



Human Factors

Overview

WHAT

- Several health and physiological factors that can influence a pilot's ability to fly safely

WHY

- Many of these factors not only affect the health and well-being of the pilot, but can quickly lead to in-flight emergencies

CONTENT

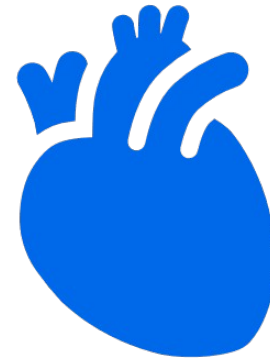
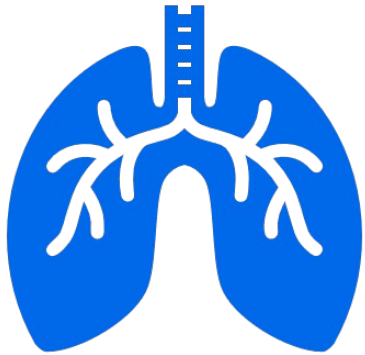
- Hypoxia & Hyperventilation
- Middle Ear and Sinus Problems
- Spatial Disorientation
- Motion Sickness
- Carbon Monoxide Poisoning
- Fatigue and Stress
- Dehydration
- Hypothermia
- Optical Illusions
- Nitrogen and Scuba Diving
- Alcohol and Drugs
- ADM, CRM, & SRM



Hypoxia

Types

- Hypoxic: Lack of oxygen to the lungs
- Hypemic: Not enough blood
- Stagnant: Not flowing
- Histotoxic: Inability of the cells to use oxygen



Hypoxia

Symptoms & Treatment

- Symptoms
 - Cyanosis, headache, impaired judgement & reactions, euphoria, visual impairment, drowsiness, lightheaded/dizzy, tingling, numbness
- Time of Useful Consciousness

Altitude	Time of Useful Consciousness
40,000'	15 to 20 seconds
30,000'	1 to 2 minutes
22,000'	5 to 10 minutes

- Treatment – Use supplemental oxygen immediately and get to a lower altitude



Hyperventilation

- Excessive loss of carbon dioxide from the blood
- Causes
 - Emotional stress, fright or pain, leading to increased breathing rate and depth
- Symptoms
 - Very similar to Hypoxia
 - Lightheaded/dizzy, tingling, visual impairment, hot and cold, muscle spasms
- Treatment
 - Breathe normally (best prevention and cure)
 - Breathe into a paper bag, or talk out loud
 - If unsure, treat for Hypoxia (more dangerous condition)



Middle Ear and Sinus Problems

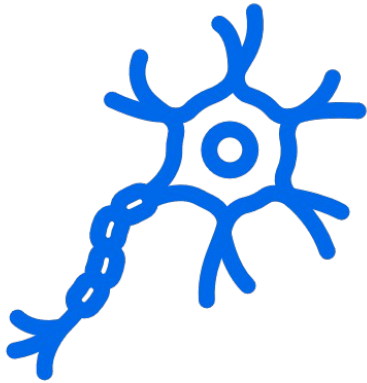
- Middle Ear
 - Difference in pressure in the middle ear & outside the body
 - Symptoms: Pain, reduced hearing sensitivity
 - Treatment: Chew gum, stretch jaw, valsalva, medicine
- Sinus
 - Normally, sinus pressure equalizes with cockpit pressure
 - Congestion can prevent pressure from equalizing
 - Symptoms: Sinus pain, upper tooth pain, bloody mucus
 - Treatment: Slow descent rates, Do Not Fly



Source: PHAK, FAA



Spatial Disorientation

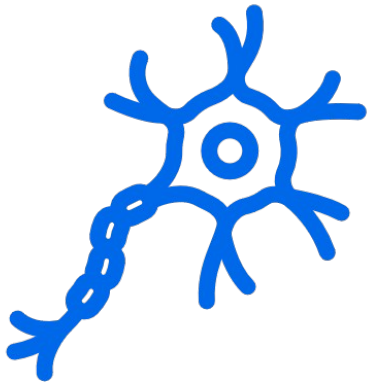


Overview

Lack of orientation with the position, attitude, or movement of the plane in space

- Orientation Systems
 - Visual: Eyes (largest source of information)
 - Somatosensory: Nerves that sense position based on gravity & feeling
 - Vestibular: Motion sensing system located in the inner ears
- Brain combines 3 systems for orientation
 - When 1 or more disagree, conflicting info can lead to disorientation

Spatial Disorientation



In Flight

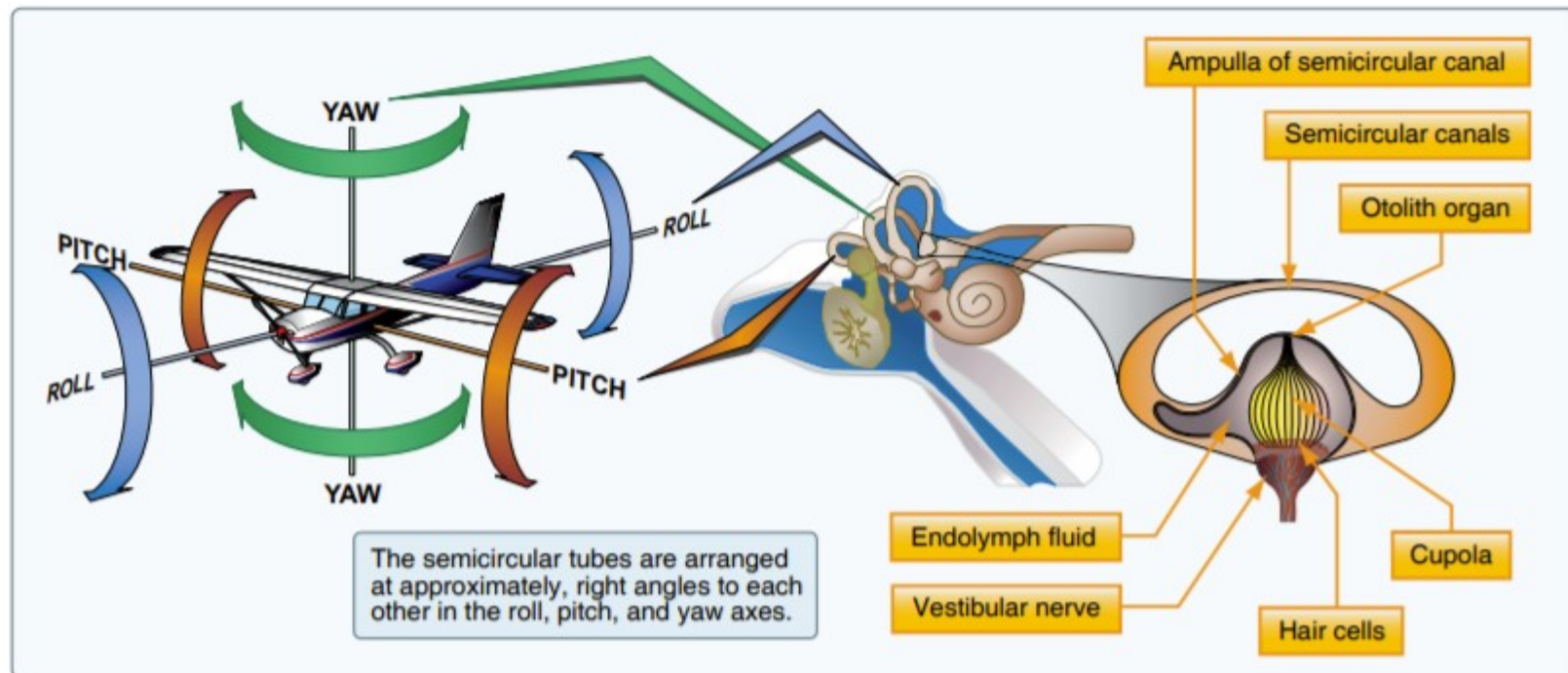
- Flying can result in conflicting info being sent to the brain
- Visual System (eyes)
 - Primary orientation system
 - Prevails over false sensations from other systems
 - In IMC, the eyes cannot correct for false sensations
- Somatosensory System (nerves)
 - Forces in flight can lead to false sensations of the direction of gravity
 - The brain cannot differentiate between forces in turns and gravity
 - Turbulence can confuse the brain
- Vestibular System (ears)
 - Semicircular Canals: Detect angular acceleration
 - Otolith Organs: Detect linear acceleration



Spatial Disorientation

In Flight: Semicircular Canals

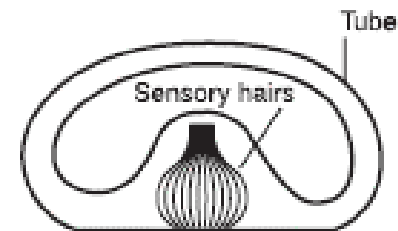
- 3 tubes, 1 on each axis, at right angles to each other
- Canals are filled with endolymph fluid
- Cupola (gelatinous structure on sensory hairs) at the center of the canal



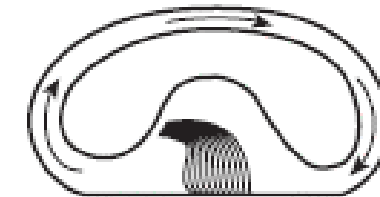
Spatial Disorientation

In Flight: Semicircular Canals

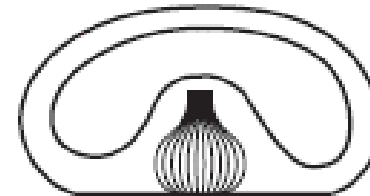
- Straight & level: Sensory hairs are upright
- A turn puts semicircular canal and its fluid in motion, deflecting the sensory hairs
- Brain interprets movement as a turn
- Recognizes movement for about 20 seconds
- In long turns, the brain can interpret a rollout as a turn in the opposite direction



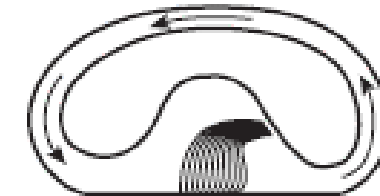
No turning
No sensation.



Start of turn
Sensation of turning as moving fluid deflects hairs.



Constant rate turn
No sensation after fluid accelerates to same speed as tube wall.



Turn stopped
Sensation of turning in opposite direction as moving fluid deflects hairs in opposite direction.

Source: PHAK, FAA

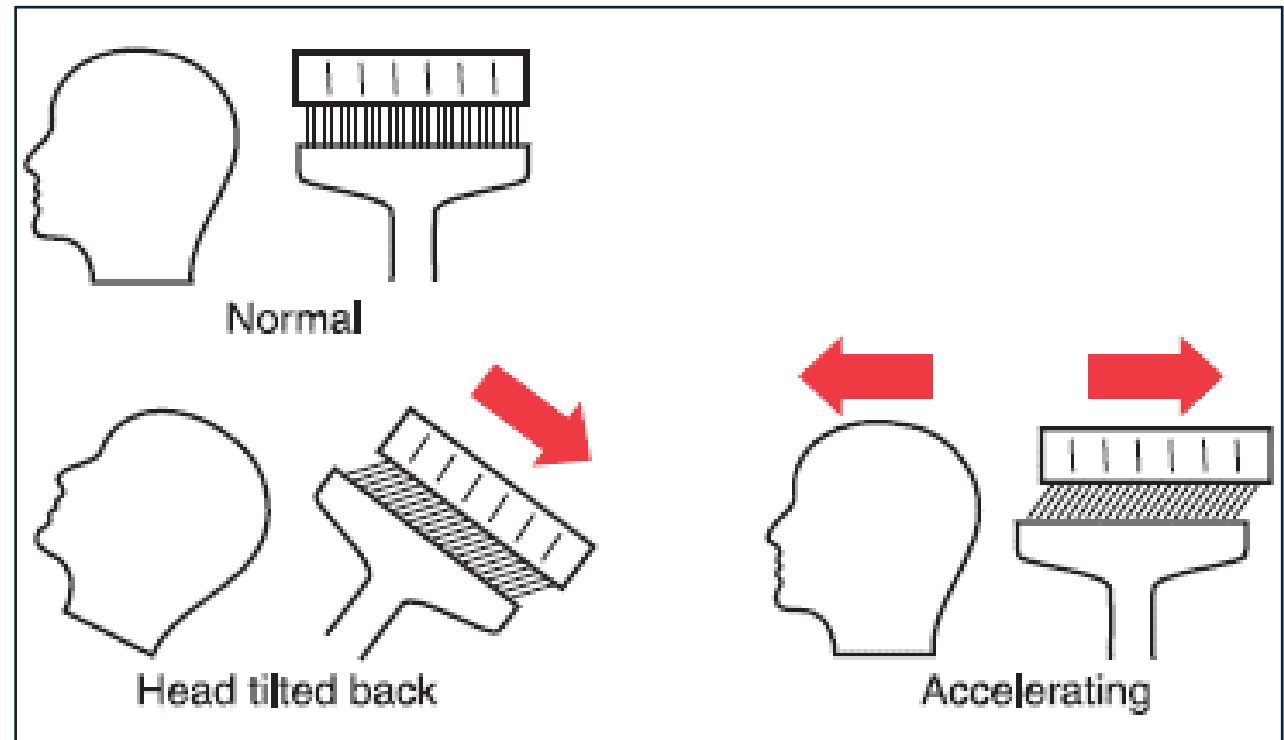


Spatial Disorientation

In Flight: Otolith Organs

Gelatinous membrane with chalk like crystals covering sensory hairs

- When you tilt your head forward or backward:
 - Weight of the crystals causes the membrane to shift due to gravity
 - Sensory hairs detect the shift
 - Brain recognizes the movement
- Otolith Organs & Acceleration
 - Forward acceleration: Illusion of tilting backward
 - Deceleration: Illusion of tilting forward



Source: PHAK, FAA



Motion Sickness

- Causes
 - Brain receiving conflicting messages about the state of the body
 - Anxiety and stress
- Symptoms
 - Discomfort, Nausea, Dizziness, Paleness, Sweating, Vomiting
 - Generally, goes away after the first few lessons
- Treatment
 - Open fresh air vents
 - Focus on objects outside the airplane
 - Avoid unnecessary head movement
 - Take control of the plane and fly smoothly



Carbon Monoxide (CO) Poisoning

- How it Happens
 - Colorless, odorless gas produced by the engine
 - Damaged, leaking exhaust system
 - Heater/defrost vents transport CO to the cockpit
- CO & the Body
 - CO attaches to the hemoglobin in the blood (200x easier than oxygen)
 - Prevents hemoglobin from carrying oxygen to cells (hypemic hypoxia)
- Effects
 - Headache, blurred vision, dizziness, drowsiness, loss of muscle power
- Detecting & Correcting
 - Carbon monoxide detectors
 - Turn off heater, open fresh air vents, use supplemental oxygen, land



Fatigue

Overview

- Effects
 - Degraded attention & concentration
 - Impaired coordination
 - Decreased ability to communicate
- Causes
 - Sleep loss, exercise/physical work, stress, prolonged cognitive work
- Acute Fatigue
 - Short term, normal occurrence in everyday life
 - Skill Fatigue: Special type of acute fatigue affecting piloting skills
 - Causes: Physical & psychological stress, mild hypoxia
 - Prevention: Proper diet, adequate rest



Fatigue

Types

- Chronic Fatigue
 - Long term, usually with psychological roots or an underlying disease
 - Causes: Continuous high-stress levels
 - Symptoms: Weakness, tiredness, heart palpitations, breathlessness, headaches, irritability, aches and pains, emotional illness
 - Prevention: Treatment by a physician
- Preventing Fatigue
 - Acute Fatigue: Stay on the ground
 - Avoid flying :
 - Without a full night's rest
 - After working excessive hours
 - After an especially exhausting or stressful day
 - Chronic Fatigue: Should be treated by a physician. Do not fly



Stress

Overview

The body's response to physical and psychological demands placed upon it

- Stress & the Body
 - Releases chemical hormones (adrenaline) into the blood
 - Increased metabolism to provide more energy to the muscles
 - Blood sugar, heart rate, respiration, blood pressure, and perspiration increase
- Stressors
 - Physical stress (noise or vibration)
 - Physiological stress (fatigue)
 - Psychological stress (difficult work or personal situations)
- Categories of Stress
 - Acute Stress (short term)
 - Chronic Stress (long term)
 - DO NOT FLY



Stress

Types

- Acute Stress
 - Short term
 - Involves an immediate threat that is perceived as a danger (fight or flight response)
 - Healthy person can cope with acute stress & prevent stress overload
 - On-going acute stress can develop into chronic stress
- Chronic Stress
 - Long term
 - Level of stress presenting an intolerable burden, exceeding the ability to cope
 - Performance falls sharply
 - Often caused by unrelenting psychological pressure – loneliness, financial/relationship worries, work problems, etc.
 - DO NOT FLY – Consult a physician



Dehydration

Critical loss of water from the body

- Causes
 - High temperatures, wind, humidity, diuretic drinks (coffee, tea, alcohol, caffeinated soda)
- Effects
 - Fatigue, headaches, cramps, tingling, tiredness, dizziness, degraded physical & mental abilities
- Dehydration & Flying
 - Flying skills diminish while attention is taken from flying
- Prevention
 - Stay hydrated
 - Wear light, porous clothing, and a hat
 - Keep the cockpit ventilated



Hypothermia

How it Happens

- The body loses heat faster than it can be produced
 - $< 95^{\circ}\text{F} / 35^{\circ}\text{C}$
- Mechanisms of Heat Loss
 - Radiation
 - Direct Contact
 - Wind
- Causes
 - Insufficiently warm clothing
 - Unable to get out of wet clothes
 - Too much time in the cold/cold water



Hypothermia

Recognition & Prevention

- Symptoms
 - Shivering, slurred speech/mumbling, slow, shallow breathing, weak pulse, clumsiness, drowsiness, confusion or memory loss, bright red, cold skin
- Prevention (COLD)
 - Cover: Wear protective clothing
 - Overexertion: Avoid activities resulting in a lot of sweat
 - Layers: Lose fitting, layered, lightweight clothing
 - Dry: Stay dry



Optical Illusions

- Runway Width
 - Narrow: Aircraft appears higher than it is
 - Wide: Aircraft appears lower than it is
- Runway & Terrain Slope
 - Upslope: Can cause pilot to fly a lower approach than normal
 - Downslope: Can cause pilot to fly a higher approach than normal
- Featureless Terrain
 - Aircraft appears at a higher altitude than it is
- Atmospheric
 - Rain: Can create the illusion of greater height
 - Haze: Can create the illusion of being a greater distance from the runway
 - Fog: Can create the illusion of pitching up
- Ground Lighting
 - Can create the illusion of runway and approach lights
 - Bright lighting can create the illusion of less distance to the runway



Nitrogen & Scuba Diving

- Scuba Diving & Flying
 - Results in a significant increase in nitrogen dissolved in the body
 - Airborne, reduced atmospheric pressure can release the excess nitrogen
 - Released too quickly, bubbles can form in the bloodstream, spinal cord, or brain
 - Symptoms include severe pain and/or impairment – death in extreme cases
- Provide time to allow nitrogen to return to normal levels before flying
 - At least 12 hrs. after a dive not requiring a controlled ascent before flight $\geq 8,000'$ MSL
 - 24 hours for flight above 8,000' MSL
 - At least 24 hrs. after a dive requiring a controlled ascent before flight $\geq 8,000'$ MSL



Alcohol & Drugs

- Alcohol
 - DON'T drink & fly
 - A small amount impairs judgement & decreases performance & cognition
 - Altitude multiplies the effects of alcohol on the brain
 - [FAR 91.17](#) - 8 hours “from bottle to throttle”
- Medications & Drugs
 - Basic Guideline: Do not fly while taking medications, unless FAA approved
 - [FAR 61.53](#): Prohibits flying if taking medication that would prevent obtaining a medical certificate
 - [FAR 91.17](#): Prohibits drug use that affects safety
 - Drugs with no effects on the ground may have serious effects airborne



ADM, CRM, & SRM

- Distractions
 - Illness
 - Medication
 - Stress
 - Alcohol
 - Fatigue
 - Emotion
- Combat Expectation Bias
 - Expectations can influence behavior



ADM, CRM, & SRM

Hazardous Attitudes

- Attitude affects the quality of decisions
- Spot hazardous attitudes & remove them

Hazardous Attitude	Antidotes
Macho Steve often brags to his friends about his skills as a pilot and how close to the ground he flies. During a local pleasure flight in his single-engine airplane, he decides to buzz some friends barbecuing at a nearby park.	Taking chances is foolish.
Anti-authority Although he knows that flying so low to the ground is prohibited by the regulations, he feels that the regulations are too restrictive in some circumstances.	Follow the rules. They are usually right.
Invulnerability Steve is not worried about an accident since he has flown this low many times before and he has not had any problems.	It could happen to me.
Impulsivity As he is buzzing the park, the airplane does not climb as well as Steve had anticipated and, without thinking, he pulls back hard on the yoke. The airspeed drops and the airplane is close to stalling as the wing brushes a power line.	Not so fast. Think first.
Resignation Although Steve manages to recover, the wing sustains minor damage. Steve thinks to himself, "It doesn't really matter how much effort I put in—the end result is the same whether I really try or not."	I'm not helpless. I can make a difference.



ADM, CRM, & SRM

Stress Management

- 3 Types of Performance Affecting Stress:
 - Physical
 - Physiological
 - Psychological
- Recognize when stress is affecting the learner

Stressors
Physical Stress Conditions associated with the environment, such as temperature and humidity extremes, noise, vibration, and lack of oxygen.
Physiological Stress Physical conditions, such as fatigue, lack of physical fitness, sleep loss, missed meals (leading to low blood sugar levels), and illness.
Psychological Stress Social or emotional factors, such as a death in the family, a divorce, a sick child, or a demotion at work. This type of stress may also be related to mental workload, such as analyzing a problem, navigating an aircraft, or making decisions.



ADM, SRM, & CRM

Resources & Workload Management

- Use all Resources
 - Internal: Equipment, systems, charts, books, ingenuity, knowledge, skill, other passengers
 - External: ATC, FSS, Guard, etc.
- Plan, Prioritize & Sequence to prevent overload
- Prepare for and recognize high workload situations





Questions?