In both cases the aviator depends almost entirely on his balance sense, coming from vestibular impulses, to keep in flying position.

We know that any of the senses may be highly cultivated by practice or by calling on them to compensate for the loss of another sense. Blind men were used in London during the war to help locate the Gothas. They could hear them quickly and detect the direction better than men with sight. Silk workers in India detect the slightest variation in thickness with great skill, through the development of their tactile sense. Tea and brandy tasters for the trade have the sense of taste trained. Many here tonight recall the blind man who for years delivered provisions in the downtown section of this city. He was a notorious character. I remember well his queer call and especially the wonderful accuracy with which he found his way through the street. His sense of direction was highly trained.

The thought of having men walk while blindfolded in a straight line and later perform some evolutions and observing whether they improved after a reasonable length of training had occurred to me as a means to train the sense of direction, but I abandoned it as not practicable, because aviators in a cloud can see their compass and

are not interested so much in keeping in a straight line as in maintaining their flying position and thus avoiding a fall. I then began to consider the question of flying while blindfolded to improve the "feel of the ship" as it is called; the balance sense. About this time, September, 1918, Maj. H. R. Raikes, R. A. F., a member of the British Aviation Mission, came to Ellington Field and suggested a compass course in flying, to train men in cross-country work. I took up the matter with him and he thought the plan of flying blindfolded as a part of an aviator's training had some practical possibilities.

Two-seated planes were selected with double control. That is, the plane could be managed from either seat. The pupil sat in the front seat beneath a black hood like that on a baby carriage. It fastened at the top with a catch to which a string was tied. A pull of the string released the catch and the hood flew open again. The linen on the fuselage (body) was painted black to keep out the light. The instructor sat in the open, in the back seat, ready to fly the plane if necessary and observing the facility with which the pupil held his course while seated beneath the hood. The pupil was to maintain his flying position by watching an inclinometer and a level.

I took some rides under this cover, but found the light coming up through the floor and under the instrument board so good that it was unnecessary to use the lamp to see the compass. I then tried holding the eyes shut, but there was a constant tendency to open them. A velvet mask was then made to fit over the goggles in such a way as to keep out all light and be removed from the eyes quickly by simply pushing the goggles up on the forehead. The hood kept the wind from the face. I also tried flying with wax plugging the ears, to cut off the sound of the engine, but the noise was not lessened enough to make it worth while, and as it was very unpleasant, I abandoned it. Before having the men attempt to fly I went up blindfolded to observe whether one could tell the position of the ship with sufficient accuracy. The pilot was instructed to begin his evolutions by making the slightest possible deviations. As we had no intercommunicating phones I held cords tied to the aviator's arms and by prearranged signals let him know as soon as I perceived any deviation from the normal flying position. We soon found that I could tell if the nose went up or down instantly. I could tell quickly when we flew with one wing or the other low; but I made some mistakes when we banked and turned at the same time. Any marked change of position could be detected easily.

The accompanying blank was then devised for charting all positions of the plane with check marks. The idea being to have a man fly blindfolded for ten minutes each day for about two weeks and see if he improved any. If such was the case I thought it would give him greater confidence while in the clouds and he would learn that he had the ability to keep an even keel without the aid of eyesight. Instead of acquiring this ability by practice in a cloud, he practiced on a clear day with a trusty instructor to take control if necessary and correct his defects. He was to attempt no evolutions, but simply to keep the ship in good flying position. Unfortunately I was ordered away for six weeks just at this time and the armistice was signed soon after. When I returned I found that the blindfold flying had not been carried out, but that the men showed improvement in their compass flying under the hood after a few lessons. One man who was a fair flyer in the open was very poor under cover; had to be given the course twice and was then far from satisfactory.

I regret that I have no report to make of the results of such a course of training.

Conclusion. Knowing that other special senses are susceptible of high development through training, a priori, we must conclude that the balance mechanism is also.

The point that we have not proven is, How long would it take to make a man confident in a fog and would the training period be so long as to be impracticable for a course in an army aviation school?*

In spite of the small air service that has been retained and the lack of government help in developing commercial aviation, airplane design and engine models have improved considerably since the war. In time, no doubt, proper instruments will be developed to make the operation of an airplane very safe. At present the best method for judging position seems to be the combined use of a gyroscopic turn indicator and an inclinometer. Given progress in a straight line, the gyroscope registers either right or left when a turn is made. It is said that the gyroscope shows the turning movement immediately and continues to register for about eighteen minutes. In banks and turns, centrifugal force will keep the compass needle from properly registering, therefore, once the airplane begins to turn, the compass is of no value as an indicator of direction. In laying a course to the north, the magnetic pole causes a

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variation in the needle to such an extent that it is difficult to fly a straight course by the compass, especially if one is climbing or descending.

I am not sure how much information an aviator gets from his deep sensibility, muscle and joint sense combined with his balance sense. These are interpreted in relation to his seat in the plane. In a turn made with perfect bank, it is difficult to tell one's position because of the perfect interadjustment of centrifugal force and gravity. It has occurred to me that the feeling of resistance on the controls may impart some information as to the position of the ship, but I do not believe that it is an important factor.

Some men have spoken of a sense of lightness or heaviness during certain evolutions, as when diving rapidly or turning. These are, I should think, registered through the deep sensibility and muscle tracts, and are due to varying degrees of the pull of gravity and centrifugal force.

At present the sense of balance is the aviator's greatest safeguard in a cloud and any particular method of cultivating it is still of value.

1825 Chestnut Street.

OPEN SAFETY PIN IN LARYNX. SIX MONTHS.*

DR. HENRY BOYLAN ORTON, Newark, New Jersey.

Lillie C., aged 6 years, white, admitted to Saint Michael's Hospital, Newark, N. J., August 24, 1920, with complaint of difficulty in breathing.

Past History. Had whooping cough at the age of 1 year, measles when 5 years old, and diphtheria six months ago. Has otherwise enjoyed good health up until six months ago.

Family History. Negative; mother, father, one brother and one sister living and well.

Present History. Six months ago, while playing with two little girls, the patient had three or four pins in her hand. They were all playing in the house when the little girl suddenly came running to her mother very cyanotic and pointed to her neck and at inter-

*Reported at the Eye, Ear, Nose and Throat Section, Academy of Medicine of Northern New Jersey.