Private Pilot (ASEL) Ground School Course

Lesson 27 | Aeromedical and Human Factors

Lesson Overview

Lesson Objectives:

- Develop knowledge of the effects aeromedical factors have on a pilot and their passengers.
- Develop an understanding of how to recognize, solve, and prevent different aeromedical factors.

Lesson Completion Standards:

- Student demonstrates satisfactory knowledge of aeromedical factors and human factors by answering questions and actively participating in classroom discussions

Physiological Factors

Aeromedical and Human Factors

Hypoxia

- Occurs when the tissues in the body do not receive enough oxygen
- Caused by several factors including an insufficient supply of oxygen, inadequate transportation of oxygen, or the inability of the body tissues to use oxygen

Hypoxia

- Early symptoms include euphoria, which can prevent you from recognizing a potentially hazardous situation
- Particularly hazardous during flights with only one pilot because symptoms can be difficult to recognize before your reactions are affected

Hypoxia Symptoms

- Headache
- Increased response time
- Impaired judgment
- Drowsiness
- Dizziness
- Tingling fingers and toes
- Numbness
- Blue fingernails and lips (cyanosis)
- Limp muscles

Time of Useful Consciousness

Altitude	Time of Useful Consciousness
45,000 feet MSL	9 to 15 seconds
40,000 feet MSL	15 to 20 seconds
35,000 feet MSL	30 to 60 seconds
30,000 feet MSL	1 to 2 minutes
28,000 feet MSL	2½ to 3 minutes
25,000 feet MSL	3 to 5 minutes
22,000 feet MSL	5 to 10 minutes
20,000 feet MSL	30 minutes or more

Forms of Hypoxia

- Hypoxic hypoxia
- Hypemic hypoxia
- Stagnant hypoxia
- Histotoxic hypoxia

Hypoxic Hypoxia

- Occurs when there are not enough molecules of oxygen available at sufficient pressure to pass between the membranes in your respiratory system
- Increases with altitude (thinner air, less oxygen)

Hypemic Hypoxia

- Occurs when your blood is not able to carry a sufficient amount of oxygen to your body's cells
- Caused by any condition that results in a reduced number of healthy blood cells such as anemia, disease, blood loss, or deformed blood cells

Hypemic Hypoxia

- Also caused by carbon monoxide (CO) poisoning, which interferes with the attachment of oxygen to the blood's hemoglobin
- CO poisoning does not produce cyanosis (blue lips or fingernails)
- Hypoxia susceptibility due to the inhalation of CO increases as altitude increases

Stagnant Hypoxia

- An oxygen deficiency in the body due to the poor circulation of the blood
- During flight, can be the result of pulling excessive positive Gs, or cold temperatures can decrease the blood supply to the extremities

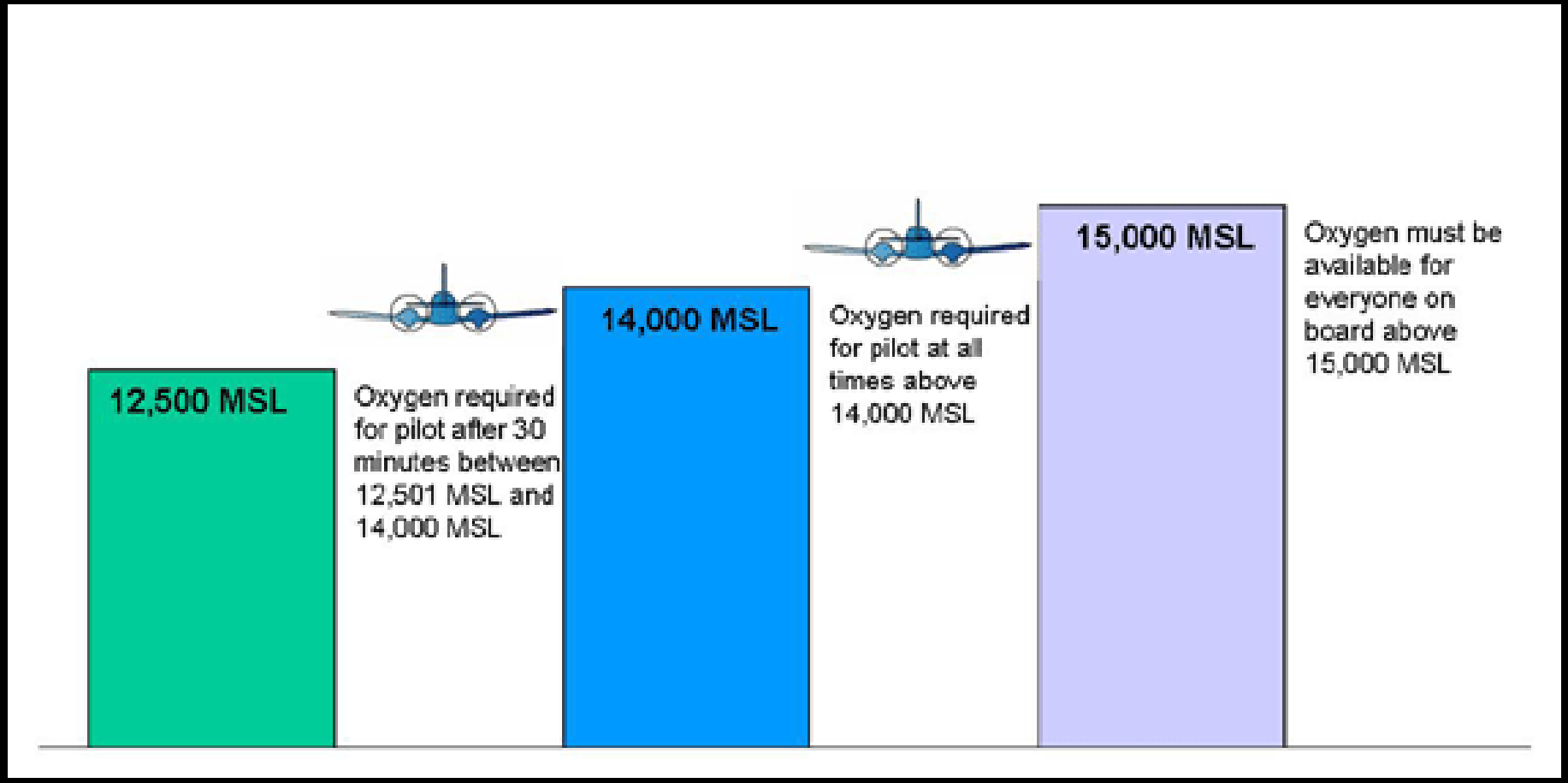
Histotoxic Hypoxia

- The inability of the cells to effectively use oxygen
- This impairment of cellular respiration can be caused by alcohol, other drugs such as narcotics, and poisons

Supplemental Oxygen Requirements

- Required flight crew must use oxygen after 30 minutes at cabin pressure altitudes above 12,500 feet MSL
- At all times at cabin pressure altitudes above 14,000 feet MSL
- Every occupant of the aircraft must be provided with supplemental oxygen at cabin pressure altitudes above 15,000 feet MSL
- Pilots are encouraged to use supplemental oxygen above 5,000 feet MSL at night

Supplemental Oxygen Requirements



Hyperventilation

- A deficiency of carbon dioxide within the body
- Can be the result of rapid or extra deep breathing due to emotional tension, anxiety, or fear
- Will experience drowsiness, dizziness, shortness of breath, and feelings of suffocation.
- Symptoms will subside after slowing rate and depth of breathing

Other Factors

- Stress
- Fatigue
- Fitness for flight
- SCUBA diving (Decompression sickness)

Decompression Sickness After Scuba Diving

- A pilot or passenger who intends to fly after scuba diving should allow the body sufficient time to rid itself of excess nitrogen absorbed during diving
- If not, decompression sickness due to evolved gas can occur during exposure to low altitude and create a serious inflight emergency

Decompression Sickness After Scuba Diving

- The recommended waiting time before going to flight altitudes of up to 8,000 feet is at least 12 hours after diving which has not required controlled ascent (nondecompression stop diving), and at least 24 hours after diving which has required controlled ascent (decompression stop diving)
- The waiting time before going to flight altitudes above 8,000 feet should be at least 24 hours after any SCUBA dive

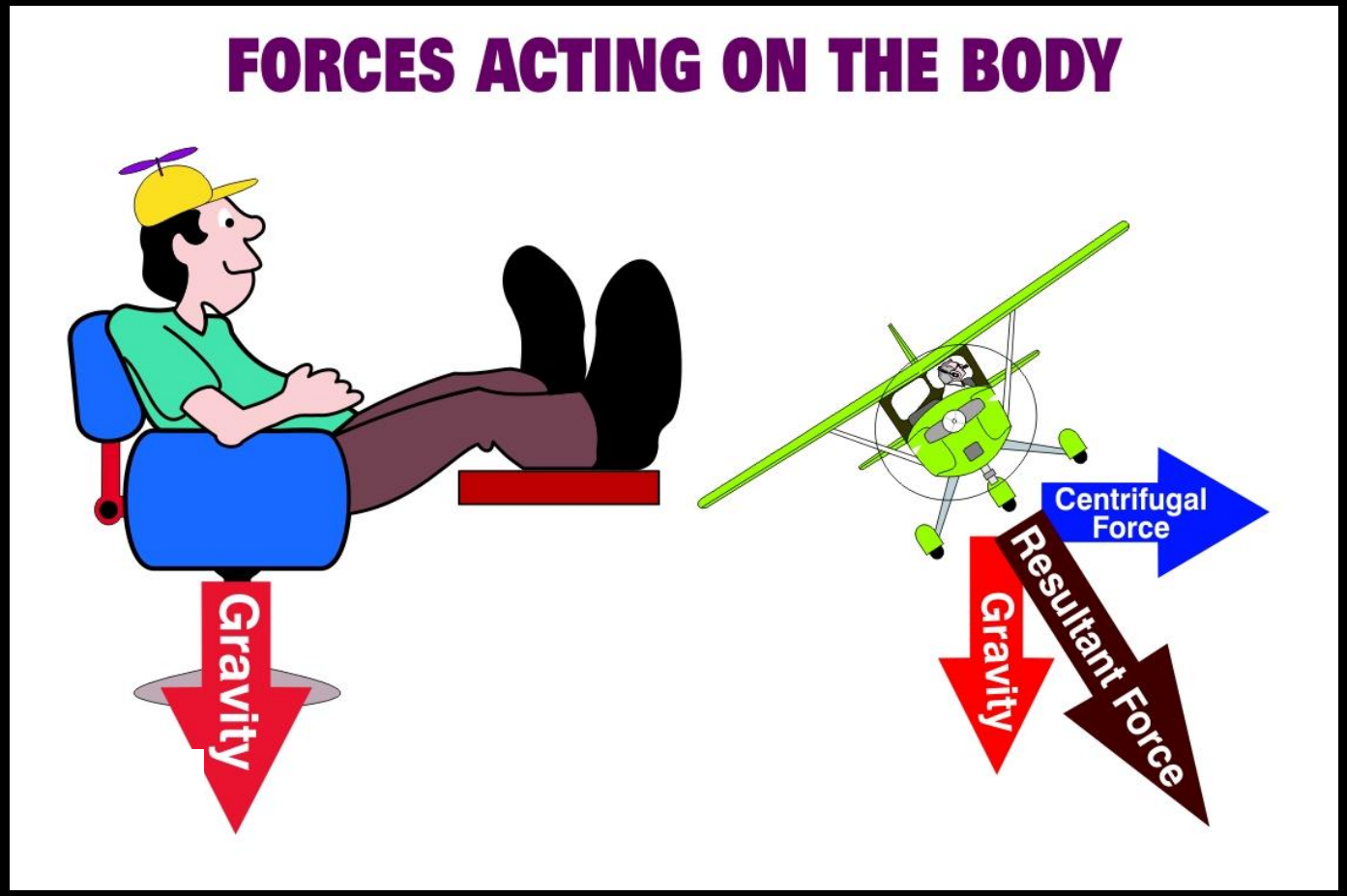
Decompression Sickness After Scuba Diving

- These recommended altitudes are actual flight altitudes above mean sea level (AMSL) and not pressurized cabin altitudes
- This takes into consideration the risk of decompression of the aircraft during flight

Disorientation

- You sense your body’s position in relation to your environment using input from three primary sources:
  - Vision
  - The Vestibular System located in your inner ear
  - Your Kinesthetic sense

Kinesthetic Sense



- During flight, you can experience disorientation if your brain receives conflicting messages from your senses
- An awareness of position obtained from the nerves in your skin, joints, and muscles
- Is unreliable because the brain cannot tell the difference between input caused by gravity and that of maneuvering G-loads

Disorientation

- In good weather and daylight, you obtain your orientation primarily through your vision
- In IFR conditions or at night, there are fewer visual cues, and your body relies upon the vestibular and kinesthetic senses to supplement your vision

Disorientation

- Because these senses can provide false cues about your orientation, the probability of disorientation occurring in IFR weather is quite high
- Fatigue, anxiety, heavy pilot workloads, and the intake of alcohol or other drugs increase your susceptibility to disorientation and visual illusions

Symptoms of Disorientation

- Lightheadedness
- Dizziness
- Feeling of instability
- Sensation of spinning

Spatial Disorientation

- Occurs when there is a conflict between the signals relayed by your central vision and information provided by your peripheral vision
- More likely when you are in IFR conditions, as your peripheral vision has practically none of the references needed to establish orientation

Spatial Disorientation

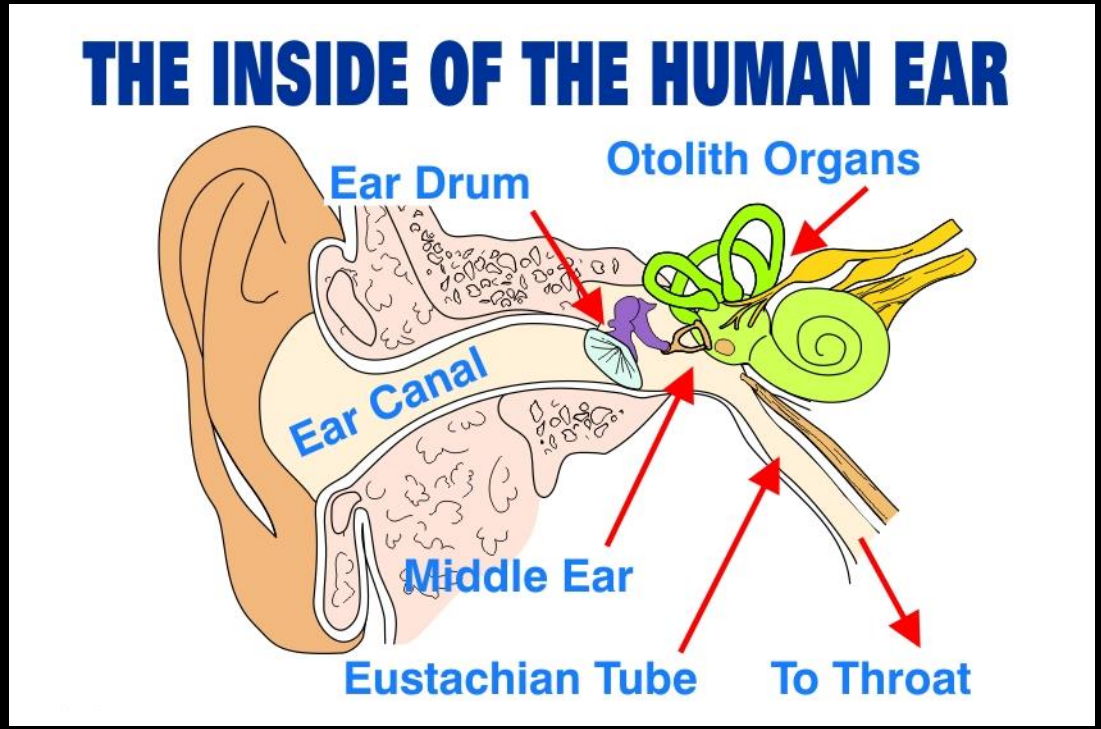
- The movement of rain or snow seen out the window by your peripheral vision can also lead to a misinterpretation of your own movement and position in space

Vestibular Disorientation

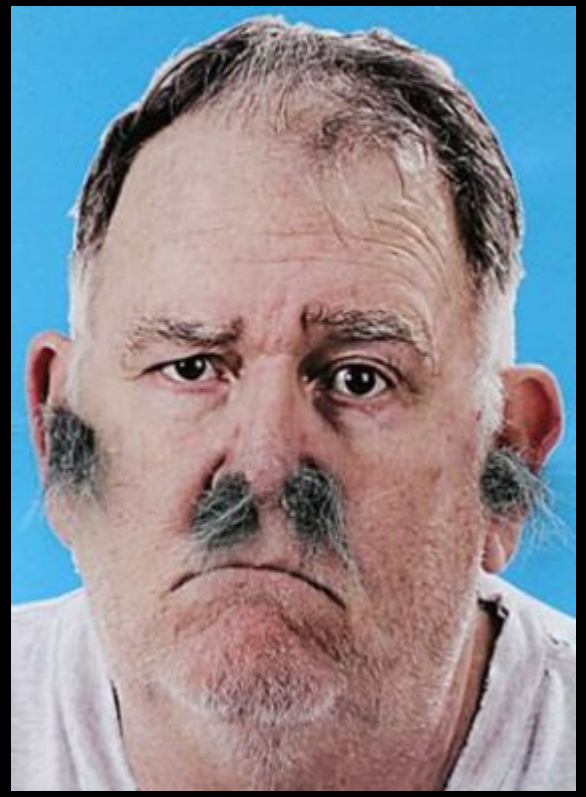
- When subjected to the different forces of flight during instrument maneuvers, the vestibular system can send misleading signals to the brain resulting in vestibular disorientation

Vestibular System

- Consists of the vestibule and three semicircular canals
- Responsible for the perception of gravity and linear acceleration



External Ear Hygiene

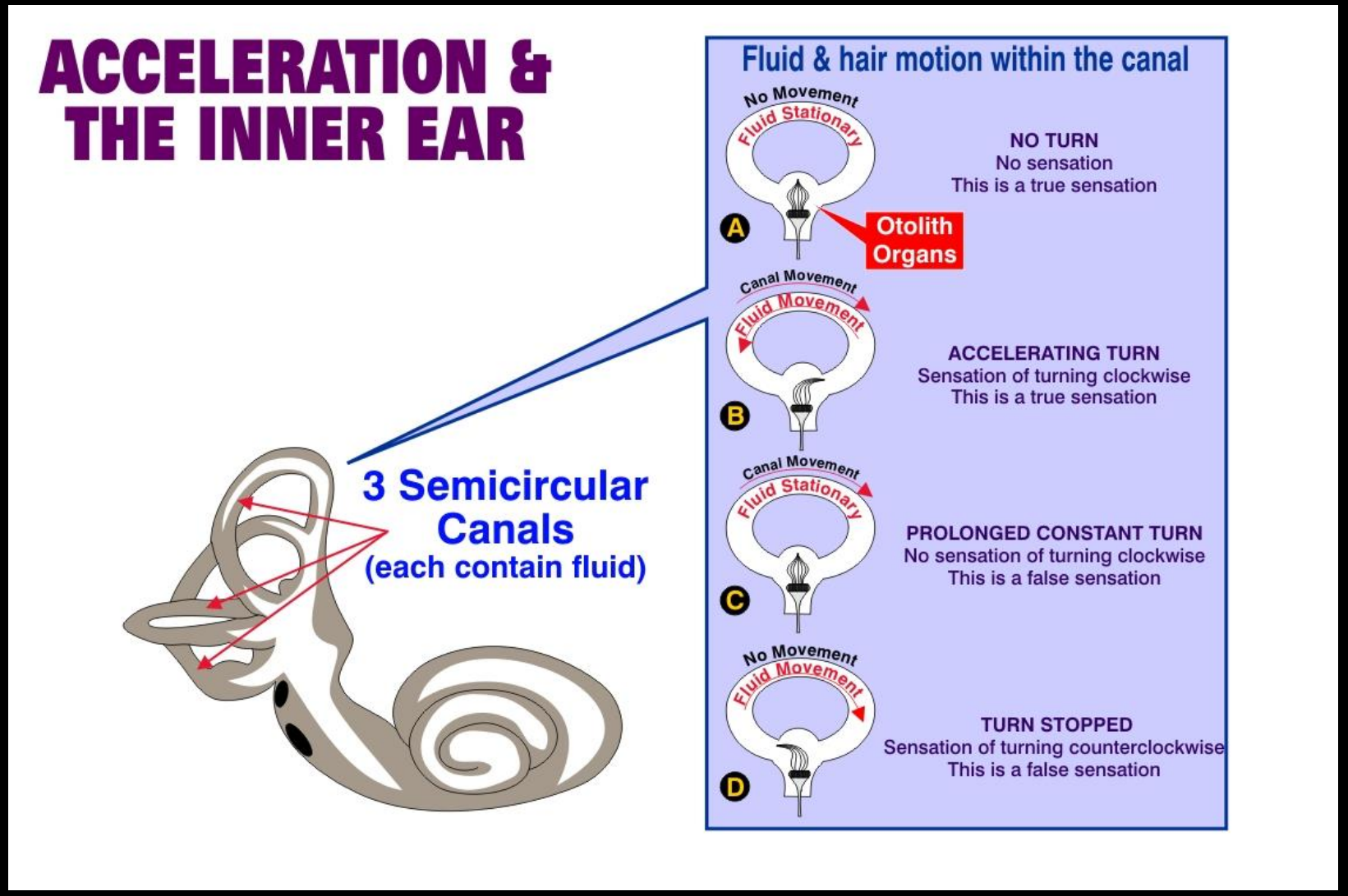


Vestibular System

- The semicircular canals are oriented in three planes, each at a 90° angle to the other two
- This allows them to sense yaw, pitch, and roll
- The canals are filled with fluid
- When the body changes position, the canals move but the fluid lags behind
- This transmits impulses to the brain to interpret the motion

Internal Ear Hygiene

Force and Acceleration Sensing



Disorientation

- Illusions caused by the motion-sensing system of the body are most commonly encountered during instrument flight
- The system may be stimulated by motion of the aircraft *or* by head or body movement
- It is not capable of distinguishing between centrifugal force and gravity, nor can it detect small changes in velocity
- May also produce false sensations, such as interpreting deceleration as a turn in the opposite direction
- These illusions and false sensations may lead to spatial disorientation

Disorientation

- The motion-sensing system may lead to a false perception of the true vertical
- For example, in a turn without visual reference, the only sensation is that of the body being pressed into the seat, a sensation normally associated with a climb, and the pilot may falsely interpret it as such
- On the other hand, recovering from turns reduces pressure on the seat and may lead the pilot to believe the aircraft is descending

Disorientation

- Spatial disorientation can happen to anyone since it is due to the normal function and limitations of the senses of balance
- It only becomes dangerous when the pilot *fails* to suppress the false sensations and place complete reliance on the indications of the flight instruments
- As instrument flight experience is acquired, the onset of spatial disorientation lessens as trust in the flight instruments is built up

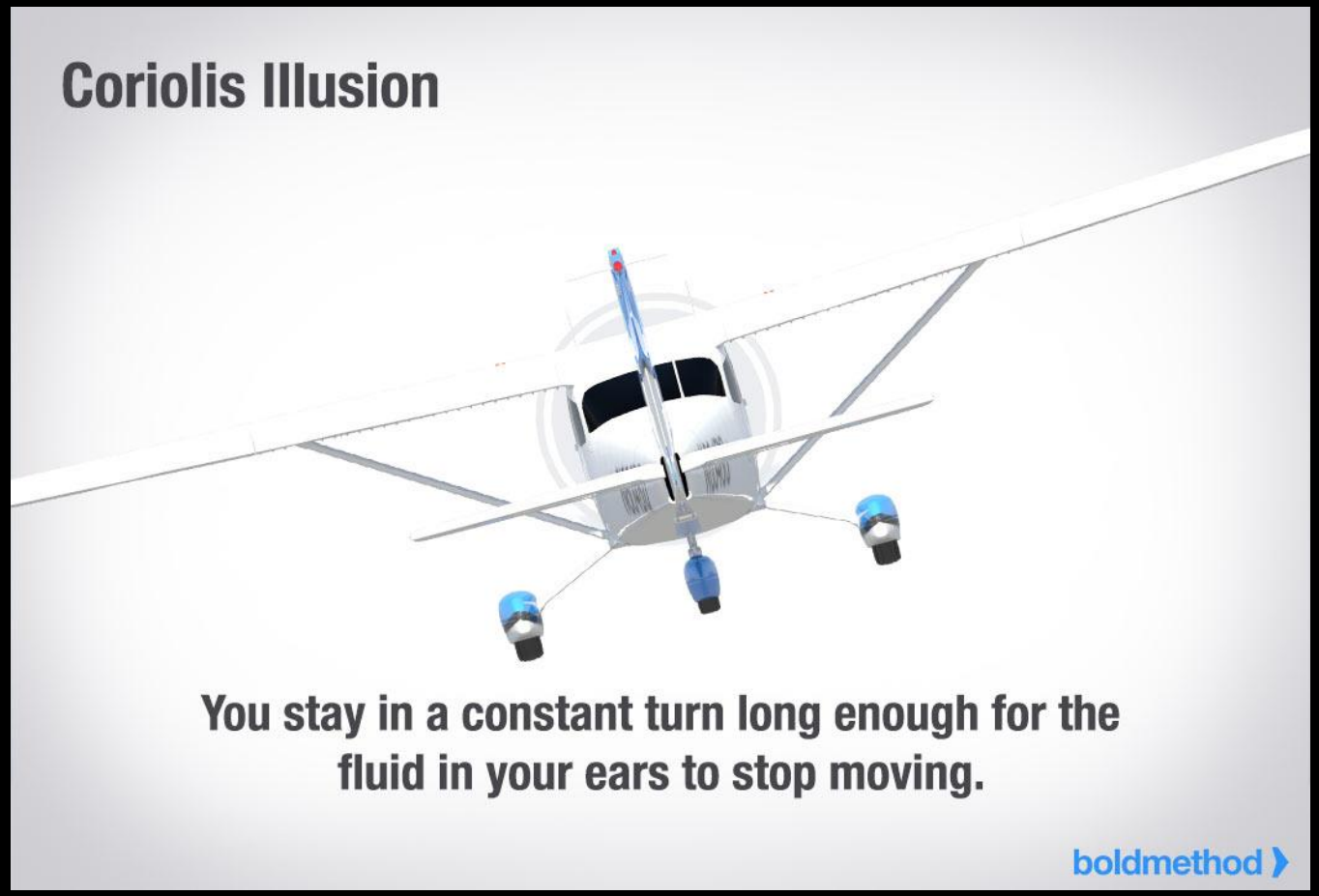
Alleviating Disorientation

- You are more subject to disorientation if you use body signals to interpret flight attitude
- To prevent or overcome spatial disorientation in IFR conditions, you must rely on and properly interpret the indication of the flight instruments
- Reducing your workload with the use of an autopilot or flight director and improving your cockpit management skills can help prevent overload and reduce the possibility of disorientation

The Leans

- The most common form of spatial disorientation is “the leans,” resulting from a banked attitude not being perceived by the pilot
- Abrupt correction of a banked attitude may stimulate the motion-sensing fluid of the inner ear, creating the sensation of banking in the opposite direction
- The pilot may roll the aircraft back to its original attitude until he thinks the aircraft is straight and level, or if level flight is maintained, will still feel compelled to align his/her body with the perceived vertical

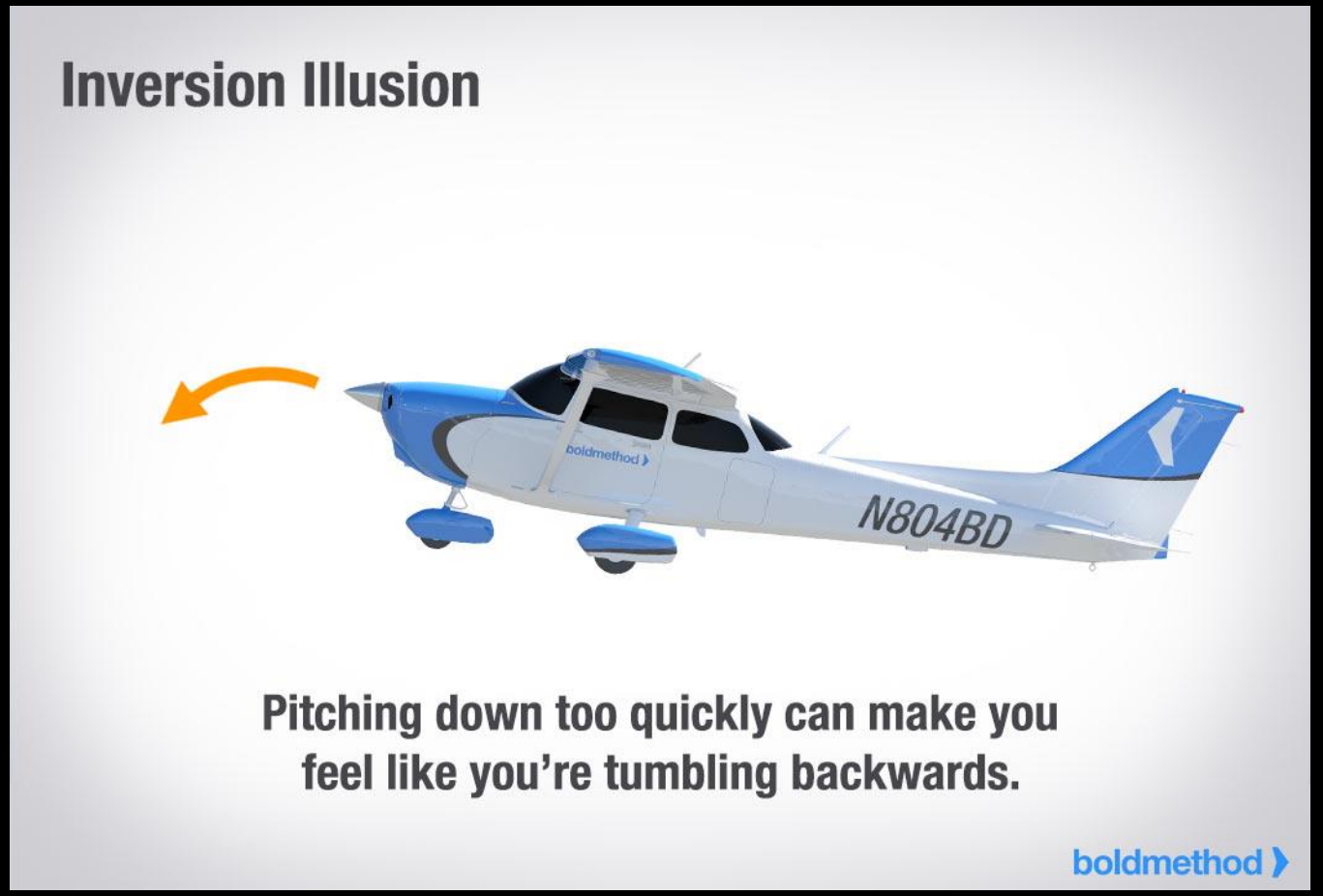
Coriolis Illusion



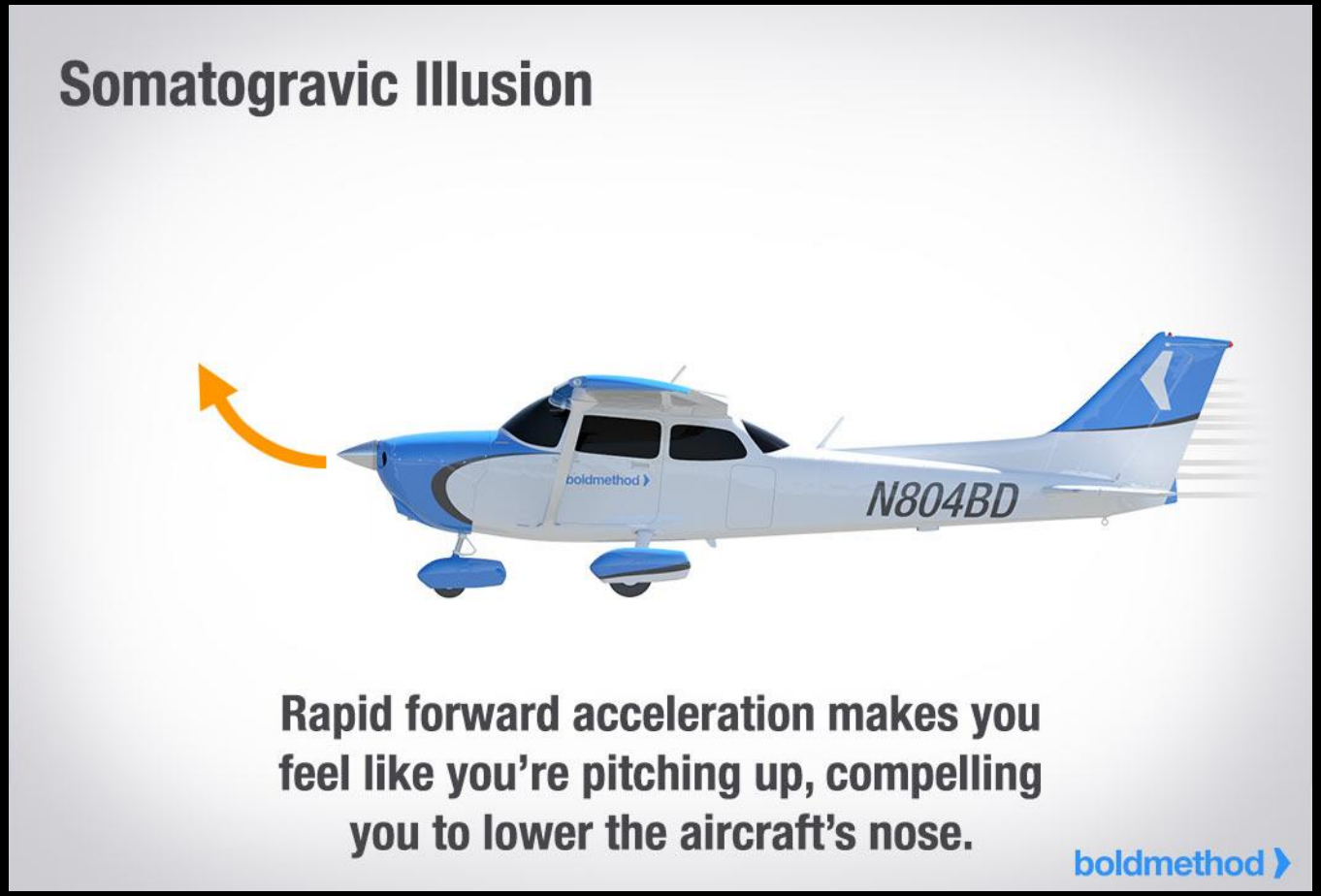
- During constant rate turn, tilting head down creates sensation of rotating, turning, or accelerating in an entirely different plane
- Attempting to stop this sensation by maneuvering the airplane may cause a dangerous attitude
- To avoid, do not move your head too fast

Inversion Illusion

- An abrupt change from climb to straight-and-level flight can create the illusion of tumbling backwards
- The disoriented pilot will push the aircraft abruptly into a nose-low attitude, possibly intensifying this illusion



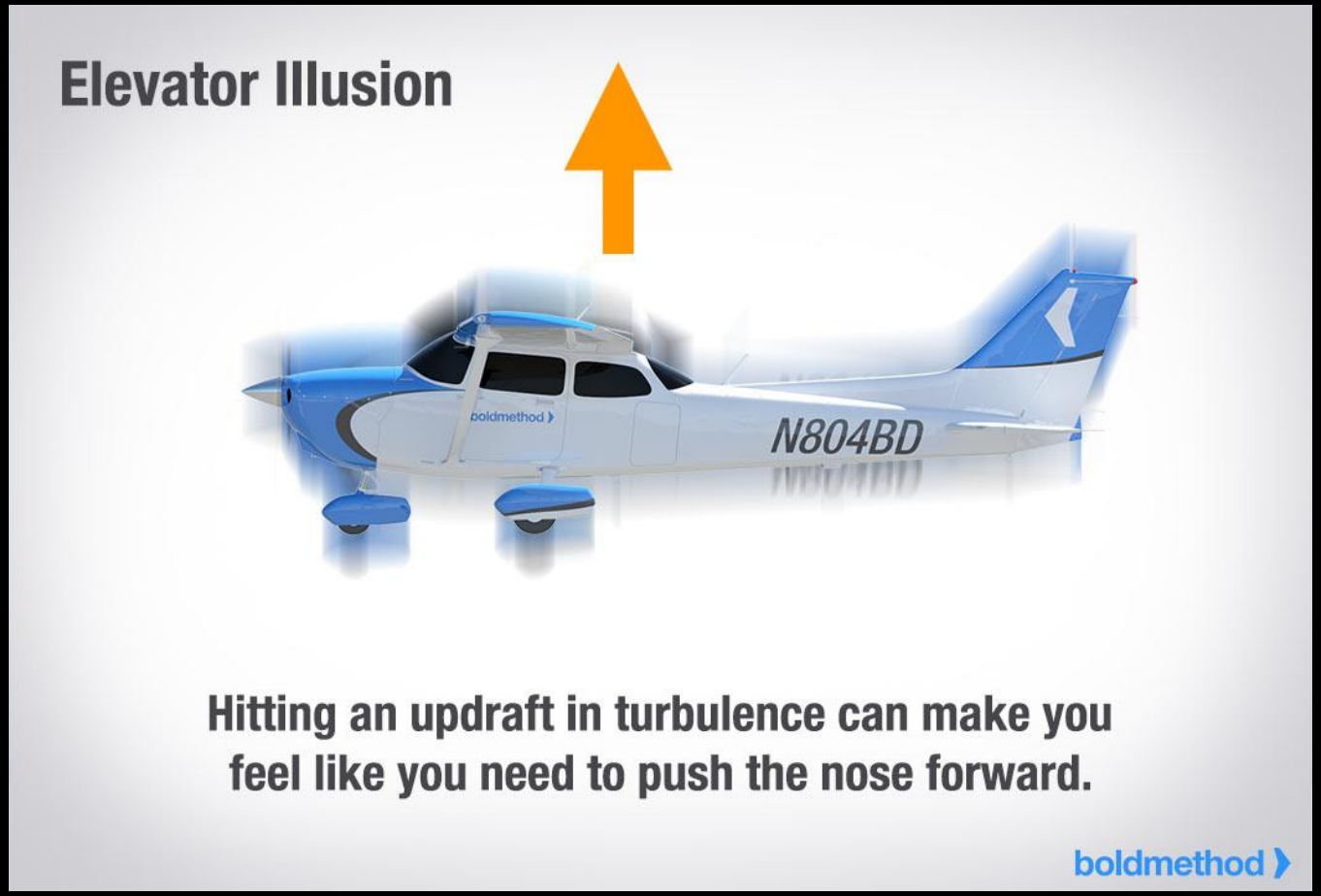
Somatogravic Illusion



Somatogravic Illusion

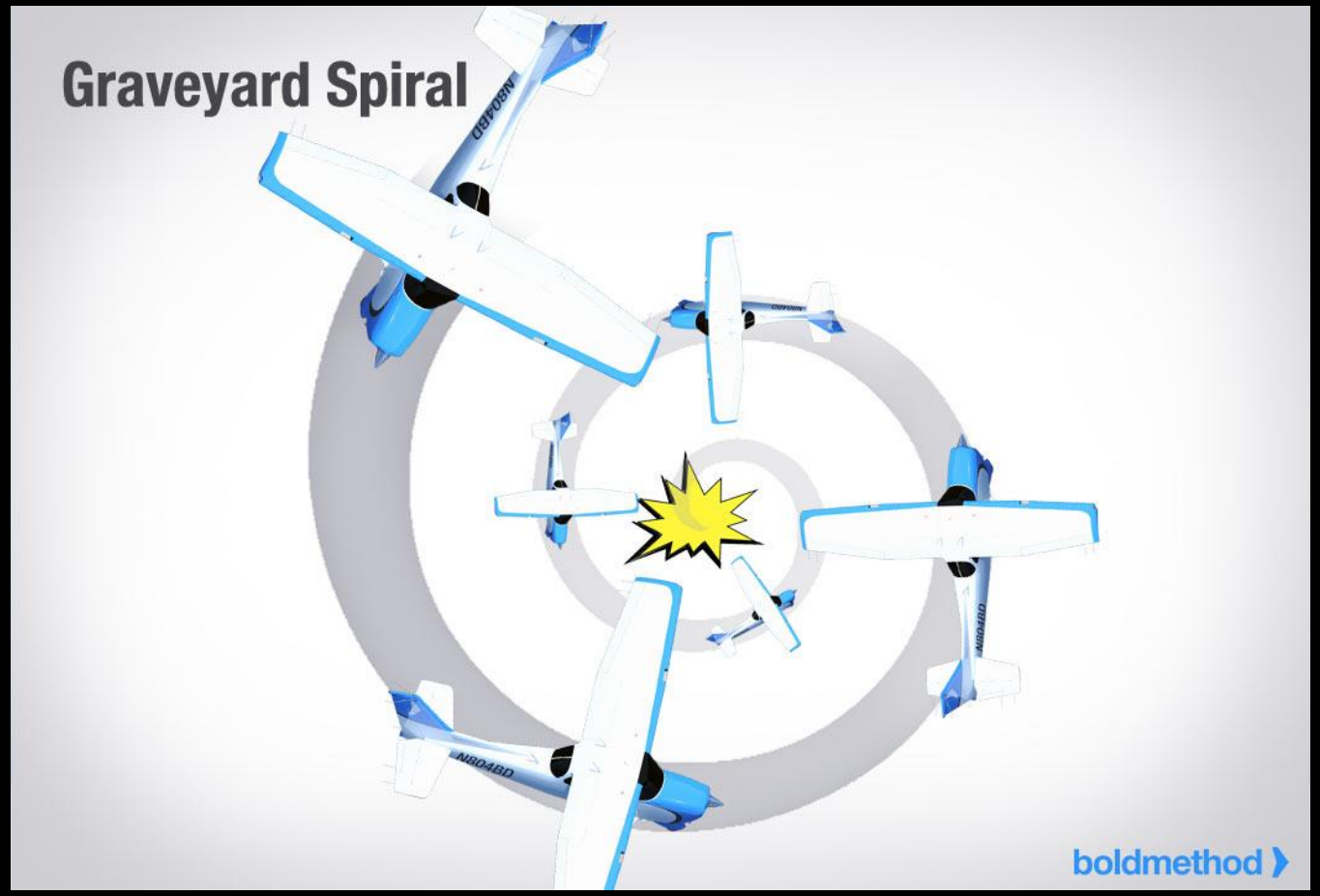
- A rapid acceleration during takeoff or go-around can create the illusion of being in a nose-up attitude
- The disoriented pilot will push the aircraft into a nose-low, or dive attitude

Elevator Illusion



Graveyard Spiral

- If you stay in a turn long enough, the fluid in your ears stops moving
- As you return to level flight, you feel like you've turned in the opposite direction, and you return to the original turn
- Because airplanes lose altitude in a turn unless you add back pressure, the airplane starts descending
- Because you think you're in a wings-level descent, you pull back on the yoke
- You tighten the spiraling turn, and lose even more altitude

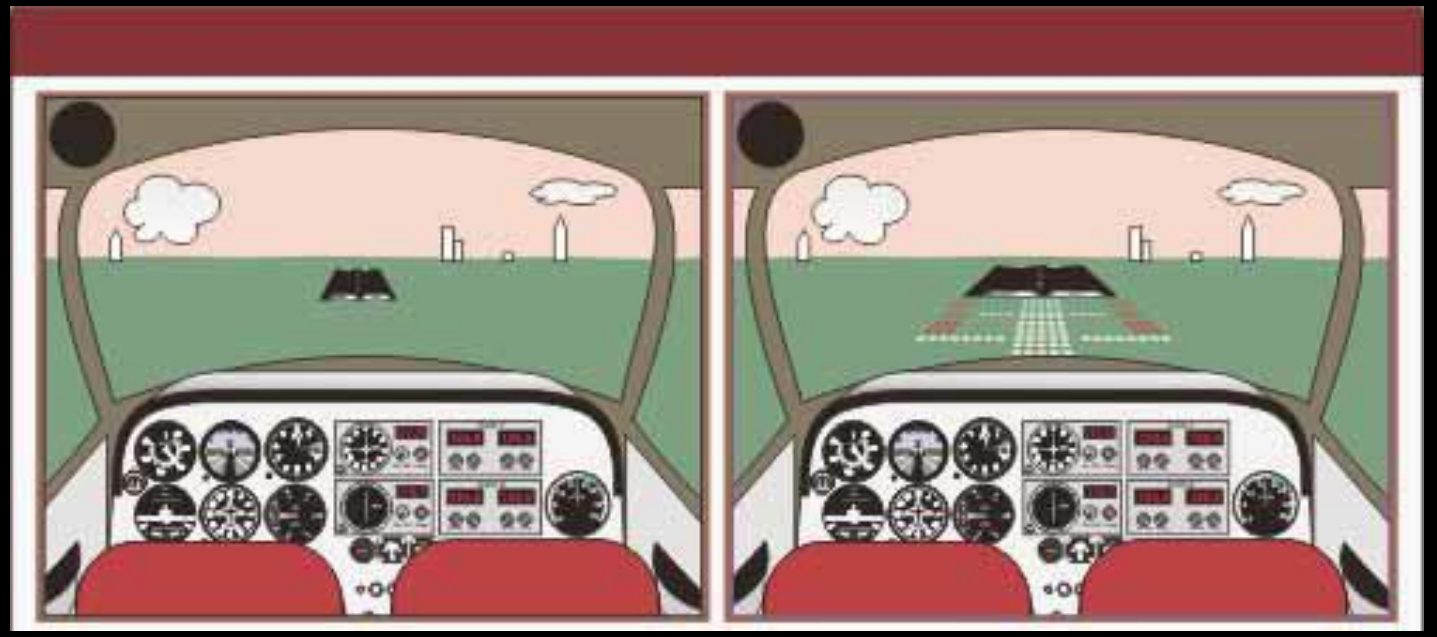


Optical Illusions

- Various atmospheric and surface features encountered while landing may create the illusion of incorrect distance from, or height above, the landing runway

Runway Width Illusion

- A runway that is narrower-than-usual can create the illusion that the aircraft is at a higher altitude that it is causing the pilot to fly a lower-than-normal approach
- A wider-than-usual runway can have the opposite effect

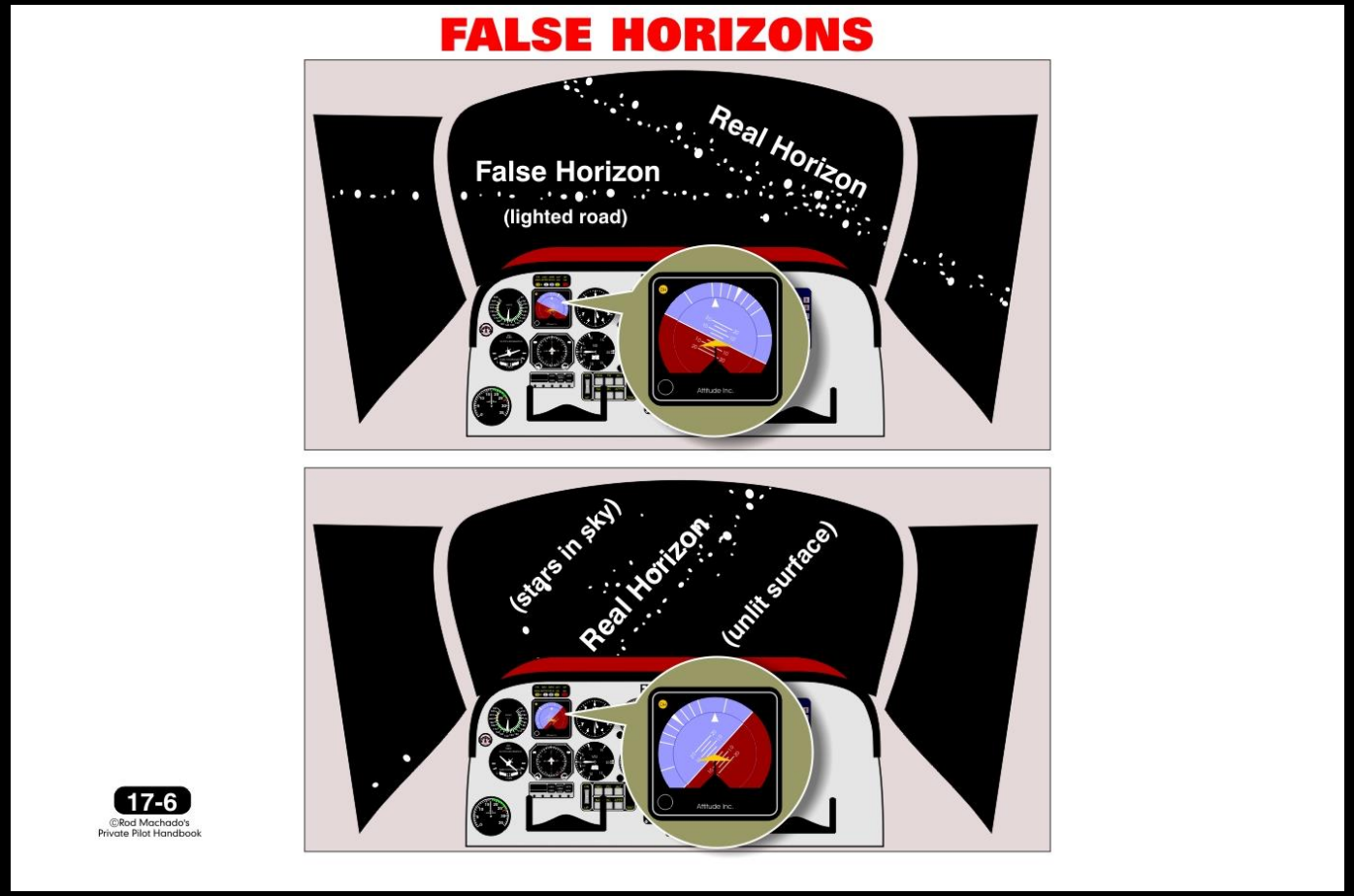


Runway and Terrain Slopes Illusion

- An upsloping runway or upsloping terrain can create the illusion that the aircraft is at a higher altitude than it actually is
- A down-sloping runway will have the opposite effect

False Horizons Illusion

- Sloping cloud formations, an obscured horizon, a dark scene spread with ground lights and stars, or certain geometric patterns of ground light can create illusions of not being aligned correctly with the actual horizon
- The disoriented pilot will place the aircraft in a dangerous position



Atmospheric Illusion

- Haze can create the illusion of being at a greater distance from the runway
- Rain on the windshield can create an illusion of greater height
- The pilot who does not recognize these illusions will fly a lower-than-normal approach

Cockpit / Tower Scanning

- Only a very small portion of the eye sends clear messages to the brain
- Eyes focus on only a narrow viewing area, so effective scanning is done with a series of short, regularly-spaced eye movements that bring successive areas of the sky into the central viewing area of the retina
- Each movement should not exceed 10°, and each area should be observed for at least 1 second to enable the eyes to detect a moving or contrasting object

Cockpit Scanning

- Pilots should execute gentle banks, at a frequency which permits continuous visual scanning of the airspace about them, during climbs and descents in flight conditions which permit visual detection of other traffic
- Particular vigilance should be exercised when operating in areas where aircraft tend to converge, such as near airports and over VOR stations

Cockpit Lighting

- Dark adaptation, during which vision becomes more sensitive to light, can be achieved to a moderate degree within 20 minutes under dim red cockpit lighting
- After that, any exposure to white light, even for a few seconds, will seriously impair night vision

Human Factors

Aeromedical and Human Factors

Drugs

- Many drugs used to alleviate symptoms of illness and disease have side effects that interfere with your ability to fly safely
- Prior to flying you should consult an aviation medical examiner about any medication you are using

Alcohol

- Alcohol and other depressants impair the body's functioning in several critical areas, causing decreased mental processing and slow motor and reaction responses
- FARs state that you must not fly within 8 hours of using alcohol, or when you have a blood alcohol level of .04% or greater
- As little as one ounce of liquor, one bottle of beer, or four ounces of wine can impair flying skills, with the alcohol consumed in these drinks being detectable in the breath and blood for at least 3 hours

Fatigue

- Fatigue is frequently associated with pilot error. Some of the effects of fatigue include degradation of attention and concentration, impaired coordination, and decreased ability to communicate.
- These factors seriously influence the ability to make effective decisions. Physical fatigue results from sleep loss, exercise, or physical work.
- Factors such as stress and prolonged performance of cognitive work result in mental fatigue.

Fatigue

- Like stress, fatigue falls into two broad categories: acute and chronic.
- Acute fatigue is short term and is a normal occurrence in everyday living. It is the kind of tiredness people feel after a period of strenuous effort, excitement, or lack of sleep. Rest after exertion and 8 hours of sound sleep ordinarily cures this condition.
- Chronic fatigue, extending over a long period of time, usually has psychological roots, although an underlying disease is sometimes responsible. Continuous high-stress levels produce chronic fatigue.
- Chronic fatigue is not relieved by proper diet and adequate rest and sleep and usually requires treatment by a physician.

Knowledge Check

When does impairment being after drinking alcohol?

A. After 3 hours
B. After 3 oz.
C. 1 drink
D. Immediately

Knowledge Check

When does impairment being after drinking alcohol?

A. ~~After 3 hours~~
B. ~~After 3 oz.~~
C. ~~1 drink~~
D. Immediately

Knowledge Check

Acute fatigue can be solved with a good night of rest?

A. True
B. False

Knowledge Check

Acute fatigue can be solved with a good night of rest?

A. True
B. ~~False~~

Knowledge Check

Which of the following illusions make you feel like the airplane is pitching up?

A. False Horizons
B. Elevator
C. Leans
D. Somatogravic

Knowledge Check

Which of the following illusions make you feel like the airplane is pitching up?

A. ~~False Horizons~~
B. ~~Elevator~~
C. ~~Leans~~
D. Somatogravic

Knowledge Check

Which type of hypoxia is a result of flying at a higher altitude?

A. Hypemic
B. Histotoxic
C. Stagnant
D. Hypoxic

Knowledge Check

Which type of hypoxia is a result of flying at a higher altitude?

A. ~~Hypemic~~
B. ~~Histotoxic~~
C. ~~Stagnant~~
D. Hypoxic

Knowledge Check

The best way to overcome disorientation is?

A. Drink water
B. Breath into a bag
C. Rely on flight instruments
D. Ignore flight instrument and use internal senses

Knowledge Check

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