Gliding Federation of Australia

(ABN 82 433 264 489)

Human Factors for Gliding

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HUMAN FACTORS IN GLIDING

Issue 1

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FOREWORD

Most aircraft accidents are linked to deficiencies in human performance. These deficiencies may involve a variety of factors. The factors include poor lookout, situation awareness (SA), decision-making, task organisation, communication, failure to recognise threats to safety and the commission of errors.

Human Factors are often perceived as 'psychobabble' and the realm of the psychologists, rather than an extension of old-fashioned 'good airmanship'. Also, Human Factors have been associated more with multi-crew and airline operations, rather than sports aviation single-pilot activities. The intent of this document is to provide guidance on the incorporation of single-pilot Human Factors into glider flight operations.

The GFA acknowledges Graham Wardell of the Auckland Gliding Club N.Z for allowing the use his Human Factors material in the development of this manual.

Once printed, this is an uncontrolled version of the manual which will not be updated by GFA; it should not be relied upon for any regulatory purpose. The current manual can be viewed at any time via GFA's website at "http://www.glidingaustralia.org".

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DEFINITION OF "HUMAN FACTORS" IN THE AVIATION CONTEXT

"Human Factors" is a general term which broadly encompasses the study of human performance and limitations pertaining to the piloting of aircraft, both in the air and on the ground. The term "Human Factors" came into being relatively recently as a result of the increasing importance of a pilot or human component as a cause of aviation accidents, including gliding accidents worldwide. However, its scope now goes beyond accident investigation to embrace all of the medical, psychological and ergonomic/engineering aspects of human beings in the aviation environment.

Because human factors continue to play a large part in aviation accidents, they will continue to be of interest and concern to all aviators. Recent studies show that more than 75% of all accidents have significant "human" causal factors.

Human Error

Human error can be defined as 'the failure of planned actions to achieve a desired goal'.

The first and most important point to make about human error is that, although it is undesirable, it is both frequent and widespread. In fact, it is a natural part of life.

When we look at what types of errors people usually make, we soon realise that they are not random. We all tend to make the same kinds of mistakes in similar situations. For example, if we are doing some photocopying we're not very likely to make the mistake of putting the original document in the paper feed tray instead of under the top cover. But most of us will have made unwanted multiple copies because we didn't cancel a setting made by the person before us, or we have walked off and forgotten to retrieve our original document from under the cover.

The lesson is that it is the situation that provokes the same kinds of errors, regardless of who is involved in doing the task. This is equally true of flying a plane, operating a ship, or driving a train, just as much as it is true of more mundane activities such as photocopying.

An understanding of our limitations as human beings in the aviation environment is just as important as an understanding of aircraft limitations in making our sport as safe as we can. We will not eradicate human error, but we can and should work towards managing it and reducing its negative consequences.

A broad knowledge of factors affecting human performance and limitations in the aviation environment is now required as part of the GFA's Glider Pilot certificate.

HUMANS AND THE "NORMAL" AND "AVIATION" ENVIRONMENTS.

Human beings are well adapted to living on the earth's surface at moderate temperatures, breathing a sea-level atmosphere, in conditions of good visual orientation references, and generally moving about at slow speeds under a gravitational forces of 1"g". Disturb any of those conditions and the human being is placed in an environment that is as unnatural and potentially hostile as that under water or in outer space. The aviation environment itself can disturb all of these conditions.

Affected to a greater or lesser extent are normal human functions of–

- Vision
- Hearing
- Balance and orientation
- Respiration
- Mental capacity (judgment and decision-making, affected by stress, fatigue, overload etc.)

In addition the pilot and passengers must cope with such special external environmental factors as–

- "G" forces
- Pressure changes
- Temperature changes
- Humidity changes.

Adverse medical factors may also come into play, such as–

- Influence of drink or drugs
- Dehydration
- Hypoxia
- Disease
- Illness

VISION IN THE AVIATION ENVIRONMENT

Good vision, both inside and outside of the cockpit is obviously essential for safe flight. It is extremely important to us as pilots for the basic function of telling us where we are going, where we have been, and what is sharing our immediate airspace with us. What may not be widely recognised is that vision also plays a major role in the balance and orientation mechanism of the human body, to which we will return shortly. Not only do the eyes provide 80% of the orientation information received by the brain, but the mechanism of vision, including the visual function of the brain requires 30% of our oxygen supply. The visual mechanism is particularly sensitive to hypoxia, and this explains why visual effects are often among the earliest to manifest themselves in this condition.

Limitations of Vision (Factors adversely affecting vision)

We will list these now before discussing some of them in more detail shortly.

Inherent limitations

- The blind spot
- The time lag
- The seeing and focusing mechanism
- Empty visual field blindness
- Visual illusions

Physical impairment

- Muscular fatigue
- Damage – grit cataract
- Congenital or naturally developed conditions such as short or long sightedness, or astigmatism.

Environmental factors

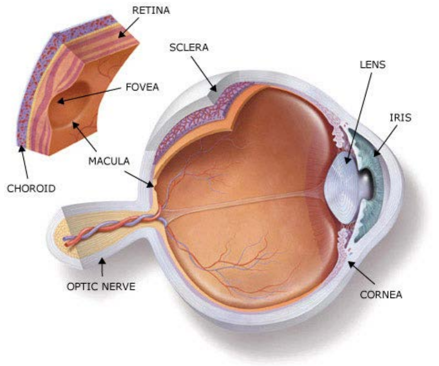
- Hypoxia
- “g forces
- Heat/cold
- Turbulence
- UV or IR Radiation
- Glare
- Luminance, ambient lighting and contrast

Equipment

- Canopy design
- Canopy condition, cleanliness, cracks, scratches, water
- Incorrect sunglasses
- Inappropriate headgear
- O2 masks

The process of “seeing” and “focusing”

The eyes are muscles which, at rest, focus 3 to 4 meters in front of us. For flying we need to be able to focus on distant objects outside of the cockpit (ground features and other aircraft) as well as items inside of the cockpit (instruments and maps). For the pilot the necessary process of effectively “seeing” this wide range of objects at different distances requires muscular effort, special techniques, and a good understanding of how the human vision system works, along with its limitations.



Interestingly, the binocular depth perception attributable to two good eyes only works out to a distance of about 10 meters. After this, the amount of eye separation does not give a great enough difference in images to be useful. Beyond 10 metres, pilots are estimating distances by their experience of the comparative sizes, shapes, alignment and perspective of objects they see. However, the eyes can sometimes be fooled in this respect, as we will see when we look at some visual illusions.

The eye can detect light energy of different colours and intensity. Light entering the eye is converted into light energy that the brain can detect by light energy receptors in the retina of the eye.

These receptors are of two types, called cones and rods. Cones are concentrated near the centre of the retina, and detect brighter light energy and sharp, fine detail. The cones also register colour.

The rods, on the other hand, react to much weaker light energy, and are distributed more widely around the retina. They do not detect as sharp images nor register colours as well as the cones, but they do detect movement better than cones, especially in the peripheral areas of vision. This is why, when we detect (or think we detect) some movement "out of the corner of our eye" we instinctively turn our head in that direction to bring the much sharper and fine detailed powers of the cones in the centre of the retina into play.

The blind spot

Most of you will be aware of the existence of an eye's "blind spot".

Small nerves behind the retina carry light-generated nerve signals to the brain via the optic nerve, an area at the stalk of the eye which they all join up to form. There are no light receptors (rods or cones) in this area of the retina, so any light energy falling on this area does not reach the visual centre of the brain. This is the eye's "blind spot".

Now take a look at Addendum 1 (Visual illusions - Blind Spot)

Pilots, or for that matter people generally, are not continually aware of their "blind spot", as the brain tends to "fill in" what it thinks should be there!

The "time lag" between "seeing" and "responding"

The time lag in the "seeing" process is particularly important when considering reaction times. "Look out" for pilots is not only a process of looking and "seeing" what may be there, but also a process of recognising, deciding, and responding to what may be there. Just as "seeing" takes a finite time, so does deciding and reacting.

PROCESS		TIME TAKEN	TIME LAPSE
Looking	Is there something out there?	0.2 seconds	0.2 seconds
Seeing	Yes, there is definitely something out there!	0.3 seconds	0.5 seconds
Recognising	Is it another glider… a Twin Astir?	1.0 seconds	1.5 seconds
Evaluating	It is coming this way…I need to turn, NOW!	3.0 seconds	4.5 seconds
Responding	Manoeuvring to avoid the collision.	3.0 seconds	7.5 seconds

In ideal conditions anything up to 7.5 seconds may elapse from looking to avoiding. How far do two converging aircraft travel in this time?

At:	120 kts	closure they travel	1013 - 1520 ft
	150 kts	closure they travel	1267 - 1900 ft
	180 kts	closure they travel	1520 - 2280 ft
	400 kts	closure they travel	3378 - 5066 ft

Scenario – you are in the wave with a Boeing 737 or BAe 146 steaming towards you from your wing tip... he has only a very small cross section to detect at nearly a mile... and he may be eating his lunch! How often will you be scanning out at your wing tip? Sure, the sky is a big place.... but all too often it ends up just a wee bit too small to fit two aeroplanes in!

Scanning

Because of inherent limitations in the seeing and focussing mechanism, seeing something properly presents problems for the pilot, particularly in "lookout". As we have noted, the best vision during daytime is central vision, using the cones of the central retina. The area of acute vision occurs in a "cone" shape of about20° angle from the centre of the retina, giving the pilot about 20° arc of accurate vision at any one time. The process of looking, seeing, and recognising does not occur instantaneously, but takes a finite time to happen. In fact, about 1½ seconds under normal conditions! Taking the limited angle of accurate vision available, and the time lag into account, it is clear that to scan the airspace outside of the cockpit effectively a pilot should divide the area to be scanned into 20° sectors, and allow sufficient time in each sector for the "seeing" to fully occur. Because glare, luminance, and contrast factors can delay the "seeing time" even further, allowing 2 seconds per 20° sector is recommended. Hence the development of the "20 Degrees – 2 seconds" rule.

We need to develop a scan that maximises our lookout. The vulnerable areas are ahead of us where we can run into someone and to the side of us from where we may be run into. In aviation the third dimension of above and below and the closure rates possible further increase our visual task.

Obviously we also need to scan back inside the cockpit for similar durations (20Degrees – 2 seconds) to check what is happening there. We need to refocus our eyes; if we have a relatively empty visual field the eyes will focus near their resting distance at about 3 meters in front of us and won't see objects beyond that. If we have just had them focused on the instruments we should focus our eyes to the distance we want them to scan at by looking at and focusing on a more distant object like a ground feature or cloud, then scan out in our sector.

Empty visual field blindness[1]

It is important for pilots to be aware that when flying in conditions of low visual stimulus a significant form of "short-sightedness" can occur. Low visual stimulus is where the visual field looks very much the same in all directions, and is relatively unbroken by distinctive or different features. This may occur for example when flying in haze above a solid cloud layer, or over a smooth sea surface. The "short-sightedness" because the eye "rests", taking up its natural relaxed focal length of about 3 to 4 meters! Under low stimulus conditions the danger is that although the pilot may think he is keeping a good look out, he is in fact focussing just outside of the cockpit!

Empty visual field blindness can be overcome by periodically transferring the gaze to some distant cloud or land feature, thus exercising the focal properties of the eye. Even consciously focussing on the wing tip from time to time may help.

The effect of hypoxia on vision.

The brain is very sensitive to oxygen levels, and the visual system is one of the most sensitive parts of the brain. In fact it requires 30% of the body's oxygen requirements! The visual system is therefore extremely susceptible to oxygen deprivation, and will be among the first "systems" of the body to be adversely affected thereby. Visual acuity (sharpness), peripheral vision, colour perception, and visual brightness will all be affected.

The effect of "g" forces on vision.

The application of positive "g" forces will reduce the blood supply to the brain and therefore the oxygen supply to the brain will be diminished. Initially the pilot may notice:

- loss of colour ("grey out").
- loss of peripheral vision (tunnel vision).
- blurring of vision (loss of visual sharpness).

[1] Also known as "Low visual stimulus short-sightedness" or "Empty field myopia"

- total loss of vision ("black out"). Not the same as unconsciousness, although that may quickly follow if "g" force is maintained!

The effect of fatigue on vision

The muscular side of vision is of course largely automatic, but, like any muscular activity may be affected by fatigue. Focussing and re-focussing of the eye requires a certain amount of energy, and the eyes can be among the first bodily facilities to become tired if the body is tired. We are all familiar with the need to rub, close, or rest the eyes when we are tired. The normal field of vision, visual acuity, and general visual effectiveness all clearly suffer when we are tired.

Canopies and vision.

Do not forget your canopy as a visual aid. It is, because if it was not there you would not see very much because of the airflow in your face. Treat a canopy as you would your favourite pair of expensive sunglasses. A clean canopy is a delight, but a dirty or scratched one is the complete opposite. The canopy should be cleaned well before each flight, inside and out, with a non-abrasive cleaning agent which will not scratch a Perspex or glass surface. Any soft clean lint-free rag is a suitable applicator. Wiping should be done vertically rather than horizontally.

Visual illusions

General

The human visual system is not always accurate. It can play very real "tricks "which can fool unwary pilots with disastrous consequences. Because vision is so important to safe flight it is important to understand how visual illusions can occur and anticipate them.

We have already seen the blind spot in action. A pilot in a cockpit with window and door frames needs to be aware not only of the blind spot, but also of the tendency of the eyes to "fill in" gaps in vision without the pilot being aware of what is happening. The eyes could give an illusion of a continuously empty sky, but that door or window frame could hide and approaching aircraft if it is in the pilot's blind spot. Special scanning techniques are required to overcome this problem.

When the brain receives visual signals from the eyes and its visual centre it tries to "make sense" of what it sees. In order to do this it may fill in gaps or move things around slightly in order to make better sense of the messages it receives. It can bend straight lines, or straighten out curves. It can lengthen or shorten lines. The brain does not always see what is there!

Now look at Addendums 2 (Movement), 3 (line Bending) and 4 (ambiguous illusions and mind sets).

Height illusions

The human brain is not always good at making visual comparisons, particularly in situations of poor visibility, distracting line features or lack of familiar surrounding objects or features.

For example, when a pilot is familiar with trees of a certain height near his home field, but travels to a different area where the trees look the same shape but are in fact much smaller, the pilot will end up flying much lower if he is judging airfield height by the size of the trees alone! Fatal accidents have been caused by this visual illusion.

Landing area perspectives.

In learning to fly pilots become familiar with the shape and perspective of their home runway, particularly on final approach. They learn how the perspective changes when they are either higher or lower than normal. But this familiar perspective can "trick" the pilot when landing on a different runway.

For example, a pilot used to landing on a relatively short runway may think he is too high when approaching a much longer runway at a correct approach slope. The pilot may take unnecessary corrective action, and end up dangerously low. The exact reverse may be true when flying onto a runway shorter than the pilot is used to.

Runways sloping uphill or downhill can produce similar illusions for the unwary pilot. A pilot approaching an uphill runway may think he is too high, and if he corrects for that illusion may get too low. The reverse applies if the runway slopes downhill. The pilot may think he is too low, and may end up too high if he corrects.

Runways of a different width than the pilot is used to can fool the unwary pilot in the same way. A normal approach angle onto a wider runway may appear too low, and that onto a narrower runway may appear too high.

Glider pilots will be able to avoid these problems if they ignore the perspective(but not the slope!), but fly to an aiming point just short of the touchdown point at the correct airspeed and angle as they are trained to do. In fact this is the exact technique recommended for bush and agricultural pilots using short, sloping, and sometimes “one-way” airstrips.

RESPIRATION IN THE AVIATION ENVIRONMENT.

Respiration is so important in our discussion that we will treat it as a separate topic. Respiration is the process whereby oxygen, which is essential to the proper functioning of all body cells, is ingested into the body from the atmosphere by the lungs, transferred into the bloodstream, and transported teach individual cell in the body to be converted into energy and other things necessary for life. The process is usually automatic (involuntary) so that the unwary may take it for granted.

At the end of the air passages in the lungs are the alveoli – about 300 million minute air sacs. The alveoli are surrounded by fine capillaries carrying blood. The walls of the alveoli are very thin and semi-permeable. There is a pressure gradient across them, which allows oxygen to pass into the blood and carbon dioxide to come out of the blood into the alveoli. Once in the blood stream the oxygen is able to combine with haemoglobin, and in that form is able to be transported in the bloodstream to all cells of the body.

How much oxygen do we need?

A certain amount of oxygen is essential for the proper functioning of the human body. The air we breathe is a mixture of gasses. Gas Composition by Volume is:

- Nitrogen 78%
- Oxygen 21%
- Others 1%

The 78% of the air that is nitrogen plays no part in the respiration process, which depends entirely on the amount of available oxygen. The ratios of oxygen to the other components of the air we breathe remains constant at the altitudes we operate gliders, but pressure of the air reduces with altitude. As a general rule of thumb total pressure of the air has halved by 18,000 ft and again by34,000 ft. By Dalton’s Law (the law of partial pressures) the total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual component gases. The partial pressure is the pressure that each gas would exert if it alone occupied the volume of the mixture at the same temperature. So the actual amount of oxygen available reduces with altitude in the same proportion as other gases making up the air.

The “standard atmosphere” assumes a sea-level pressure of 1013.25 millibars (or hectopascals), or 14.7 psi; or 760 mm of Hg (Mercury). The partial pressure of oxygen at sea level outside of the lungs is approximately 150 mm Hg (20% of 760). Once breathed into the lungs this partial pressure of oxygen is further reduced to 102 mm Hg because of the continual presence in the lungs of carbon dioxide and water vapour. 102 mm Hg of oxygen is therefore the required partial pressure of oxygen in the lungs for normal human functioning. Any major reduction in the pressure of oxygen available in the lungs will have adverse consequences for normal functioning.

As we climb higher in the atmosphere the actual quantity and pressure of oxygen available for respiration is reduced below the required 102 mm Hg of oxygen. Less oxygen is available to the body's cells and vital organs, especially the brain. Surprisingly, adverse effects of the reduction in available oxygen are not particularly noticeable up to 8,000 ft but become critical at 10,000 ft. Above 10,000 ft we must artificially make additional O_2 available by means of an oxygen supply system fitted to the aircraft. This additional (supplemental) oxygen is added to the available air mix to restore the required partial pressure of oxygen in the lungs for proper bodily functioning.

In Australia, pilots are required to use supplemental oxygen any time the aircraft is being flown above 10,000 feet.

However, in practical application in gliders, the use of supplemental oxygen is advisable for cross country / competition pilots who work "hard" and spend a lot of time at 8,000 feet and above (both pilot and passenger, if applicable).

Civil Aviation Safety Authority of Australia's Civil Aviation Order 20.4 describes in detail the requirements for the use of oxygen & protective breathing equipment.

Hypoxia (Oxygen Deficiency)

Definition.

Hypoxia is a condition of oxygen deficiency in the body tissues sufficient to cause functional impairment. It is dangerous to pilots for a number of reasons, as we shall see. The early symptoms of mild hypoxia may include euphoria, confusion, impaired vision, and poor judgement. If left unchecked and allowed to continue it will lead to loss of consciousness and DEATH!

Symptoms and effects of Hypoxia

General

- Euphoria
- Target fixation
- Personality changes
- Loss of self-criticism, judgement
- Fuzziness (not dizziness)
- Amnesia
- Lethargy
- Mental confusion
- Sensitivity to heat/cold
- Cyanosis (bluing of extremities)
- Unconsciousness
- Death

Visual

- Decrease in colour perception
- Decrease in peripheral awareness
- Decrease in visual acuity (dimming)

Neuro Muscular

- Clumsiness
- Fine Tremor
- Slurring of speech
- Slow movements
- Hypoxic flap

The insidious effect of hypoxia and the time of useful consciousness.

These are two very important and sobering aspects of hypoxia that should make pilots especially wary.

1. The insidious effect of hypoxia
2. The time of useful consciousness

The time of useful consciousness is the time within which a pilot can remain capable of competently controlling an aircraft.

Time of Useful Consciousness

Altitude	Sitting	Moderate Activity
18,000 ft	20 – 30 minutes	10 – 15 minutes
21,000 ft	10 minutes	5 minutes
25,000 ft	3 minutes	2 minutes
28,000 ft	1 ½ minutes	1 minute
30,000 ft	1 ¼ minutes	45 seconds
35,000 ft	45 seconds	30 seconds
40,000 ft	30 seconds	18 seconds
43,000 ft	15 seconds	9 seconds

BEWARE THE TRAP! The table is great, if you know when to start the timing! These figures are taken from research in a controlled environment. Sitting up there in our glider, we may not know when the leak starts, or the hose kinks or disconnects!

What this table does tell us is that when a failure occurs we have little time to detect it, let alone fix it before we lose useful consciousness. We may end up laughing as our world fades away! We must therefore establish a routine that regularly checks for hypoxia.

Factors influencing the onset, intensity of, or tolerance to hypoxia

- Altitude attained
- Rate of Ascent
- Time at Altitude
- Physical Activity
- Ambient Temperature
- Illness
- Fatigue
- Drugs / Alcohol
- Smoking
- Stress / Workload
- Level of Fitness

Action In The Event Of Suspecting Hypoxia

<u>In Ourselves</u>

- go on to oxygen and select high flow (BEWARE THE OXYGEN PARADOX – see below)
- check integrity of system; connections, lines for kinks, contents, mask fitting
- extend brakes and trim glider in max rate descent
- Descend to below 10,000 feet.
- tell someone what is happening
- unless absolutely sure of why problem occurred and fixed, return and land
- caution on returning, you will have been fatigued by the incident so don't rush, and listen to advice from the ground

<u>In others</u>

Where possible, get them to do the above. This may require slow, clear instruction by radio. Remember, they are unlikely to realise they are hypoxic and will be reluctant to listen – assuming they hear you at all! If nearby, watch from a safe distance – their vision won't be too good!

The Oxygen Paradox

This is the temporary worsening of symptoms when oxygen is restored to someone previously hypoxic. It is the result a momentary reflex constricting the arteries to the brain when there is a sudden increase in the amount of oxygen in the blood. The danger is that you may go on to oxygen, look or feel worse, then suspect it isn't working and turn it back off!!

Causes of oxygen deficiency

- Not using supplemental oxygen when it is required.
- Failure to turn on O^2 supply
- Poor-fitting mask
- Mask removal
- A system failure
- "Cheating on the O_2 supply.

Hyperventilation (Over breathing)

Hyperventilation is a condition where an abnormal increase in the rate of ventilation (breathing) results in an excess loss of carbon dioxide from the body, which in turn raises the alkalinity of the blood. This change in pH causes a number of adverse effects.

Symptoms of hyperventilation

- Rapid pulse
- Feeling of unreality
- Unpleasant light-headedness, dizziness or faintness
- Tightness or Constriction of Chest
- Numbness or tingling especially around the hands, feet and mouth
- Further anxiety
- Clumsiness and Tremors
- Muscle spasms to the hands if hyperventilation is prolonged
- Fainting in severe cases
- Feeling of Shortage of Breath

Causes of hyperventilation

- Excessive anxiety, worry or fear
- Pain
- Loud noise
- Vibration
- Excessive heat
- Motion sickness
- Hypoxia
- “G” loading

After a collapse from hyperventilation breathing normally returns to normal and consciousness is regained within a minute or so. Whilst hyperventilation in itself is not dangerous and has no permanent adverse effects, it could be dangerous if a pilot who is the only one flying an aircraft succumbs to its more severe effects. Hyperventilation therefore needs to be understood and avoided, or treated early if it occurs.

Treatment of hyperventilation

- Slow down the breathing 12-16 times / min (Do Not Hold Your Breath!!)
- Take shallower breaths
- Provide reassurance
- “Re-breath” CO_2 by breathing into and out of a rolled up newspaper or paper bag for a period. Cupped hands may assist if no suitable receptacle is available.

Remember, the hyperventilation may be a symptom of hypoxia, but this is unlikely at lower altitudes. If there is any doubt at all whether a pilot is hyperventilating or is hypoxic, then they should be treated as for hypoxia (administer O_2 or descend to below 10,000 ft AMSL). Whereas a person who is hyperventilating will not be harmed if they are given 100% oxygen to breathe, telling a person who is hypoxic just to slow their breathing could be fatal to them!

PRESSURE CHANGES

Ascent (decreasing atmospheric pressure)

Trapped gases and Barotrauma.

Whenever there is a drop in air pressure outside of a closed cavity with flexible walls, any gas trapped in the enclosed cavity will tend to expand as the pressure differential across the wall takes effect. According to Boyle’s Law, at a constant Temperature if you halve the pressure of a gas, the volume will double. This influences what happens to trapped gasses in our bodies when we gain altitude.

There are several areas in the human body where gases are present and can be trapped when a person ascends. The main ones are:

- the stomach
- the intestines
- the middle ear
- the sinuses
- the teeth

The stomach

The stomach and intestines seldom poses any problem on ascent as there is usually ample room for the gases to expand. A little discomfort may sometimes be felt, however.

The middle ear

Gases trapped in the middle ear behind the eardrum can usually escape through the Eustachian tubes, provided they are open. Normal rates of climb causes few problems provided the Eustachian tubes are open.

The sinuses

Gases trapped in the sinuses can cause pain on ascent if they are constricted, as there little room in them for expansion. Normal rates of climb present few problems.

The teeth

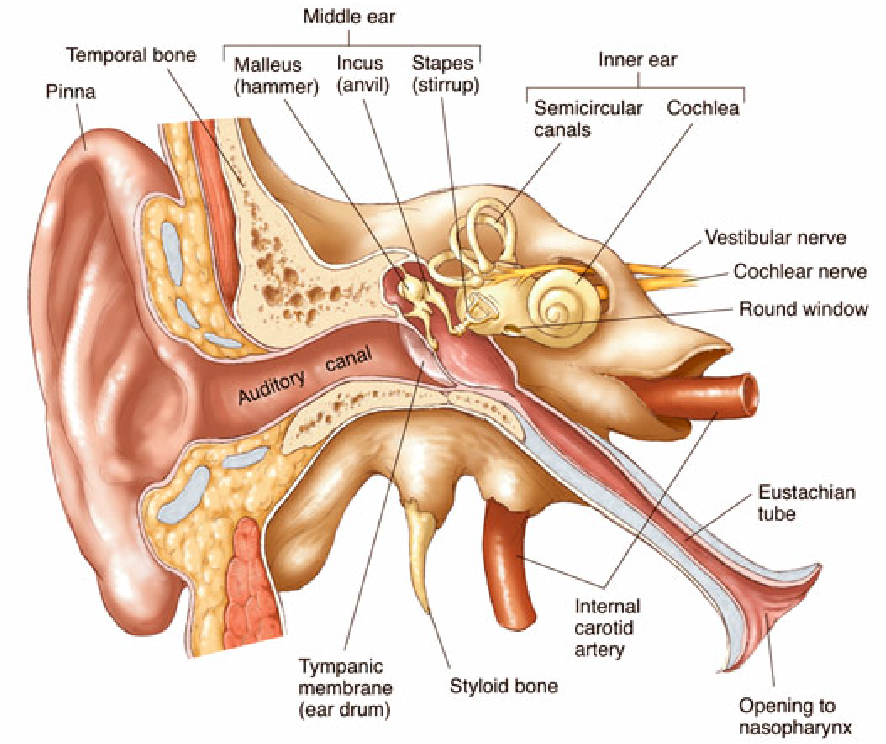
Gas trapped under a filling or in deceased pulp can expand and cause pain when pressure is reduced. Fillings have been known to dislodge!

Treatment:

- Pain is normally relieved on landing
- Take pain relief
- Visit your dentist

Descent (increasing atmospheric pressure)

On descent any trapped gases will contract, tending to create a vacuum unless the pressure differential can be equalised.



The middle ear

Ear pain on descent can be a common and severe problem if the Eustachian tubes are blocked. The Eustachian tubes may be unblocked by swallowing, moving the jaw, or by using the valsalva manoeuvre[2].

[2] A “valsalva” is performed by pinching the nose, tilting the head back slightly and momentarily pressurising the throat by forcing air up from the lungs, causing the ears to “pop”.

Severe problems which may result are pain, damaged eardrum, loss of hearing, or infection of the inner ear[3].

The sinuses

Sinus pain on descent is not easily relieved, but fortunately is not common unless the sinuses are constricted due to inflammation or infection. Any resulting pain can extend from the cheek to above the eyes.

Flying with a cold is not recommended because it may prevent you clearing your ears or sinuses[4].

Nitrogen and "the bends"[5]

About 80% of the earth's atmosphere is nitrogen. It is not required for respiration, but may be found in solution in the body organs and bloodstream. Dissolved gases such as nitrogen do not pose a significant problem for pilots below about 10,000 feet, but in prolonged flight above 18,000 ft problems could well occur, with the likelihood of problems becoming quite strong above 25,000 ft. Under these conditions a pilot may suffer "the bends" just as underwater divers may if they ascend too quickly in the water having been at depth for lengthy periods. Pilots, however, are not as susceptible as divers as the relative pressure changes they are subjected to are much less. A diver ascending to the surface from a depth of 30 metres undergoes a pressure change of 3 atmospheres, whereas a pilot ascending to 18,000 ft would experience a pressure change of less than ½ an atmosphere!

Pilots flying too soon after scuba diving are especially susceptible to the bends, and could expect symptoms of greater severity and at much lower levels than had they not recently been diving. A good "rule of thumb" is to allow at least 24hours between the last dive and flying. A delay of 48 hours would be wise if the dive depth has exceeded 35 meters (120 ft) or if the flight is to be above 8000 ft AMSL.

The problem is that with the decreased air pressure at altitude the nitrogen in the body organs and bloodstream comes out of solution and forms gas bubbles. These bubbles are then free to move about the bloodstream and become lodged in the joints, the brain, spinal cord, and under the skin causing a variety of symptoms. A severe attack of "the bends" can cause serious and permanent problems.

Symptoms of "the bends"

- Joint pains
- Itchiness
- Numbness
- Tingling
- Paralysis of parts of the body
- Poor co-ordination and movement
- Mental confusion

Visual disorders

- Inner ear problems
- Shortness of breath
- Tight or painful chest
- Painful coughing
- Unconsciousness in severe cases

Treatment of "the bends"

Urgent compression in a dive chamber is imperative. Anyone with the bends being transported by air to a dive chamber must NOT be flown at a cabin altitude above 500 ft AMSL as this would seriously aggravate their condition.

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[3] See "Colds and flu".
[4] See "Colds and flu".
[5] Sometimes known as "decompression sickness" or "dysbarism".

BALANCE AND ORIENTATION

Definition of orientation and introduction

"Orientation", sometimes called "spatial orientation", is basically the ability to know which way is up, or where we are positioned in relation to the sky, the ground, or the surface of the water we may be in.

For human beings on the ground it is very much a part of everyday life – a largely automatic process which we take for granted. Not much thought is required, for example, to detect whether at any given moment we are standing up or lying down; whether we are at rest or moving, accelerating or turning. The human body has developed the visual system in conjunction with other movement sensors in the body to enable us to orientate ourselves when necessary. Vision plays a large part in this process. At least 80% of the orientation information received by the brain comes from the visual system.

In our normal earthbound environment we have our feet on the ground or on some other object. We are under a vertical gravitational force of 1"g", and are not moving very fast. We can easily confirm our position visually by reference to the earth's horizon, or if that is not visible, by buildings or houses which, our experience tells us, are normally built with their walls vertical.

In the flying environment, however, things can go wildly awry. We may lose our visual reference, or may have to cope with a wide range of speeds and accelerations ("g" forces) ranging from negative values to up to +5g for glider pilots. The structural design of many gliders will not allow you to exceed about 3g or 4g in any case.

The balance and orientation mechanisms of the body

The balance and orientation systems of the human body consist of:

- The visual system
- The "balance" organs
- The pressure/stretch/position nerve system

The visual system

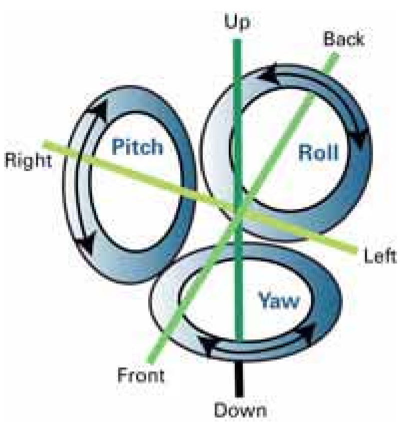
The importance of vision in orientation has already been noted and stressed (80% of the brain's orientation information). It remains just as important in the aviation environment as it does on the ground. We as pilots learn from the very beginning of our flight instruction to fly an aircraft by attitude, visually comparing its position with the earth's horizon. We learn turns, speed ranges, straight and level flight, stalls, and even aerobatics using the same visual reference. A pilot hoping to fly without this visual reference must rely on artificial aids such as flight instruments, and must undergo special training to accomplish this safely.

The balance organs

There are two main "balance" organs in the human body, both contained in each inner ear in area about the size of a pea. They are the semicircular canals, and the otolith organs and together are known as the vestibular system

The Semicircular Canals

There are three semi-circular canals in each ear, and in functional terms they operate as three matched pairs, in each of the three primary axes of motion. The canals in each ear are all at right angles to each other, and function as angular accelerometers. Significantly, they have a stimulation threshold of $2^{o}/sec^{2}$, below which they are not able to detect angular motion. This is of crucial significance in the aviation setting – if a turn is made (intentionally or otherwise) at a rate of angular acceleration less than this threshold, the canals will not register the turn. In the absence of visual cues that a turn is happening, and with the force of gravity still in the head-to-foot direction and as such giving unchanged proprioceptive information, the pilot will not realise that a turn is underway and will feel straight and level.

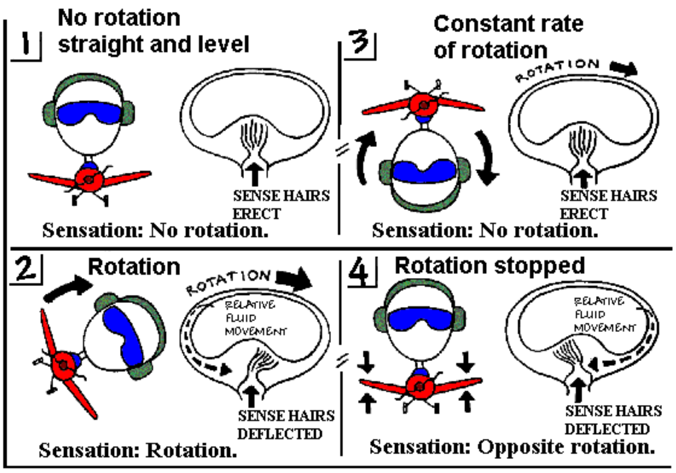


The Leans

The leans is manifested by a false sensation of roll. It is extremely common, and is so named because it may cause pilots to lean to one side in order to cancel out the false sensation. The leans can occur in conditions of good visual cues.

The typical situation in which the leans may occur involves a pilot flying an aircraft, trimmed for straight and level flight. For whatever reason (wind gust, etc.) one wing may drop and the aircraft may then enter a gentle turn. This turn is at a rate of angular acceleration less than the threshold for activation of the semicircular canals. The result of this is that the pilot (who is generally head-down in the cockpit, studying a map for example) believes that they are still straight and level, while the aircraft is in a turn. As soon as the pilot looks up and out of the aircraft or at the instruments, the inadvertent turn is recognised and immediate recovery actions taken to restore actual straight and level flight. However, the crucial element here is that return to straight and level flight is generally made at a rate of angular acceleration greater than the threshold for activation of the semi-circular canals. As such the first input the canals receive is when the aircraft returns to straight and level flight. However, the canals now register an apparent change from straight and level flight to a turn in the opposite direction.

Hence, if the initial inadvertent turn was to the left, the pilot now sits in a straight and level aircraft with the canals now signalling an apparent turn to the right. In order to effectively make their head fell straight and level, the pilot leans in the direction of the initial turn (in this case, to the left). This may feel bizarre, with the pilot seeing the aircraft straight and level, and at the same time feeling straight and level but being aware of themself leaning to one side. Fortunately, if this is maintained the erroneous sensation of roll will wear off and leaning to one side is no longer required. Clearly, though, there is potential for disorientation and confusion to develop, and in a worst case scenario the pilot may become incapacitated by the unusual sensations and lose control of the aircraft.



<u>The somatogyral illusion</u>

The somatogyral illusion is also known as the graveyard spin or spiral. It is again a function of how the vestibular system works. During the entry into a spiral turn or a spin (deliberately or inadvertently), the vestibular system (in particular the semicircular canals) will register the initial angular acceleration. This of course assumes that the entry into the turn is above the threshold for activation of the semi-circular canals.

Once the spiral turn or spin is stabilized, the angular acceleration will tend towards zero, with a constant velocity turn (i.e. no acceleration). In this situation the semicircular canals will not be stimulated, as they only register a change in angular velocity. The canals will effectively then signal that there is no turn happening. The visual system, however, being the dominant orientation mechanism, will over-ride the vestibular system signals and confirm the ongoing turn, due to the outside visual world rotating as the turn continues.

However, if there are poor visual cues, the pilot may experience a sensation that they are no longer turning. When the spiral turn or spin is halted, and a return to straight and level flight affected, the semi-circular canals may register the change in angular velocity associated with the cessation of turning. This can then create an illusion within the pilot that they are now turning in the opposite direction to the original turn. This strong sense of false rotation may lead, in the absence of good visual cues, to a re-entry into the original turn or spin. This may cancel out the false sense of rotation, with the pilot now believing that they are straight and level, but in fact they have re-entered the original turn or spin, and be losing altitude as a result.

Unless this dangerous situation is recognised and appropriate recovery steps taken, impact with the ground will inevitably result.

The link between the visual and vestibular is very obvious during the somatogyral illusion. Upon recovery from the spin or prolonged spiral turn, the semi-circular canals signal the false sense of rotation in the opposite direction. This vestibular input then can result in a series of involuntary oscillatory eye movements known as nystagmus. This can then lead to the oculogyral illusion, where the visual field appears to move, and in so doing tends to reinforce the false sense of rotation. In effect, the pilot then gets apparently confirmatory visual evidence of rotation, which can lead the pilot to re-enter the original turn. This combined effect makes this illusion extremely dangerous.

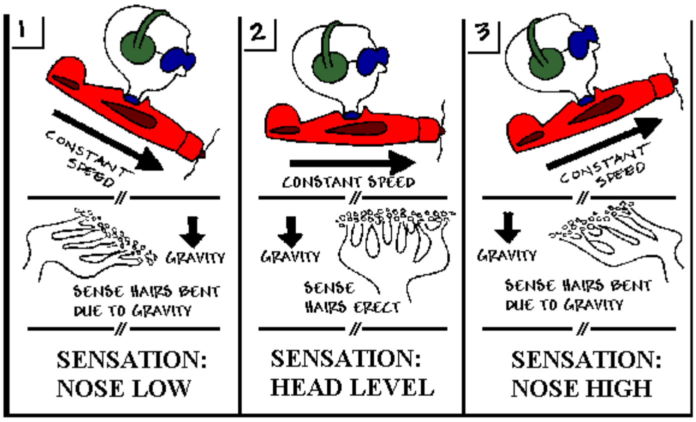
Vestibular stimulation generally results in visual changes, such as nystagmus. The visual effects of vestibular stimulation reflect the very close connection between the two systems, which are critically important for normal orientation.

Once the sense of nystagmus has worn off, clear visual information may then be available to the pilot. Looking at the instruments may reveal that the original turn has been re-entered. The pilot may then recover, but in so doing may then get the false sense of rotation again, and succumb to the illusion once more by inadvertently re-entering the original turn. Nystagmus may then reappear, and only when it resolves will the pilot see what is happening and then recover. However, it can be seen that this cycle of turn, recover, turn and recover can continue right up to ground impact, with the pilot experiencing multiple episodes of the illusion. The pilot can of course become completely disoriented and confused and lose all control of the aircraft. Tightening of the turn can also exacerbate the sense of false rotation.

This is a particularly dangerous illusion, and has claimed many lives.

The Otolith Organs

There are two otolith organs in each ear, one in the vertical plane and the other in the horizontal plane. These organs operate as linear accelerometers, and under normal conditions the vertical otolith signals the effect of the Earth's gravitational field. The Otolith organs are located near the semicircular canals in each ear. They each consist of a tiny jelly-like crystals perched on "stilts" of a group of vertical hairs. They sense both head or body tilt and longitudinal acceleration.



The otoliths can give erroneous information. In particular they can misinterpret a forwards acceleration as a steep climb, with disastrous consequences if a pilot attempts to correct a steep climb that is not there near the ground. The diagram opposite shows the effects of head position on the otolith organs.

The pressure/stretch/position nerve system

This system is a network of nerve receptors distributed around the body which, as the name suggests, detect pressure on the body, muscle stretch, and limb position. Clear examples are pressure on the soles of the feet when standing, pressure on the buttocks when sitting. If you lie down with an arm underneath your body, your brain knows exactly where your arms is in relation to your body even with your eyes closed because of this system.

Like the balance organs, care should be taken not to rely on these systems alone, as they can mislead. For instance, "seat of the pants" pressure centres of the body cannot distinguish between a +3g loop or a +3g steep turn.

Eye / Balance Interaction

There is a strong reflex connection between the eyes and the balance organs called the oculogyral reflex. It enables accurate visual tracking of objects even when the body and head are moving about quite rapidly or erratically.

The oculogyral reflex can be seen in action in this simple demonstration.

1 Hold your thumb up vertically at arm's length and focus on the thumbnail. Move the thumb around erratically and try to keep the eyes focussed on the nail. (Very difficult!)
2 Next, hold the thumb still but move the head around erratically while trying to keep the eyes focussed on the thumb nail.

Disorientation

A person on the ground will not often become disorientated, as all three balance and orientation mechanisms are generally working together to confirm the information that each is passing to the brain. In the flying environment, however, there is a high potential for confusing and conflicting input of information to the brain. A pilot is said to be disorientated if he or she cannot ascertain their actual orientation in space. A good example for our purposes is loss of good visual horizon reference on which most of us heavily rely. If we lose that important orientation tool for long, and attempt to rely on other senses (the "seat of the pants" or "the feel of things") without proper training in the use of flight instruments the results can be catastrophic.

Stay in VMC (Visual meteorological conditions) - 60 seconds is all you will usually have before loss of control without a visible horizon!

There are two main types of disorientation:

(i) Those where the pilot is aware something is wrong; and
(ii) Those where the pilot is not aware that anything is wrong.

Sooner or later most pilots will experience one of these forms of disorientation. An understanding of the causes of disorientation, some avoidance techniques, and some cures is therefore essential.

Flicker vertigo

A form of disorientation can be caused by flicker vertigo, which may occur when bright light source in the pilot's field of vision is being interrupted rapidly and intermittently by some object such as a propeller or rotor blades. Many motorists will have encountered the phenomenon whilst driving along a road where the sun is shining through a row of trees into your field if vision. The flickering effect can be quite distracting and, if prolonged, can cause a person to become dizzy and unwell. In extreme cases it could lead to convulsions or a "fit". Pilots encountering the phenomenon should avert their gaze, use a sun shade, or reposition the aircraft to avoid the effect.

Motion sickness

Motion sickness is more common among passengers and trainee pilots than among experienced aviators. It is caused by prolonged unaccustomed motion of the body which upsets the orientation system. It may begin with a feeling of general unwellness, leading to dizziness, nausea, paleness, and cold sweats. Vomiting may often follow, and if the feeling persists the person may become quite ill.

Motion sickness can be aggravated by anxiety and low cockpit activity levels. It can be alleviated by gaining further air experience as early as possible, thus reducing anxiety and building self-confidence. Keeping fit, resting well, eating sensibly before flight, and avoiding alcohol may help considerably. Pilots should relax while flying, and unless flying IMC through necessity, should keep the horizon in sight whenever possible. Passengers should be given warning of any manoeuvres, and unnecessary manoeuvres should be avoided.

Instructors and passenger-rated glider pilots should always bear in mind that the student or passenger should be put at their ease as far as possible by the creation of a relaxed and friendly atmosphere. This will do a lot to reduce the chances of motion sickness occurring. Students should be given as much of the flying as possible, but given short time-out periods to relax if their workload is high or they cease to relax. Students should be relaxed, reassured, and encouraged as far as possible. No passengers or students should be introduced to aerobatics too soon, or for too long. Instructors and passenger-rated glider pilots should be able to fly smoothly to minimise the chances of motion sickness becoming a problem.

TEMPERATURE AND CLIMATIC CONSIDERATIONS

Heatstroke or heat stress

Exposure to high environmental temperatures is clearly the main cause of overheating or heat stress. The exposure may be coupled with and be exacerbated by the breathing of dry air or oxygen. It may also be exacerbated by wind, exertion, dehydration, or fatigue. The prevention of heat stress, and its related condition, dehydration (see next), is particularly important for glider pilots, particularly on long flights because of the physical design of cockpits, and the limited capacity for carrying on-board food and drink. Glider flights often demand high levels of concentration, and take place in weather where temperatures are generally high.

Heatstroke occurs when the body's internal temperature control system gets overloaded. The body will respond to high temperatures by firstly pumping extra blood to the skin, and then by using sweat glands to produce sweat which cools the body by evaporation of moisture on the skin. In extreme conditions of high humidity and high temperatures the body may have trouble dissipating enough heat by these normal methods, and body temperatures can then quickly rise to dangerous levels.

Mild attacks of heatstroke can result in nothing more than a heat rash, muscle cramps, or headache. But if an attack is more severe, or if a mild attack is allowed to deteriorate into a severe condition, confusion, disorientation, or hallucinations may result, as may collapse and even death. If the body is dehydrated then it may stop sweating altogether. If this occurs you have a real medical emergency that requires immediate medical attention.

Precautions against heatstroke

Susceptibility to heatstroke may depend on your underlying physical condition, how dehydrated you have become, and whether you have had time to acclimatize to the sudden increase in temperature. Certain precautions can be taken to guard against the unexpected onslaught of heat stress, such as:

- Drink plenty of fluids, avoiding diuretics such as alcohol and caffeinated beverages.
- Always wear a hat when exposed to the sun (essential for glider pilots)_
- Wear loose fitting clothing which allows air to circulate around the body.
- Wear clothing which shields the skin from direct exposure to the sun.
- Keep the body cool as far as possible by proper ventilation or shading.

Symptoms of Heat Stress

The symptoms of heat stress may be severe, and may include:

- Heat rash
- Muscle Cramps
- Headache
- Nausea (and vomiting)
- Dryness of mouth, nose and eyes
- General dehydration
- Poor concentration
- Drowsiness
- Weakness
- Lethargy
- Slurred speech
- Confusion
- Disorientation
- Hallucinations
- Total collapse (or, in extreme cases death)

Any of these symptoms may be so bad as to preclude a pilot from maintaining proper control of an aircraft.

Summary of measures to prevent heatstroke or heat stress.

- Ensure the body is fit, and properly watered and hydrated.
- Wear a sun hat.
- Attempt to control the environment with good ventilation and sensible clothing.

Dehydration

Dehydration is related to heat stress, and may have many of the same symptoms in severe cases. It results from a severe imbalance of water content of the human system which can severely impair human performance. Causes are the same as for heat stress, with the added factor of perspiration of a glider pilot in a hot cockpit environment.

Prevention and treatment of dehydration.

The development of severe symptoms of dehydration of a pilot in flight can have catastrophic consequences. Prevention should therefore be the aim.

Dehydration is best prevented by the frequent intake of suitable cool fluids; you need at least 250mls/hour to cover fluid lost through respiration alone! 500-600mls/hour is recommended for particularly hot days. Glider pilots on long flights in hot temperatures (two hours or more) should always carry at least 2 litres of water on board to cope with any eventuality. A pilot might expect to consume anywhere from 300-500 mls/hour to replace fluid lost through perspiration and to keep the body properly hydrated. The importance of adequate fluid intake for glider pilots cannot be too highly stressed. Even the most experienced pilots can tell stories of suffering from heat stroke or dehydration, and the effect this can have on their ability to properly fly an aircraft.

Any headache may be meliorated by the taking of an analgesic.

Overcooling

Overcooling may be just as much a problem for pilots as overheating. The direct cause is low environmental temperatures. Contributing factors include:

- Insufficient Correct Clothing
- Not Protecting all the Body (The greatest heat loss occurs through the head)
- Hypoxia
- Fatigue
- Food- Not enough or the wrong sort
- Anxiety
- Injury
- Recent Illness, Especially Flu
- Wind
- Wet Clothing
- Chills due to perspiration at recent higher temperatures.

Symptoms of Cold Stress

- Uncontrolled shivering
- Signs of tiredness
- Clumsiness – poor co-ordination
- Irrational behaviour
- Lack of interest,
- Lethargy
- Slurring of speech
- Visual problems

HEARING

Little need be said about hearing in this course as it relates to gliding. There are a number of issues which confront power pilots that are not applicable to gliding.

Suffice it to say that good hearing is essential to safe flight operations if there are passengers, or if a radio is being used in the aircraft. In gliding good hearing is also extremely useful in listening to airflow noise and to any airframe aberrations that may develop. Any pilot should take care of his hearing by avoiding exposure to damaging noise at any time, and avoiding infections of the ear as far as possible.

MENTAL AND PSYCHOLOGICAL FACTORS

The psychological and mental “profile” of the ideal pilot.

It is difficult to define what makes a good pilot. It is far easier to list some characteristics of what makes a bad pilot. Modern aviation psychology as applied by air forces in the psychological “screening” and personality testing is able to throw some light on this process, and give some basic “rules of thumb” which are as applicable to voluntary sports aviation clubs as they are to the military. It is important for a safety perspective for club officials and all responsible members of these organisations to have a basic understanding of the role that pilot personality can have in safe aviation practices.

People who are erratic or reckless in their personal behaviour generally do not make good pilots. “Bad” pilots may be over confident, “show-offs”, slapdash, impulsive, careless, complacent, dogmatic, timid, arrogant, inaccurate, poor communicators, unable to think ahead, lack awareness and judgment, be reckless or foolish, or be rough on aircraft and equipment. All of the “good” pilots in this club should be alert for the “bad” pilots who will usually require close watching or special attention if they are to develop into “good” pilots and continue flying!

“Good” pilots, on the other hand, display good airmanship at all times. Airmanship may be defined as the display of good common sense, good aviation practices, and high standards in the air. They not only have good flying skills, but other personality attributes which, if not innate, can be learned or developed. They will be confident, consistent, safe, calm, dependable, knowledgeable, and flexible with good decision-making skills. They learn by experience and the experience of others, and they know their own limits and never exceed them. They always set a good example, and are willing to assist others in achieving their own high standards. They generally do not have incidents or accidents that are a result of bad actions or faulty decisions by the pilot. They stay out of trouble.

Psychological Impairment

Psychological factors such as attitudes to safety, pilot personality, human learning mechanisms, mental capacity and workload, may all play a part in the equation, either as the result of innate problems, or of the physical or physiological nature of the aviation environment.

Mental Capacity Generally

When a pilot is first learning to fly (or drive a car) the mental workload and flow of information to the brain is high. The brain will be working to near full capacity, and therefore any residual capacity for making decisions or handling any new tasks or problems (including emergencies!) is low.

As a pilot becomes more experienced (and many tasks become more automated) residual mental capacity is increased, allowing more accurate flying and improved situational awareness. More prompt and better decisions, even in times of complex tasks or activity will be possible.

Impairments to Proper Mental Performance

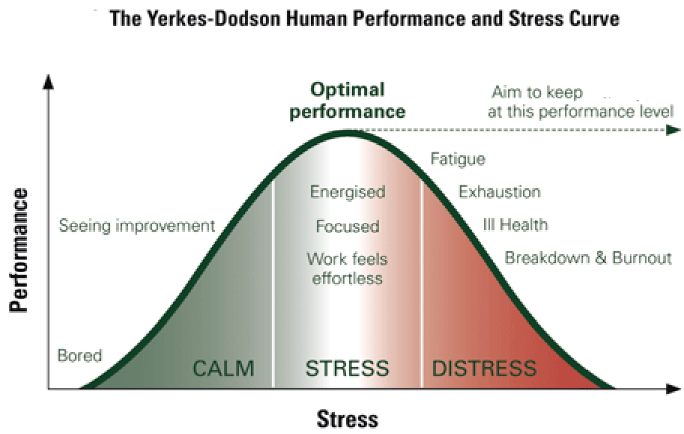
Overload of activity or information.

The human brain can easily become overloaded with too much activity or information. Performance suffers as normal functioning breaks down and load shedding automatically occurs. In this state some information or tasks may be neglected, and accidents may follow. Interestingly, if mental activity (arousal) is too low, a decrease in pilot performance may also result.

Stress

Stress has been defined as “The non-specific response of a human to any demands for change”. Another definition might be “an excess of environmental demands over an individual’s capacity to meet them.” The demands can be real or imagined – the effect on the human body is the same. Too much stress leads to a “general adaptation syndrome”, and then to eventual collapse. Some stress is perfectly normal, and is in fact essential to human survival. Our bodies are built for stress and strain. Even getting out of bed puts some demand on the body! Stress is therefore a normal part of living, working, relating and succeeding. Only the comatose and the dead do not experience stress from time to time in their daily lives.

How Much Stress is Normal?



Obviously we like to vary our diet of stimulation and like some times of excitement and some times of relaxation. While a good balance is maintained, few people have problems with stress. However, many people do not keep or achieve a good balance between effort and recreation. It is obvious that those involved with gliding should be able to recognise the signs and symptoms of stress that take us beyond our comfort zone and degrade our performance and jeopardise our safety and efficiency. By learning to recognise the signs we can develop means of managing stress and minimising possible negative consequences.

Stressors

Factors which cause stress are caused stressors. The capacity of individuals to meet the demands of stress will vary considerably, and what stresses one person in a given situation will not necessarily stress another. However the individual handles a particular stressor, there will be some physical, mental and emotional reaction. Too much stress or arousal is not good for a pilot, but neither is too little. There is an optimum amount of stress for best human performance, and a level above and below this amount will decrease performance (refer "performance and stress (arousal) curve" above). A pilot may be subjected to two main types of stressors, direct and indirect.

(i) Direct stressors

As the name suggests, direct stressors are those resulting from the immediate task of flying an aircraft. Direct stressors (flying-related) may arise from such things as glare, turbulence, weather, time delays, unexpected mechanical, air traffic control, or navigation problems, temperature extremes, dehydration, hypoxia, visual illusions, disorientation, fatigue, lack of fitness to fly, or ergonomic factors.

(ii) Indirect Stressors

Indirect stressors may relate to the pilot's normal domestic environment such as personal, family or relationship problems, financial concerns problems, or job satisfaction concerns. This type of stressor is cumulative, that is they all "add up" to contribute to the total stress at any given time.

As long as a pilot's abilities are greater than the demands placed upon him or her, stress should not become a problem. If the demand exceed abilities, then a stage is reached where the chances of an accident become quite high. It is important therefore that pilots should not attempt anything which is beyond their capabilities.

Signs and symptoms of stress.

When subjected to stressors we are put in a stressed state which invokes a variety of possible responses.

A person may make mistakes, become short-tempered, forget important tasks, start smoking or smoking more, drink alcohol excessively, display noisy or uncharacteristic behaviour, have frequent conflicts with other people, develop marital or relationship problems, fly dangerously or unsafely, or become involved with the law.

More direct symptoms while flying may include nervousness or shaking, anxiety, sweating (esp. forehead or palms of the hands), and over breathing (hyperventilation). If the stress becomes very acute or severe, the pilot may attempt to compensate, acting out certain non-typical behaviours, for example "tough guy" or "macho" displays in order to hide the stress within. Some sort of "break down" may result.

Prolonged acute stress can have long term physical manifestations such as peptic ulcers, high blood pressure, heart disease, ulcerative colitis and asthma.

Coping with stress.

The best ways to reduce stress and its additive effects are to–

- Keep physically fit and healthy
- Eat well
- Rest well
- Relax well
- Sleep well
- Know your capabilities and keep within them
- Think and plan ahead
- Get organised
- Prioritise
- Delegate and load shed
- Seek assistance where necessary
- Avoid procrastinating
- Understand how stress affects YOU, and do something about it!

Fatigue

A definition of fatigue is the accumulation of stress, usually of unresolved stress building up over a period. Fatigue is usually quite debilitating, and significantly fatigued pilot will be unable to fly safely.

The main causes of fatigue are lack of good quality sleep, prolonged excessive workload, or too long without adequate rest. Fatigue, like stress, can be exacerbated by the effects of any minor illness, drugs or alcohol. It is chronic stress from heat, cold, hypoxia, dehydration, hunger, sleep disturbances, new operating environment and weather conditions that are the most common causes of fatigue for glider pilots.

Signs and symptoms of fatigue.

The symptoms of fatigue are similar to those of excessive stress.

- reduced visual field
- drowsiness
- we suffer channelised attention
- we are easily distracted or can be pre-occupied • our judgment erodes
- we become careless and take unnecessary risks
- we lose our sense of timing
- our coordination deteriorates
- we become forgetful
- our reaction times increase
- we may accept lower standards
- we are susceptible to illusions
- we become irritable

The effects can be quite insidious and difficult to recognise in ourselves until well advanced. Pilots seem to pride themselves on being able to 'hack it'.

Treatment for fatigue.

Fatigue cannot be overcome quickly. It can really only be relieved by resolving the underlying workload or stress problems, and by allowing adequate rest and sleep. An understanding of stress and stress management techniques will also help. These include such elementary steps as better organisation, better management of time and workload, good prioritisation, improved physical fitness and better quality sleep.

“G” FORCES

General

The human cardio-vascular (blood circulation) system is designed to function optimally at a normal “g” force of 1. It is a complex pressure system which is particularly susceptible to the application of extra (positive “g”) or less (negative “g”) forces than this “norm”.

When an aircraft is flying under positive "g" loading (e.g. when flying a 'loop') the blood in the pilot's head is forced downwards towards the stomach and legs. The blood supply to the brain is reduced and therefore the oxygen supply to the brain will be diminished.

Up to about 2½g the body can adjust to this effect by means of a reflex known as the "physiologic compensation", although this compensation takes several seconds to occur.

Application of further "g" however, results in so much blood being drained from the brain that the pilot will progressively suffer the following–

- loss of colour ("grey out")
- loss of peripheral vision (tunnel vision)
- blurring of vision (loss of visual sharpness)
- Total loss of vision ("black out")
- G-induced loss of consciousness or G-LOC

Negative "g"

The limits of human tolerance to negative "g" are less than for positive "g". Under sustained negative "g" a pilot may suffer blood congestion problems with blood having difficulty flowing back to the heart. Oxygen availability to the eyes and brain becomes just as compromised as if there was insufficient blood pressure. The "red-out" described by pilots under negative "g" is probably congested blood collecting in and around the eyelids. Sustained negative "g" is difficult to achieve in a glider, so a glider pilot is not often confronted with great problems with negative "g". Gliders themselves, as other aircraft, are stressed for much less negative "g" (about half) than positive "g". Pilots must at all times observe the operating limits of the aircraft they are flying.

Palliative measures

Anti-G straining manoeuvre.

The pilot's ability to maintain consciousness is related to maintaining blood pressure to the brain. A properly trained pilot may utilise a technique called the anti-G straining manoeuvre, which involves the simultaneous isometric straining of the muscles of the upper and lower legs, stomach, upper chest, neck and shoulder muscles, while still breathing! Clearly this technique requires special training, and must be done correctly for good effect. The maximum "g" tolerance that an experienced pilot can sustain without an anti-G suit is between 5 and 6g. This will be more than most gliders can tolerate in any event!

Anti-G suits.

An anti-G suit is usually a pair of trousers with automatic G-controlled inflatable bladders built into them to exert pressure against the legs and abdomen. These areas of the body are squeezed during the application of "g" forces, thus reducing the pooling of blood in this area of the body by a kind of tourniquet effect. A pilot experienced in the use of an anti-G suit may increase his tolerance of "g" force to about 9g.

Factors affecting "g" tolerance

Factors ENHANCING "g" tolerance.

- Recent frequent exposure (practice)
- Weight training
- Body position
- Anti-G straining
- Anti-G suits
- Being short
- Being female

Factors REDUCING "g" tolerance.

- Lack of recent exposure
- Fatigue
- Illness (dehydration, hangover, drugs, hypoxia)
- Heat stress
- Hyperventilation

- Low blood pressure
- Being male
- Being tall

ADVERSE MEDICAL FACTORS

Drugs and alcohol

Illicit drugs

Needless to say, the piloting of an aircraft while under the influence of any illicit perception, mood, or performance altering drugs such as opiates, LSD, cannabis or amphetamines is absolutely prohibited for all pilots.

Alcohol

The effects of alcohol on a pilot's performance should never be under-estimated, and it can last for many hours after the last glass has been consumed. While the consequences of excessive alcohol intake on performance are well known, most people are less aware that their performance can be impaired long after their blood alcohol concentration returns to zero. For that matter, even low or moderate amounts of alcohol the night before can seriously jeopardise the safety of a flight the following morning. Even though your blood alcohol concentration may have returned to zero you may still suffer from less-publicised after-effects, of alcohol use such as fatigue, nausea and headache.

Effects of alcohol

- Poor performance generally
- Disorientation
- Dehydration
- Increased susceptibility to "g" forces
- Increased susceptibility to hypoxia
- Increased susceptibility to decompression sickness (the bends)
- Interference with temperature regulation of the body

General effect on performance.

The immediate effects of alcohol on performance, particularly orientation perception and judgment, are well-known, but are worth examining again briefly here.

Orientation in flight depends on three basic mechanisms–

- Sight
- balance (vestibular system)
- 'seat of the pants' feel

Even small amounts of alcohol can significantly impair all of these systems. The impairment of the vestibular system by alcohol will he well known to anyone who has had a big night on the town and woken the next morning to find that even the slightest head movement results in dizziness and the room going into a high velocity spin. This is caused by alcohol entering the semicircular canals, which are responsible for sensing angular movements of the head. The alcohol dilutes the fluid in the canals, reducing its density by a considerable degree, meaning that with any given head movement the fluid will travel further and faster, resulting in exaggerated signals of head movement being sent to the brain. This phenomenon is extremely disorientating on the ground, but it is much worse in the three-dimensional environment of flight.

The Coriolis phenomenon is a severe tumbling sensation brought on by moving the head out of the plane of rotation, simultaneously stimulating one set of semicircular canals and deactivating another set. Even modest amounts of alcohol can induce this effect with even the slightest head movement while flying, causing significant tumbling feelings and disorientation. This is particularly dangerous in IFR flight, which is made significantly more difficult by this phenomenon. The effect of alcohol on the vestibular system can persist for up to several days after blood alcohol levels have returned to zero.

Nystagmus affects the visual system and is described as a series of involuntary oscillatory eye movements generated by stimulation of the semi–circular canals. Nystagmus can be caused by spin recoveries, and its symptoms are amplified, in severity and duration, if there is alcohol in the system.

Pilots suffering from nystagmus find it extremely difficult to focus on either the outside world or the instrument panel. The disorientating potential of such a situation is quite marked, and it can lead to complete loss of control of an aircraft. Nystagmus can be demonstrated up to 11 hours following the intake of a single dose of alcohol.

The Hangover

Hangover includes symptoms such as headache, gastrointestinal disturbance, impaired mental ability, and fatigue. It can seriously degrade a pilot's performance, even if the blood alcohol level is zero. This is well illustrated by a study in which pilots flew a simulator profile 14 hours after achieving a blood alcohol level of 0.01 per cent. Their procedural error rate was 68 percent.

The general feelings of ill-health during the hangover period also have a negative effect on the performance of the pilot. For example, the headache is at best a distraction, but it can be severe enough to effectively incapacitate the pilot and limit his or her ability to control the aircraft safely.

The hangover syndrome can last 24 to 48 hours (depending on the amount of alcohol consumed in the intervening period).

Alcohol-related fatigue

Alcohol is a widely used and readily available aid to sleep. The problem with alcohol is that it interferes with normal sleep patterns. This results in poor quality sleep, even though the total hours of sleep may be in the normal range. The reason for this is that alcohol promotes early deep sleep and suppresses early REM (rapid eye movement) sleep, the phase in which dreaming occurs. This can occur with quite small doses of alcohol, that is, with blood alcohol concentrations as low as 0.025 percent. Larger doses may suppress REM sleep altogether. The change in sleep patterns or the deprivation of REM sleep causes subjective feelings of tiredness and impaired concentration the next day

The news is not all bad however. Because the body will metabolise alcohol at the average rate of one standard drink per hour, alcohol can be safely consumed with an evening meal for example, providing enough time is allowed for your blood alcohol concentration to drop. The best target is to have a blood alcohol concentration of 0.0 percent before lights out! This point is worth emphasising – a nightcap just before retiring to bed may make you feel more fatigued and less alert the next morning. Alcohol also has a number of other effects on sleep. It causes early morning waking, and the diuretic effect may also promote a number of awakenings during the night as the requirement to empty one's bladder at frequent intervals becomes paramount. Alcohol will also accentuate the effects of jet lag. A few drinks after a flight across several time zones will certainly not help recovery from jet lag, and it may in fact make the situation worse by degrading the quality of any sleep that the pilot manages to get.

The dehydrating effects of alcohol

Alcohol in our system dehydrates us, and causes the excretion of electrolytes, minerals and salts.

Effect of Alcohol on tolerance to "g" forces.

Of importance to acrobatic pilots is the fact that alcohol reduces tolerance to g. Some studies have shown that even a moderate level of alcohol will reduce the "g" tolerance of the pilot by approximately 0.5 g. Alcohol relaxes smooth muscle and allows the veins and arteries to dilate. When "g" is applied, a greater percentage of the pilot's blood volume is driven to the lower body – away from the head. This effect is made worse by the dehydrating effect of alcohol, which reduces blood volume. Less overall blood volume and a greater percentage of blood heading into the legs will reduce tolerance to positive "g" and increase the risk of G-LOC (G-induced loss of consciousness). Increased levels of "g" also tend to exaggerate the nystagmus induced by alcohol, a situation that can persist for some 48 hours.

Effect of Alcohol on tolerance to hypoxia.

The presence of alcohol in the blood stream and organs impairs the metabolism and utilisation of oxygen.

Conclusion re alcohol.

Alcohol has a number of persistent effects that can negatively impact on flight safety. There are significant problems in flying during the hangover period, and, as shown above, even flying the morning after a few drinks the night before may not necessarily be the safest option. Adherence to a simple bottle to throttle rule does not guarantee maximum performance in the air. As safety-conscious pilots we should only fly when we are mentally and physically fit. In some cases that may mean not flying the morning after the night before.

Civil Aviation Regulations

Part 67 of the Civil Aviation Safety Regulations 1998 (CASR) specifies that an applicant for a medical certificate, i.e. a pilot or air traffic controller, must not “engage in any problematic use of substances (within the meaning given by section 1.1 of Annex 1, Personnel Licensing, to the Chicago Convention12)”, and if an applicant for a medical certificate has a history of “problematic use of substances”, then he or she must demonstrate that he or she has abstained from such use, has no safety-relevant medical problems associated with that use, and is undertaking or has completed a course of therapy for that use. Regulation 256 of the Civil Aviation Regulations 1988 (CAR) proscribes the use of drugs and alcohol by aircraft crew and air traffic controllers while on duty and for eight hours before duty, and precludes them from carrying out duties while affected by drugs or alcohol.

Blood sugar levels

The body needs a ready supply of sugar (glucose) in the blood for energy. Too much or too little in the blood is harmful, so the body must regulate the level within tight limits. This function is performed by the pancreas, which secretes insulin into the blood stream whenever blood glucose levels are too high.

High blood sugar

If insulin from the pancreas is insufficient or ineffective high glucose levels in the blood will result. If undetected or untreated this can lead to diabetes, a dangerous condition leading to damage to the small blood vessels of the eyes, kidneys and heart. Severe illness, collapse, blindness, kidney or heart failure can result. In severe cases a patient may be permanently dependent on daily insulin injections or dialysis for survival. Pilots who develop diabetes may have difficulty maintaining a pilot’s licence, although it should be possible to fly gliders solo.

Low blood sugar in the body (hypoglycaemia)

This condition can temporarily occur from time to time in normal people. It needs to be understood by pilots as the symptoms can be quite marked, and can interfere with the ability of a pilot to fly safely.

The condition can be brought on if a meal is missed, causing temporary “dips” in normal blood sugar levels. Symptoms can be quite marked, and may include–

- Shakiness
- Nervousness
- cold sweating
- increased heart rate
- faintness.

Symptoms may be exacerbated by a “hang-over”, some other minor illness, or hypoxia.

Causes of hypoglycaemia

- Decreased Intake of sugar or energy foods
- Increased Consumption of sugar by the body.
- Combination of Both
- Missed meals
- Too much sweet too quick
- Illness
- Alcohol or drugs
- Intense workload
- “G” forces
- Fatigue
- Heat or cold stress
- Hypoxia

Effects of hypoglycaemia

- Reduced Performance

- Increased Frequency of Errors
- Greater risk of accidents

Reactive (or “rebound”) Hypoglycaemia

It is important to know that hypoglycaemia can be made worse if a person eats a small candy or chocolate bar (i.e. ingests a small amount of sugar into the body quickly. This will turn on the body’s insulin production, which in turn reduces the overall blood sugar level still further!, making the original situation considerably worse. Starch or protein food snacks (such as sandwiches with mixed fillings) are preferable to sugary ones if a snack is required in flight.

While rebound hypoglycaemia is rare, its effect can be catastrophic. It can be avoided by the taking of regular, balanced meals (every four hours or so), and avoiding the eating of small sweet foods when it is felt that blood sugar levels are low.

Colds and flu

Flying with a cold is not recommended because it may prevent you clearing your ears or sinuses. Severe colds or influenza-like inflammations can cause headaches or other distracting symptoms. Any illness with a fever can interfere with the normal hydration and temperature regulation of the body.

A cold will make a pilot less able to think and react decisively, particularly in an emergency. A cold will also cause congestion in the nose, sinuses and ears. In particular, a cold can block the Eustachian tubes which connect the back of the throat to the inside of each eardrum. A cold may also block the sinuses.

Main effect of blocked sinuses or Eustachian tubes or sinuses.

If the Eustachian tubes or the sinuses become blocked the pilot will be unable to equalise the pressure inside the middle ear and other head cavities during climbing or descent. This can result in severe pain because of trapped gasses within these cavities. The ascent does not often present a problem for the Eustachian tubes, because air can usually escape outwards through the tubes during the climb. During the descent, however, air can often not return into the tubes, causing a vacuum in the middle ear which can result in severe pain, dizziness, and a rupture of the eardrum. If the eardrum ruptures, problems with hearing and unfitness to fly may last for several months or more. Pilots are therefore advised NOT to fly if they have a HEAVY cold.

The valsalva manoeuvre.

A “valsalva” is performed by pinching the nose, tilting the head back slightly and momentarily pressurising the throat by forcing air up from the lungs, causing the ears to “pop”. If the ears can easily be cleared in this fashion then the pilot is probably safe to fly.

The manoeuvre should only be attempted if the cold is light, or if the pilot is recovering from a cold. This is because in cases of severe cold or sinus infection the infection could be forced up into the middle ear or sinus and worsen the situation.

Hay fever.

Hay fever can cause congestion in the nose and sinuses similar to a cold. Unlike a cold, however, hay fever is treatable with nasal sprays. Only approved steroid nasal sprays should be used, and not anti-histamine pills, which can cause sleepiness and inattention (despite the assurances of manufacturers).

Minor Illnesses

Where a pilot has had a major illness, accident or operation which necessitates recuperation in hospital or at home, or time off work, it is usually perfectly clear that a pilot should also take a rest from flying until good health is regained. Examples of such incapacitating illnesses are angina, heart attacks, asthma attacks, peptic ulcers, kidney stones, lung collapse and diabetes.

But where the medical problems encountered by the pilot are less serious (minor illnesses), the situation is not always so straight-forward. Minor illnesses can be described as any health problem that is troublesome, perhaps intermittently, but is not severe enough to require hospitalization or confinement to bed. These illnesses usually come on quite quickly, and often resolve just as quickly. Examples are coughs, sore throat, colds, flu, mild bronchitis, headache, diarrhoea, hay fever, muscle pain, or menstrual problems. In the case of minor illnesses a pilot may sometimes have difficulty in deciding whether or not he or she is fit for flying. Most of these common illnesses can be treated with simple common sense measures. Caution should be exercised about the use of over-the-counter or "natural" remedies (see "medication" below). If there is any doubt about the fitness of the pilot to fly or about the completeness of any cure the pilot should not fly.

There may be occasions when we start out feeling okay but for whatever reason, we get tired or feel unwell. This will certainly undermine our performance and we definitely don't learn when like this. So, speak up early if dual. Your instructor will surely try to take your mind off it while returning to land. An air sickness bag is carried just in case…and many have "been there, done that", so don't be embarrassed.

Medication

Pilots should be aware that many types of medication for various illnesses may be hazardous in the aviation environment. Some medications have side-effects such as drowsiness. These often contain warnings against driving a motor vehicle for a period after taking them, and are obviously dangerous whilst flying an aircraft. If unsure of the likely effects of any medication you are taking, the safest course is to seek the advice of a doctor, preferably an aviation qualified doctor before flying as pilot in command of an aircraft.

FITNESS FOR FLIGHT

I'M SAFE

Illness It sounds obvious, but you don't have to have a raging fever to be unwell and unsafe. Not feeling 100% can count as an illness. If you had a fever you wouldn't bother going to the airfield at all, you'd just stay in bed, whereas not feeling 100% probably wouldn't stop you. Having a headache, however mild, can mean that you won't concentrate fully on what you should be concentrating on, namely the flying. Have you a blocked nose or ears? Apart from the obvious distractions of such miseries, flying at any altitude with these conditions can damage your ears and lead to various other infections.

Medication Some drugs can cause drowsiness, blurred vision, nausea, and produce various allergic reactions. Why are you taking the drugs in the first place, and are you safe to fly if you are?

Stress Non-professional pilots often use flying as a way of winding down from the grind of work. Gliding is, or can be, a very therapeutic pastime, but you must be quite sure that when you climb into the aircraft you really have forgotten all your troubles otherwise you are quite likely to find yourself entertaining a few more.

Anything which prevents you from concentrating on the flying puts you at risk. If you are pre occupied, you will be more concerned with what's in your head already than with anything that might be coming into it. Emotional stress can make you preoccupied and vulnerable to mistakes that may or may not be dangerous. If the marriage is crumbling, or the girlfriend/ boyfriend is about to/has dumped you, then, unless you are well aware of how much of you isn't really 'in gear' you should either make suitably broad allowances for it, or not fly at all. Not flying is probably the safest, if not the most attractive option. Buying a new house or having a row with somebody, even being high with euphoria, can have exactly the same distracting effects.

Alcohol The unco-ordinating effects of alcohol are indisputable, unless of course, you are already completely drunk! The RAAF's old 'eight hours from bottle to throttle' rule referred to a very modest amount of drink. In reality any residual alcohol in the system will have an adverse effect which may not be very apparent to anyone, least of all you. In addition, because of the decreasing amounts of available oxygen, one pint of booze consumed at ground level has the same effect as drinking two at 5,000' and four at 10,000'. This is not as good value as it sounds! In any event, the military — who can't afford to lose pilots or aeroplanes — now demand total abstention in the 24hrs before flying. Being drunk is one thing, but the resultant hangover is probably far worse for your flying than any illness.

Fatigue Did you have a good night's sleep? Have you already done lots of launches today? While tiredness is something that you may be familiar with and be able to allow for, boredom and even long spells of hard concentration are also forms of fatigue that shouldn't be underestimated.

Familiarity Are you in current practice? When did you last practise stalling or spinning, or have a launch failure? Not that you should give yourself a real failure just for practice, but when was the last time you really thought about what you would do if you had a genuine launch failure? When did someone else last look at your flying? Are you totally familiar with the aircraft you are about to fly? Have you read the Flight Manual recently/at all? When did you last fly the aircraft? When did you last fly at the site? Is the weather as expected? Have you flown in these conditions before? If you are doubtful about your currency with any of the above then have a check ride or read the manual.

In addition to your own health, what about the 'health' of the aircraft you are about to fly? Who DI'd it? Were they as thorough as you would be? Would it be a good idea to do a quick walk around before you get into the cockpit, just to be sure, especially if this is the very first flight of the day? Have you done positive checks on the control connections?

Eating If you go for several days without proper meals your blood sugar level falls and can cause lack of concentration. In extreme cases you can become unconsciousness. A touch of food poisoning, however mild, won't do you any favours either. The first questions asked by accident investigators after at least one gliding fatality was, "What had the pilot had to eat? And where was it prepared?" Inadequate fluid intake can also have potentially serious effects. Dehydration can rapidly incapacitate if not actually kill you. One incident involved a glider pilot becoming ill in the air, managing to land safely and then being found unconscious in the cockpit.

Pre flight

- Have you recently checked your weight?
- Is any ballast properly secured?
- Is any packing going to give on the initial part of the launch?
- Are all loose articles stowed correctly?
- Is the weather suitable for the forthcoming flight?
- If it is hot and blue do not forget to wear a sun hat and roll your sleeves down. This helps prevent dehydration and sunstroke.
- Are you prepared for emergencies such as cable breaks?
- What is the purpose of the flight? This may sound frivolous, but meandering aimlessly about can cause problems ranging from lethargy to complacency. It is not necessary to be forever striving, but neither is it very constructive to be asleep most of the time.

If you cannot honestly say I'm safe, then do not fly.

AIRMANSHIP

Airmanship includes good lookout, considerate behaviour in the air, and being ahead of events rather than dangling behind them like someone struggling with an out of control lawnmower. It also involves such apparently useless activities as 'looking both ways before crossing a one way street', as well as not plunging boldly into areas where our ignorance outweighs our competence.

Good airmanship is not simply about how we protect ourselves, but how we avoid putting other people at risk. For example, when thermalling with other gliders we should do so in such a way that we are visible to them, and they don't have to keep manoeuvring to get out of our way. If pilots constantly leave thermals when you arrive, it may not necessarily be because they don't want to be out climbed! Airmanship is good manners and caution, not aggressive behaviour towards other users of the air — nor is it bad mouthing them over the radio.

As a subject, airmanship is very difficult to teach. We all agree on good lookout and a few other major components of good airmanship, but the rest often consists of 'opinions' about the best way to do this, that or the other, and some aspects of airmanship are extremely subtle. Its teaching is further complicated by the fact that it has quite a lot to do with the individual's attitude and relationship to the world in general. The exercise of good airmanship usually means that nothing very dramatic happens! It goes unnoticed. In other words, good airmanship is most obvious when it is absent!

It is most important that the trainee understands that good airmanship is not something you turn on every now and then during a flight. Airmanship begins before you leave home for the airfield.

GFA HUMAN FACTORS EXAMINATION QUESTIONS & ANSWERS

1. The percentage of aviation accidents that have significant “human” causal factors?

   75%

2. Name two inherent limitations of human vision in the aviation environment.
   - The blind spot
   - The time lag
   - The seeing and focusing mechanism
   - Empty visual field blindness
   - Visual illusions

3. Why is it important to develop a scanning technique to maximise your LOOKOUT?

   The process of looking, seeing, and recognising does not occur instantaneously, but takes a finite time to happen. In fact, about 1½ seconds under normal conditions! Taking the limited angle of accurate vision available, and the time lag into account, it is clear that to scan the airspace outside of the cockpit effectively a pilot should divide the area to be scanned into 20° sectors, and allow sufficient time in each sector for the “seeing” to fully occur. Because glare, luminance, and contrast factors can delay the “seeing time” even further, allowing 2 seconds per 20° sector is recommended.

4. How can you overcome empty visual field blindness in flight?

   Empty visual field blindness can be overcome by periodically transferring the gaze to some distant cloud or land feature, thus exercising the focal properties of the eye. Even consciously focussing on the wing tip from time to time may help.

5. Name two effects of “g” forces on vision
   - loss of colour (“grey out”)
   - loss of peripheral vision (tunnel vision)
   - blurring of vision (loss of visual sharpness)
   - Total loss of vision (“black out”)

6. Name two aspects of vision that will be affected by hypoxia.

   Visual acuity (sharpness), peripheral vision, colour perception, and visual brightness will all be affected.

7. Above what altitude should supplemental oxygen be used?

   In Australia, pilots are required to use supplemental oxygen any time the aircraft is being flown above 10,000 feet. However, in practical application in gliders, the use of supplemental oxygen is advisable for cross country / competition pilots who work "hard" and spend a lot of time at 8,000 feet and above (both pilot and passenger, if applicable). Civil Aviation Safety Authority of Australia's Civil Aviation Order 20.4 describes in detail the requirements for the use of oxygen & protective breathing equipment.

8. Other than the impact on your vision, name three general symptoms and effects of Hypoxia.
   - Euphoria
   - Target fixation
   - Personality changes
   - Loss of self-criticism, judgement
   - Fuzziness (not dizziness)
   - Amnesia
   - Lethargy
   - Mental confusion
   - Sensitivity to heat/cold
   - Cyanosis (bluing of extremities)
   - Unconsciousness
   - Death

9. Name two areas of the human body where gases can be trapped as an aircraft ascends / descends.
    - the stomach
    - the intestines
    - the middle ear
    - the sinuses
    - the teeth

10. What is the recommended method for unblocking Eustachian tubes on aircraft descent?

    Ear pain on descent can be a common and severe problem if the Eustachian tubes are blocked. The Eustachian tubes may be unblocked by swallowing, moving the jaw, or by using the valsalva manoeuvre. A "valsalva" is performed by pinching the nose, tilting the head back slightly and momentarily pressurising the throat by forcing air up from the lungs, causing the ears to "pop".

11. Name the three elements of the balance and orientation systems of the human body.
    - The visual system
    - The "balance" organs
    - The pressure/stretch/position nerve system

12. Why is motion sickness more common among passengers and trainee pilots than among experienced aviators?

    Motion sickness is caused by prolonged unaccustomed motion of the body which upsets the orientation system. Motion sickness can be aggravated by anxiety and low cockpit activity levels. It can be alleviated by gaining further air experience as early as possible, thus reducing anxiety and building self-confidence.

13. List at least three precautions against heatstroke / heat stress.
    - Drink plenty of fluids, avoiding diuretics such as alcohol and caffeinated beverages.
    - Always wear a hat when exposed to the sun (essential for glider pilots).
    - Wear loose fitting clothing which allows air to circulate around the body.
    - Wear clothing which shields the skin from direct exposure to the sun.
    - Keep the body cool as far as possible by proper ventilation or shading.

14. List four symptoms of heat stress / heatstroke.
    - Heat rash
    - Muscle Cramps
    - Headache
    - Nausea (and vomiting)
    - Dryness of mouth, nose and eyes
    - General dehydration
    - Poor concentration
    - Drowsiness
    - Weakness
    - Lethargy
    - Slurred speech
    - Confusion
    - Disorientation
    - Hallucinations
    - Total collapse (or, in extreme cases death)

15. What is the amount of fluid intake recommended for pilots flying on particularly hot days?

    500 to 600 ml's per hour. Dehydration is best prevented by the frequent intake of suitable cool fluids; you need at least 250 ml's per hour to cover fluid lost through respiration alone! 500to 600 ml's per hour is recommended for particularly hot days. Glider pilots on long flights in hot temperatures (two hours or more) should always carry at least 2 litres of water on board to cope with any eventuality. A pilot might expect to consume anywhere from 300 to 500 ml's per hour to replace fluid lost through perspiration and to keep the body properly hydrated. The importance of adequate fluid intake for glider pilots cannot be too highly stressed.

16. From a psychological perspective, name a few traits of a 'good' pilot.
    - display of common sense
    - sound aviation practices and high standards in the air
    - confident, consistent, and calm
    - dependable with solid decision-making skills
    - willing to assist others in achieving their own high standards
    - they stay out of trouble
17. List two impairments to proper mental performance
    - Overload of activity or information
    - Stress and fatigue
    - Fatigue
18. What risks are associated with overload of activity or information for a pilot?

    Performance suffers as normal functioning breaks down and load-shedding automatically occurs. In this state some information or tasks may be neglected, and accidents may follow.
19. Describe some Indirect and Direct stressors a glider pilot may experience.

    Direct stressors are those resulting from the immediate task of flying an aircraft. Direct stressors (flying-related) may arise from such things as glare, turbulence, weather, time delays, unexpected mechanical or navigation problems, temperature extremes, dehydration, hypoxia, visual illusions, disorientation, fatigue, lack of fitness to fly, or ergonomic factors.

    Indirect stressors may relate to the pilots normal domestic environment such as personal, family or relationship problems, financial concerns problems, or job satisfaction concerns. This type of stressor is cumulative, that is they all "add up" to contribute to the total stress at any given time.
20. List some of the best ways you can reduce stress.
    - Keep physically fit and healthy
    - Eat well
    - Rest well
    - Relax well
    - Sleep well
    - Know your capabilities and keep within them
    - Think and plan ahead
    - Get organised
    - Prioritise
    - Delegate and load shed
    - Seek assistance where necessary
    - Avoid procrastinating
    - Understand how stress affects YOU, and do something about it!
21. Name at least four signs and symptoms of fatigue.
    - reduced visual field
    - drowsiness
    - we suffer channelised attention
    - we are easily distracted or can be pre-occupied
    - our judgment erodes
    - we become careless and take unnecessary risks
    - we lose our sense of timing
    - our coordination deteriorates
    - we become forgetful
    - our reaction times increase
    - we may accept lower standards
    - we are susceptible to illusions
    - we become irritable

22. How can you deal with fatigue?

    Fatigue cannot be overcome quickly. It can really only be relieved by resolving the underlying workload or stress problems, and by allowing adequate rest and sleep. An understanding of stress and stress management techniques will also help. These include such elementary steps as better organisation, better management of time and workload, good prioritisation, improved physical fitness and better quality sleep.

23. List at least three adverse medical factors for a glider pilot.
    - Illicit drugs and alcohol
    - Blood sugar levels (low & high)
    - Colds and flu
    - Hay fever
    - Medication (side effects)

24. Name four effects alcohol would have on a pilot's performance
    - Disorientation
    - Dehydration
    - Increased susceptibility to "g" forces
    - Increased susceptibility to hypoxia
    - Increased susceptibility to decompression sickness (the bends)
    - Interference with temperature regulation of the body

25. Why is flying with a cold not recommended?

    Flying with a cold is not recommended because it may prevent you clearing your ears or sinuses. Severe colds or influenza-like inflammations can cause headaches or other distracting symptoms. A cold will make a pilot less able to think and react decisively, particularly in an emergency.

ADDENDUM 1

Visual Illusion - Blind Spot

When we look at an object, light reflects off of that object, and enters our eye by passing though the cornea, pupil, and lens. The light rays then are focused onto our retina, which sends messages to our brain, allowing us to recognize what we’re looking at.

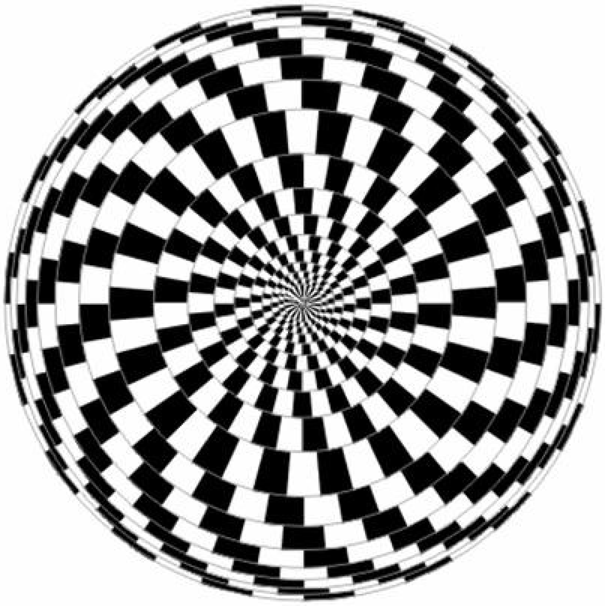
The point where the optic nerve connects to the retina creates a blind spot in each eye. It is not noticeable in everyday life, as our eyes are constantly moving, and one eye will catch what the other is missing. However, by using the above image, you can expose your blind spots.

First, close your right eye, and focus your left eye on the circle. While still looking at the circle, move the page slowly closer to you, until the cross disappears. When you no longer see the cross, it has fallen into your blind spot. To test the other eye, close your left eye, and look at the cross with your right. Again, move closer until the circle has disappeared.

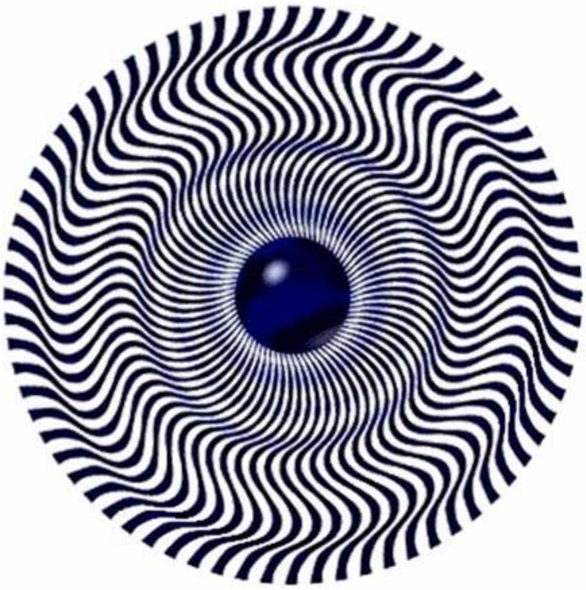
ADDENDUM 2

Visual Illusions – Movement

If you stare at the below circular design, you should see movement of some sort, such as pulsating, shifting and/or rotating. This is caused by how the eyes and mind detect and interpret the information. As your eyes naturally move, even if slightly, an afterimage follows with your eyes causing the appearance of movement that does not exist. The rotating black and white design was intentionally designed to play on the afterimage and other visual conceits. To the human mind, if any printed picture is going to move on the page, it will be this circular, rotating design.



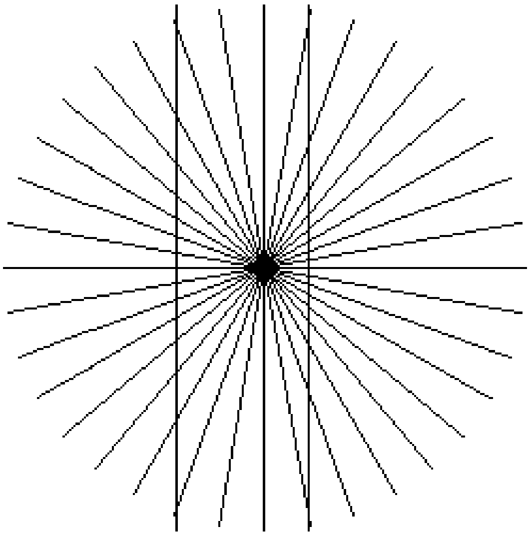
The below is another design that often produces the appearance of movement when stared at-such as rotating, pulsating and/or shifting. Even though the image is stationary, it's difficult to not visually perceive it as stationary.

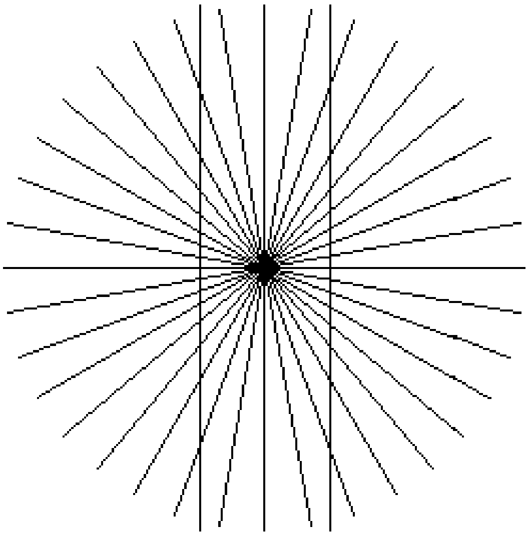


ADDENDUM 3

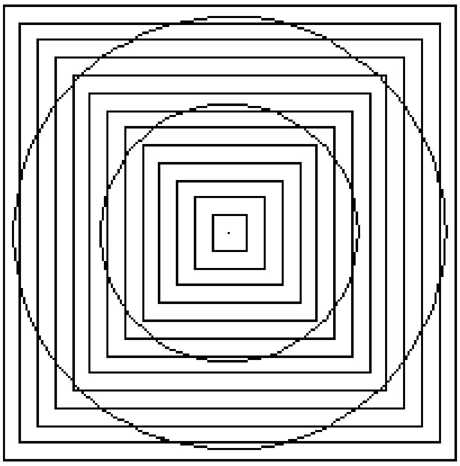
Visual Illusions – Line Bending

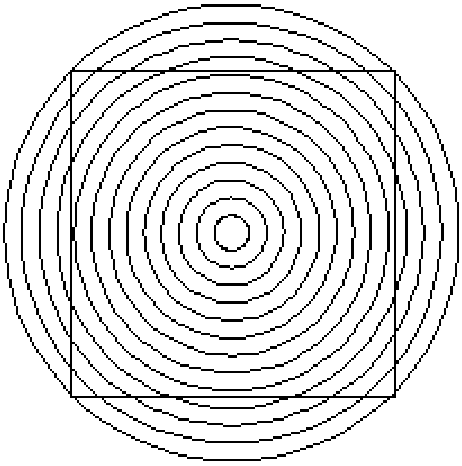
The Herring illusion below, presents parallel lines against a background of radial lines. The parallel lines appear bowed or bent.





Pattern-dominance illusions, as usually presented, seem to be strictly due to conflict of overlapping patterns in a single plane. Our perception of the geometry of one pattern is altered by the presence of the other pattern. The illusion seems not to rely upon any suggestion of perspective in the drawing.





Most people judge that the circles in the left drawing a bit off-round, being gently flattened at four places, near the corners of the squares. Few would say that the circles distort the squares in this case.

ADDENDUM 4

Ambiguous Illusions

Take a look at the image below. What do you see? You might see a young woman or perhaps you see an old woman. Both answers are correct. Ambiguous Illusions pair two pictures together in one. What you see first depends on your own perceptions.

Mind Sets

The following is an example of a "mind set". It is well known that if a person has a strong expectation of seeing something, when the expected situation arrives the person will see what is expected rather than what is actually there.