

Illusions In Flight

Good flight isn't possible without good information. So what if your own body is feeding you misinformation?

If the sensation of flight is natural to humans only when we fall, the sensation of powered aerial manoeuvres must be completely alien.

So it is, that the human body can become disoriented easily in flight, giving incorrect feedback that can be recognised only with prior knowledge.

"These illusions occur because our balance mechanisms were not designed for flight," says CAA Principal Medical Officer Dougal Watson. "An understanding of these illusions and how to stop them causing problems is important for all pilots."

Spatial disorientation is a major cause of human-related aircraft accidents, and can lead to loss of control or controlled flight into terrain.

Let's look at some of the illusions a pilot may experience.

Somatogyral Illusions

Sensory cells inside your ear, within the *crista ampullaris*, detect angular movement such as banking, spinning, or spiralling.

One of the most common in-flight illusions is known as **The Leans**.

Around 30 seconds into a steady bank, the vestibular system within the ear 'catches up', leading to a sensation of level flight.

A bank can even be gentle enough to not be detected by the inner ear at all, for example when an aircraft is not trimmed correctly. An abrupt correction to level can then trick the mind into thinking the aircraft is now banking in the opposite direction.

"I well remember my first 'leans'," says Dougal. "Despite a thorough understanding of the physiology, I was totally unprepared for that powerful false feeling of roll, when I knew that my wings were level."

Such spatial disorientation was implicated in the 1978 crash of Air India Flight 855, a Boeing 747 that came down in the Arabian Sea just 101 seconds after leaving the runway.

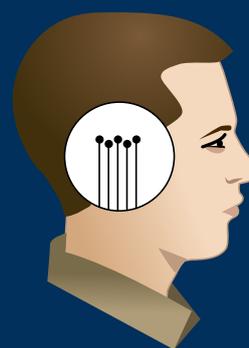
Following an apparent miscommunication about instrument readings, and without visual reference, the pilot erroneously rolled the aircraft to the left and never regained level flight. There were no survivors.

To reduce the likelihood of such illusions, if you can't avoid IMC, always maintain an instrument scan and try to avoid very slow turns, particularly when you have no visual references.

Similar to The Leans, the **Graveyard Spiral** occurs when a pilot in IMC wrongly perceives the state of a banking aircraft. Believing it is level, the pilot tries to correct the accompanying descent by pulling back on the stick. This only tightens the spiral, and increases the descent rate.

Somatogavic Illusion

Head stationary and upright



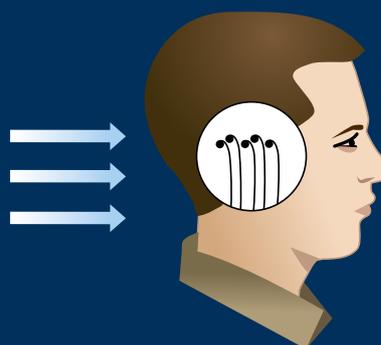
The impression is "I'm stationary and upright"

Head tilted up



The impression is "I'm pitching up"

Forward acceleration



The false impression is "I'm pitching up"

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The **Graveyard Spin** occurs when coming out of a spin. The sensation can trick a pilot into thinking they're now spinning the opposite way, causing them to correct and re-enter the original spin.

The **Coriolis Illusion** occurs when a pilot moves their head too quickly during a constant turn that is no longer stimulating their inner ear. The sudden head movement can lead a pilot to believe the aircraft is yawing, pitching, or rolling.

Somatogravic Illusions

Linear accelerations stimulate the otolith organs in your ear.

When accelerating quickly, these organs can give the impression that the plane is pitching up, causing a pilot to instinctively lower the nose. The opposite can occur under rapid deceleration.

Five lives were lost in Queensland in 1990, after the pilot of Beech King Air VH-LFH is believed to have pitched his aircraft into a shallow descent after takeoff.

Without an instrument scan, and with no visual reference through the dark night, the pilot had no way of knowing the aircraft was on a collision course with the ground just 600 metres past the end of the Wondai runway.

This sensation is most commonly known as a **False Climb** or **Head-up Illusion**. The opposite of this, occurring under sudden linear *deceleration* is known as **Head-down Illusion**, which can end in a pilot pitching up to the point of stalling.

Inversion Illusion occurs when pitching down too quickly from climb to level, causing a sensation of tumbling backwards.

The natural response to this sensation is to push the nose further down, which can start the cycle over again.

Steady control inputs are the key, and if you don't have visual reference, an instrument scan can quickly tell you what the aircraft is doing.

During a takeoff at night, switch to instruments as you rotate and stay on the dials, maintaining V_x until you've reached a safe altitude. No attempt should be made to look back at the runway lights or any other ground lighting.

Optical Illusions

What a pilot sees outside the cockpit informs a lot of what they do inside the cockpit. Unfortunately, that view can also be deceptive.

Linear Perspective Illusions can occur over sloping terrain, or where a runway is wider or narrower than a pilot is used to.

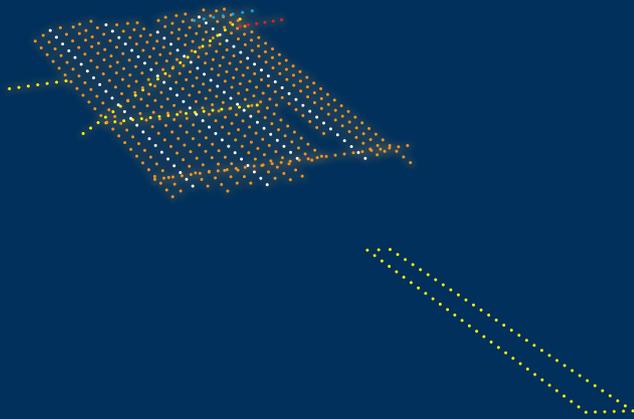
From a greater height, a wide runway may appear to be the same width as a narrow runway. For that reason, a pilot used to narrower runways could believe that their height on approach is lower than it really is.

A final approach over down-sloping terrain can give the same illusion. This could result in a pilot pitching the nose up and bringing the aircraft towards a stall condition.

Up-sloping terrain on approach, or a particularly long or narrow runway, can elicit the opposite effect, with a pilot inclined to believe they are too high on approach. This can quickly translate into an aircraft flying too low on its approach path.

Dougal recounts his experience of this.

"I remember flying into Melbourne's Tullamarine Airport for the first time, and flaring at about 100 feet. All of my previous flying had been on thin grass strips and I was unprepared for this illusion caused by the runway width."



This illustrates a classic black hole, where there are no visual references before the aerodrome, but town lights beyond it.



A pilot may read a **False Horizon** when in mountainous or unfamiliar territory. What appears to be the horizon may simply be an unrelated geographic feature.

This can be an even greater issue at night, when a row of lights may give the false impression of having a relationship to the real horizon. Ground lights can even be confused for stars.

Autokinetic Illusion occurs when a pilot fixates on a single point of light against a dark background. This could be a star, a planet, or a light on the ground.

“Almost every pilot will have experienced some of these illusions during their flying career. Those that make the effort to learn about them will be better prepared for their next flight.”

Without other visual references, subtle movements of the eye can give the illusion that the point of light itself is moving.

To prevent this happening, avoid focusing on a single light, and look to one side and use your peripheral vision.

The **Black Hole Approach** happens when a pilot approaches a lighted runway over unlit terrain – a ‘black hole’. This can cause disorientation and in the worst case could see a pilot land short of the runway.

Even in daylight, featureless terrain can give a pilot the illusion of a lack of movement, or a false sense of their height above ground.

In May 2012, a Hughes 500 with no apparent mechanical defects crashed into Lake Sumner on a calm and clear day. The sole occupant didn’t survive the impact.

The probable cause of the accident was spatial disorientation resulting in controlled flight into terrain.

Repeating Pattern Illusion is particularly troublesome for helicopter pilots operating at low level over calm water. Any repeating pattern, such as the ripples on a lake, can be visually misaligned by the left and right eyes, resulting in incorrect altitude perception.

Similarly, glassy water landings are notoriously difficult in

floatplanes, a procedure often likened to landing on a mirror.

Other Illusions

While less common than vestibular and optical illusions, a pilot may also experience ‘dissociative’ illusions.

These illusions are generally associated with high altitude flight, where the pilot has a relatively low level workload, ie, during an autopilot-controlled transit.

The **Break-off Phenomenon** can result in a pilot feeling that they are sitting on the wing of the aircraft, watching themselves flying.

When experiencing the **Knife Edge Illusion**, a pilot can feel their aircraft is extremely sensitive to control inputs. The opposite of this is the **Giant Hand Illusion**, in which a pilot can feel as though the aircraft is unresponsive to inputs, as if held aloft by a giant hand.

Avoidance and Recovery

Spatial disorientation and visual illusions are most commonly experienced when flying with reduced visibility.

Whether this is at night, with the added distraction of bright ground lights and the stars above, or during the day in fog, it is crucial to maintain a regular instrument scan.

Doing so is important during any flight, but even more so when visual references are lacking. Instrument readings may be the only way to get an accurate and immediate picture of the location and attitude of the aeroplane.

Where night flight is necessary, cockpit lights and torches should be kept dim, and a scanning motion should be used when looking outside the aircraft to avoid fixating on lights.

Instrument approaches under such conditions are preferable to visual approaches, and the use of visual approach slope indicators and approach lights can help.

Dougal Watson repeats the importance of knowledge and preparedness.

“Almost every pilot will have experienced some of these illusions during their flying career. Those that make the effort to learn about them will be better prepared for their next flight.”

Further Reading

Email info@caa.govt.nz to get a free copy of the GAP booklet *Night VFR*. ■