

Reducing the Threat of the Somatogravic Illusion

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- The Somatogravic Illusion.
- Knowledge of the Illusion Amongst Pilots.
- Current Training for the Illusion.
- Factors Contributing to the Illusion.
- Factors Mitigating the Illusion.
- Reducing the threat of the Illusion.

Somato (body) gravic (sensing).

An incorrect perception of attitude due to the brain misinterpreting the gravito-inertial acceleration sensed by the vestibular system during prolonged linear acceleration; with reduced, absent or confused visual and proprioceptive information.

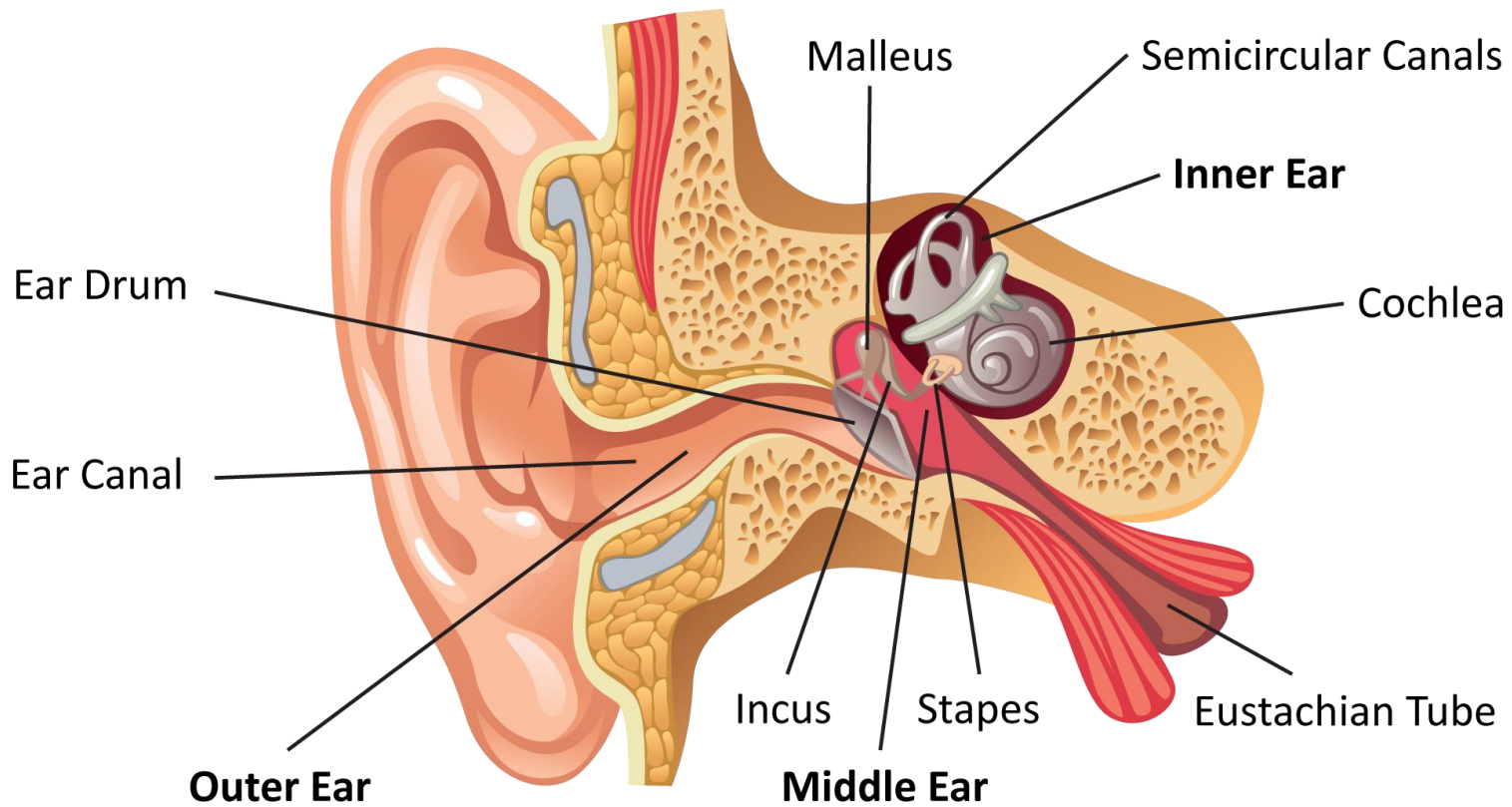


Image: Davidson Hearing Aids

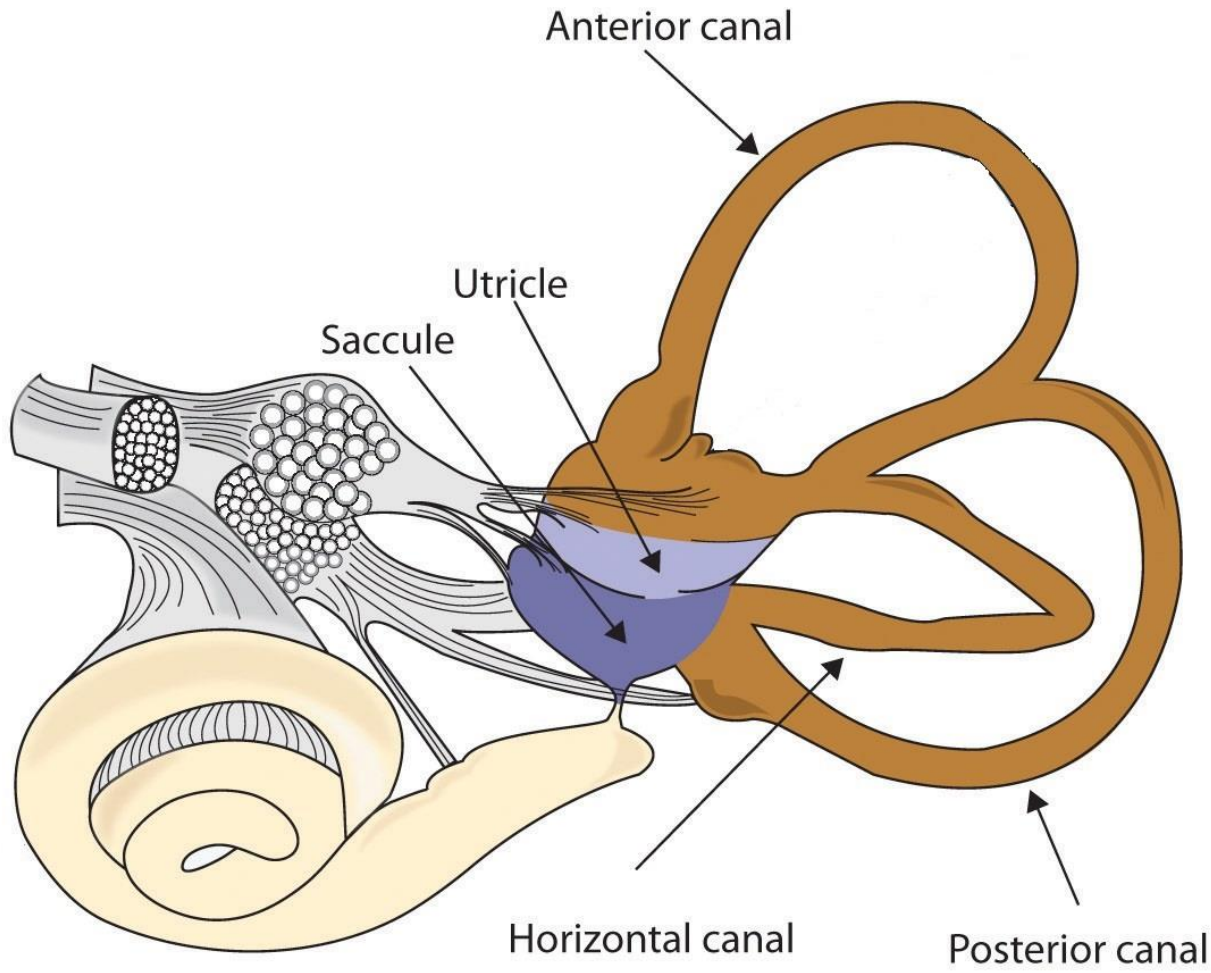


Image: Saylor Academy

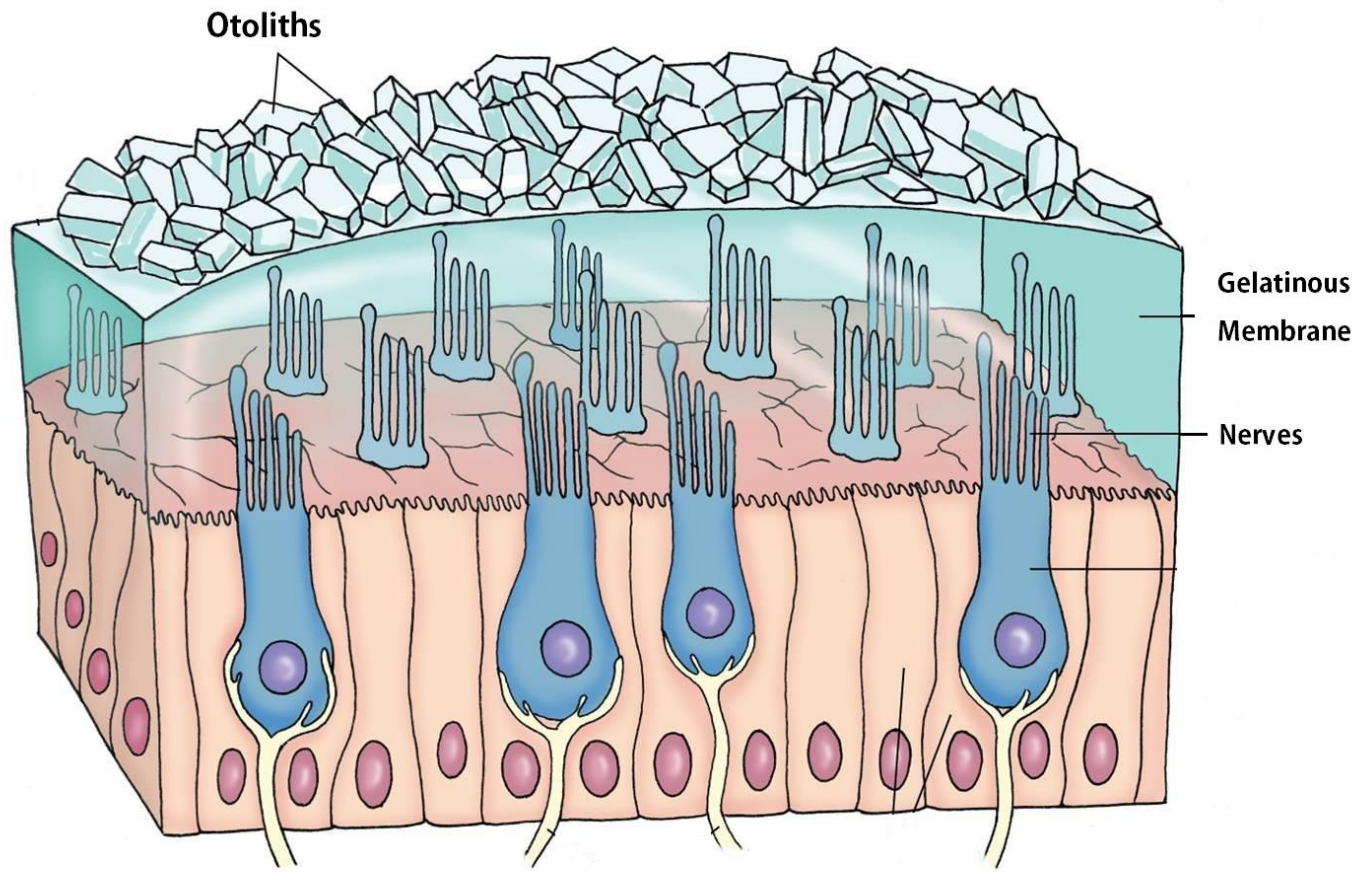
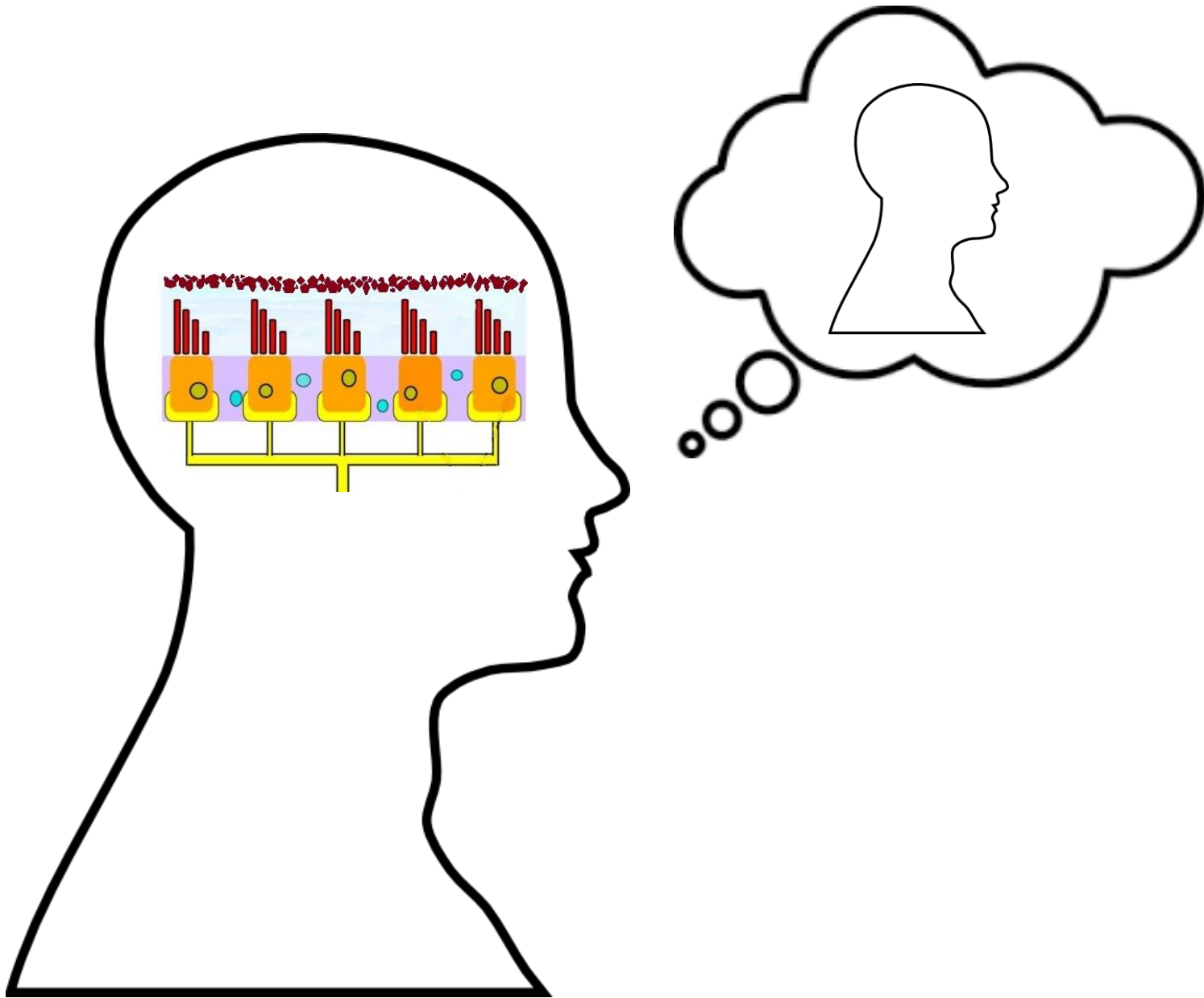
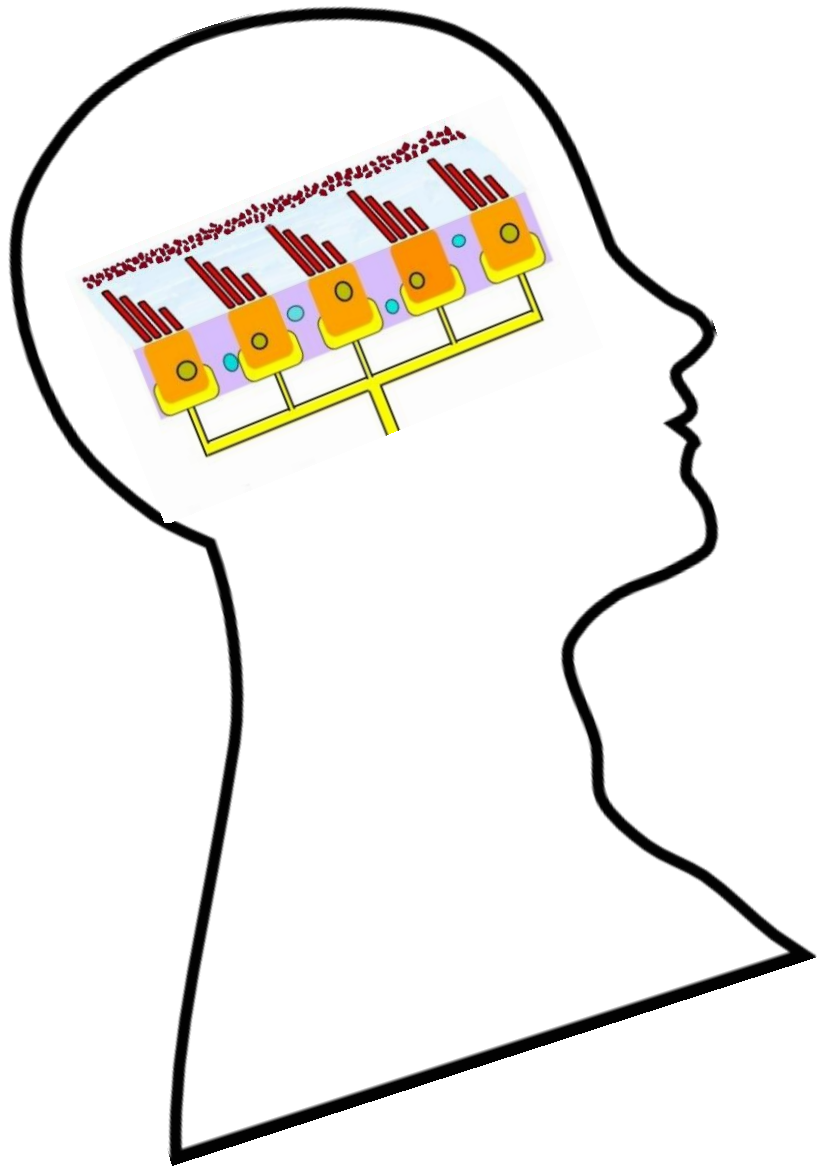
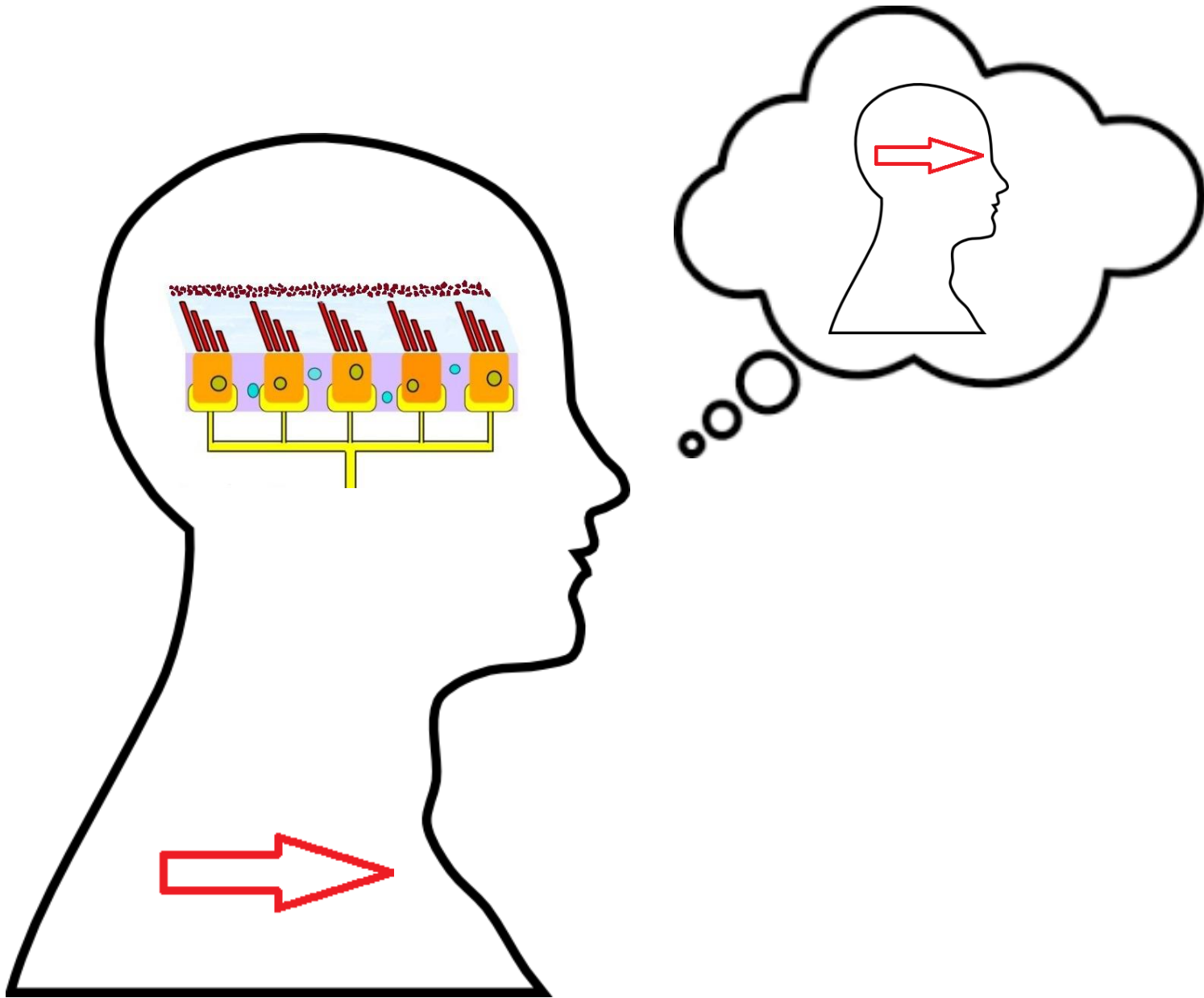
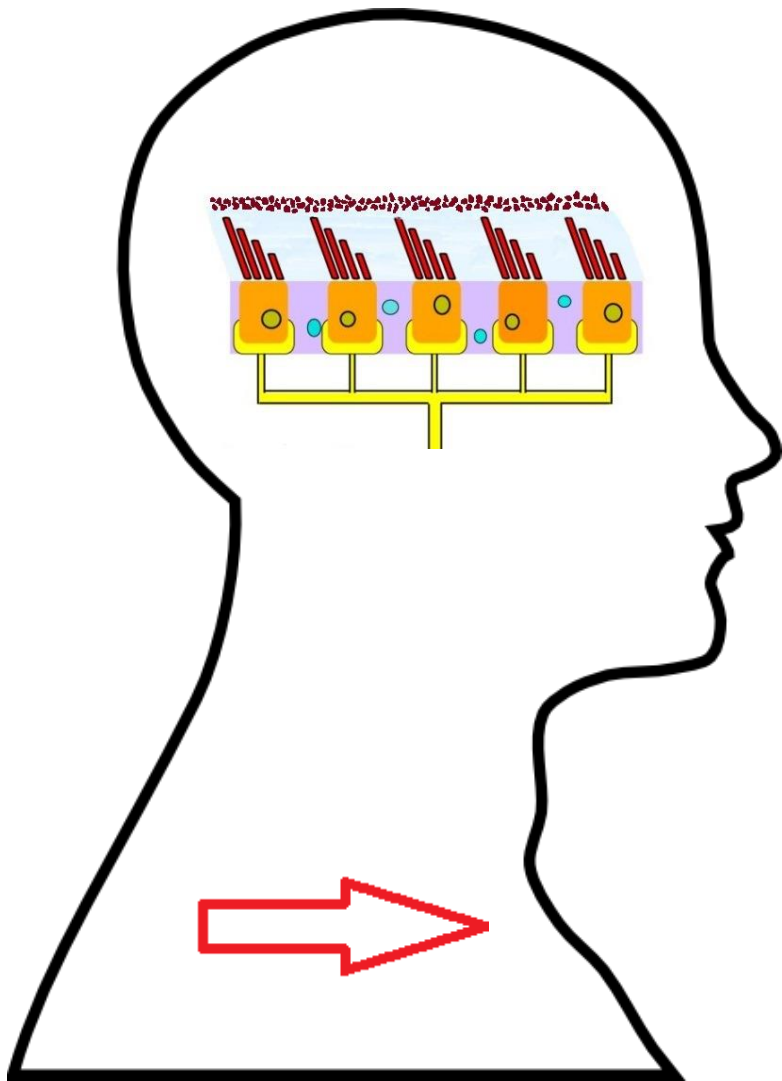


Image: www.studyblue.com









About 80% of human orientation is visual.

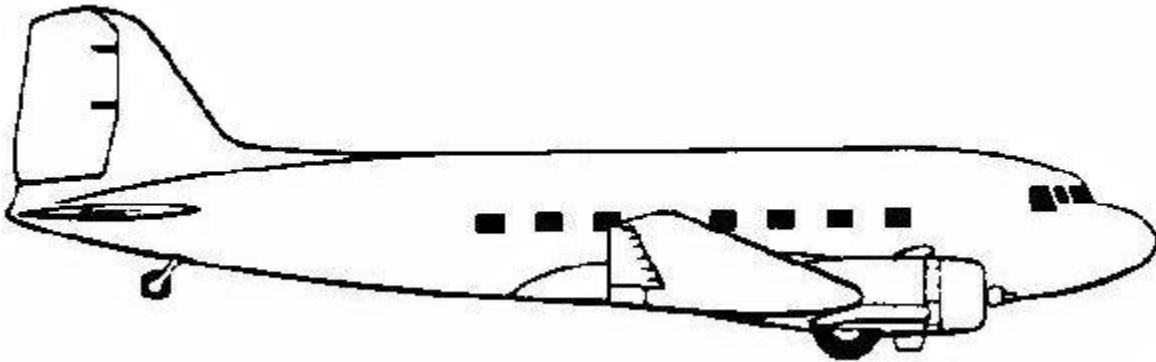
About 10% is from the proprioceptive sensors.

About 10% is from the vestibular system.

If the visual element is missing, then the sense of orientation will defer to the vestibular and proprioception inputs



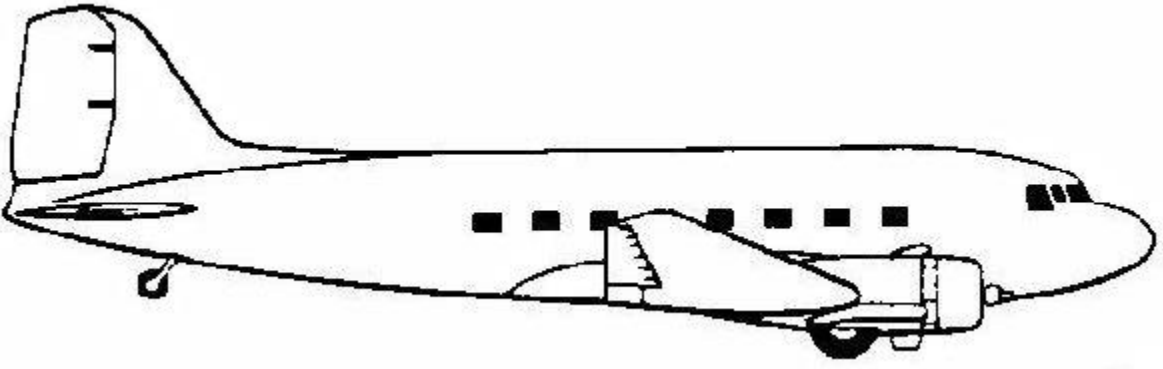
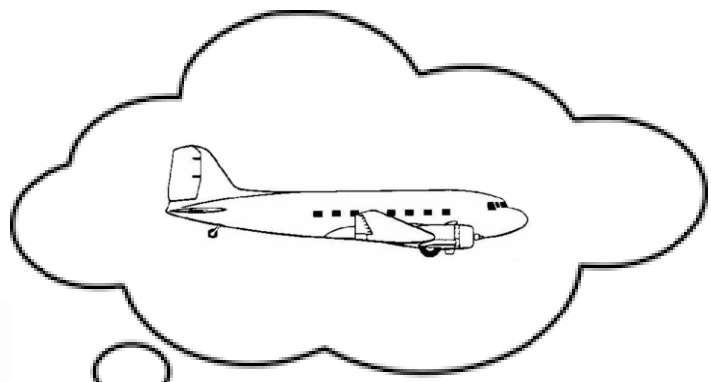
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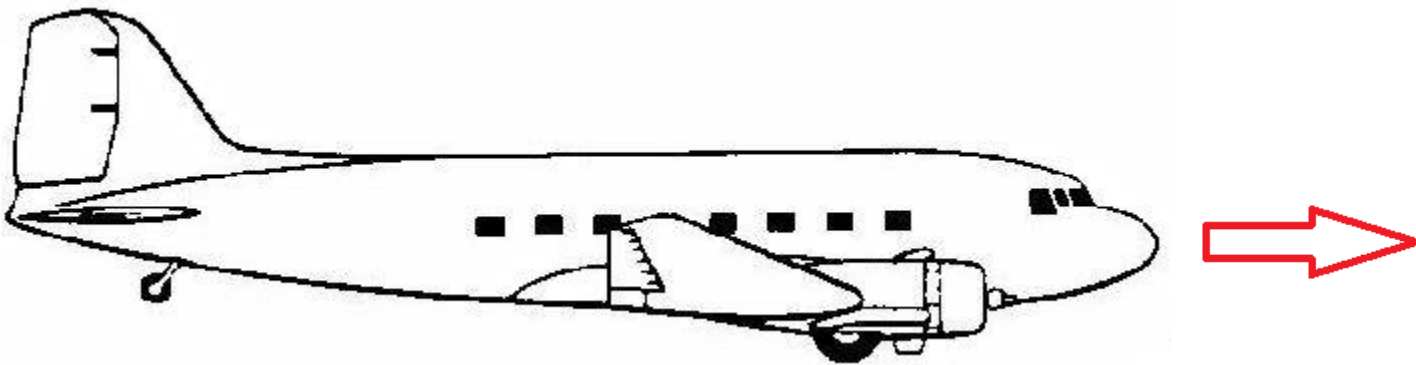
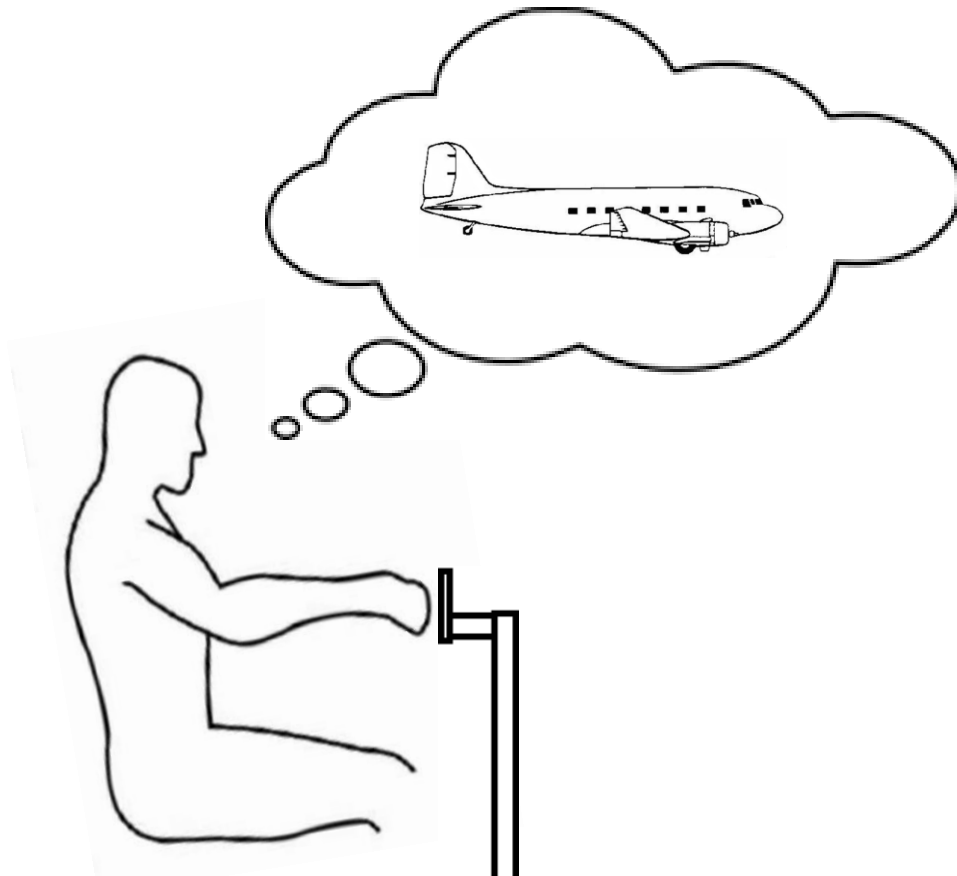
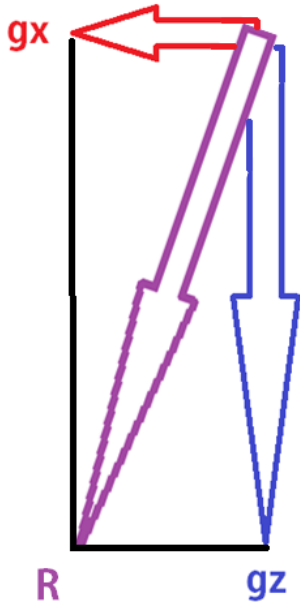


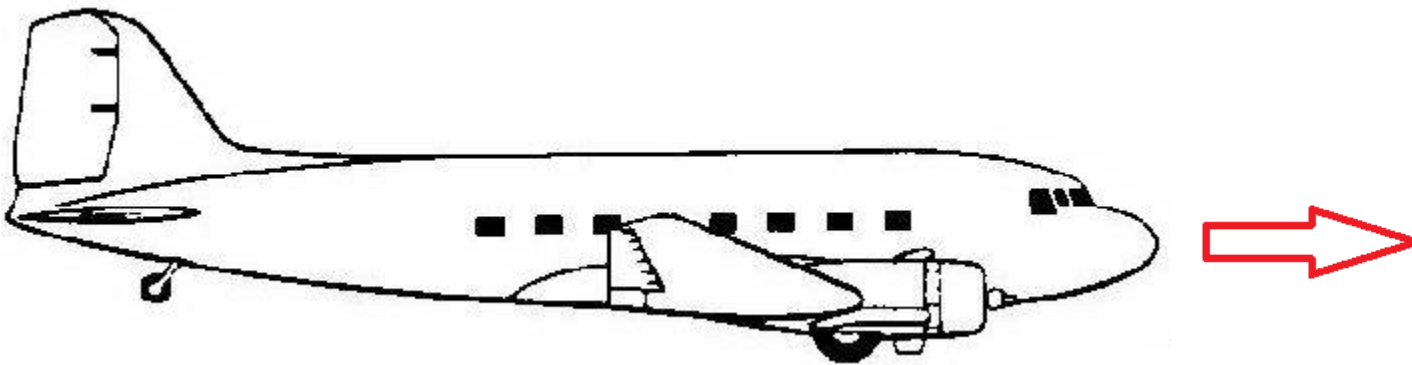
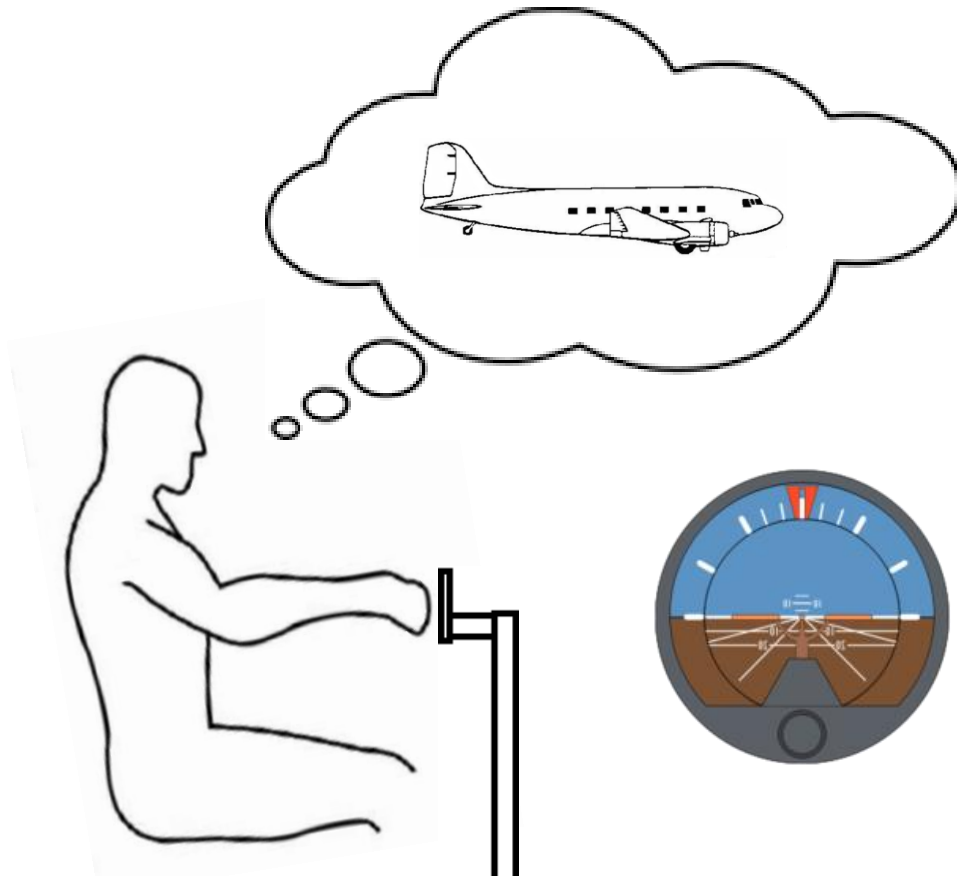
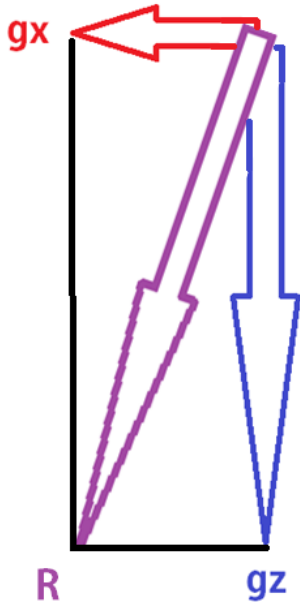
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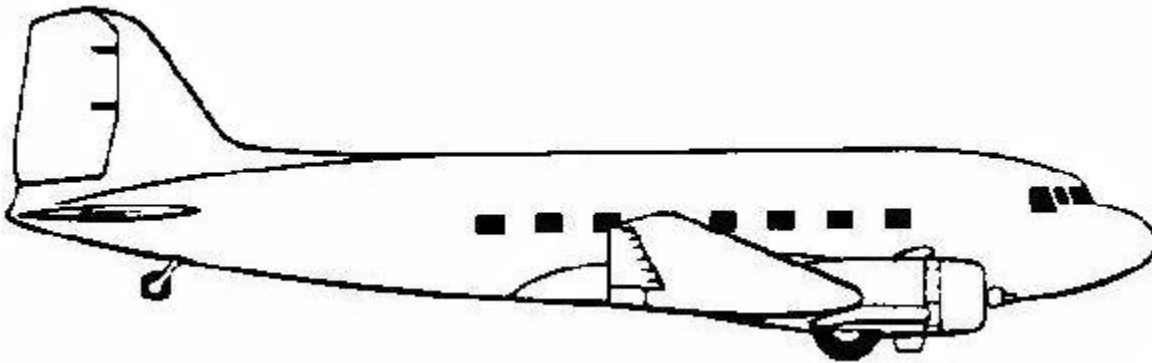
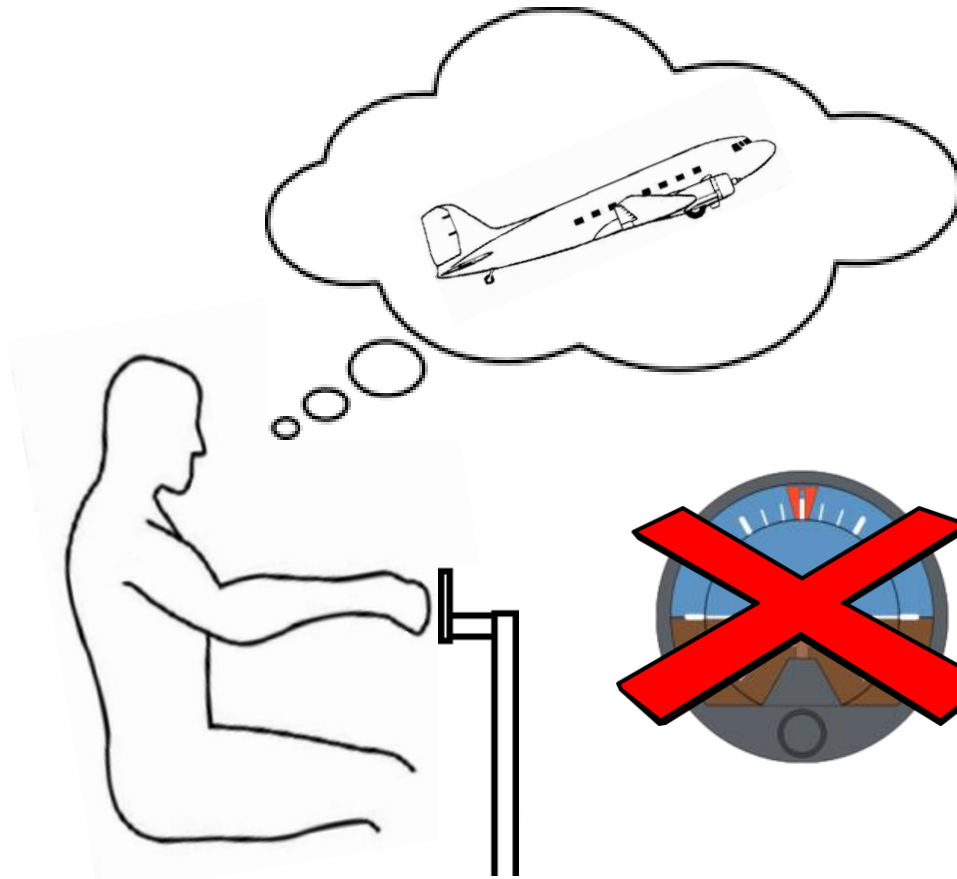
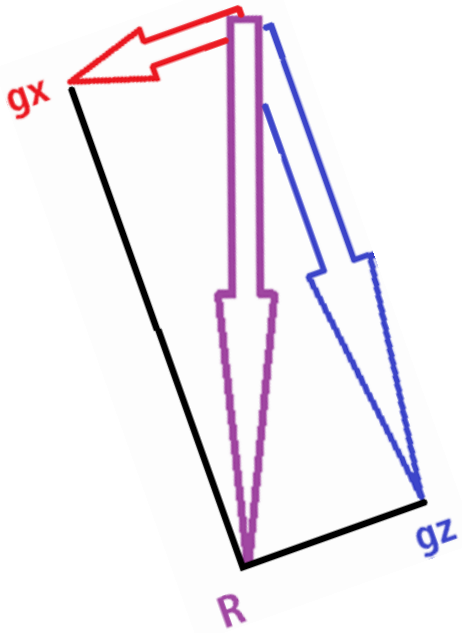


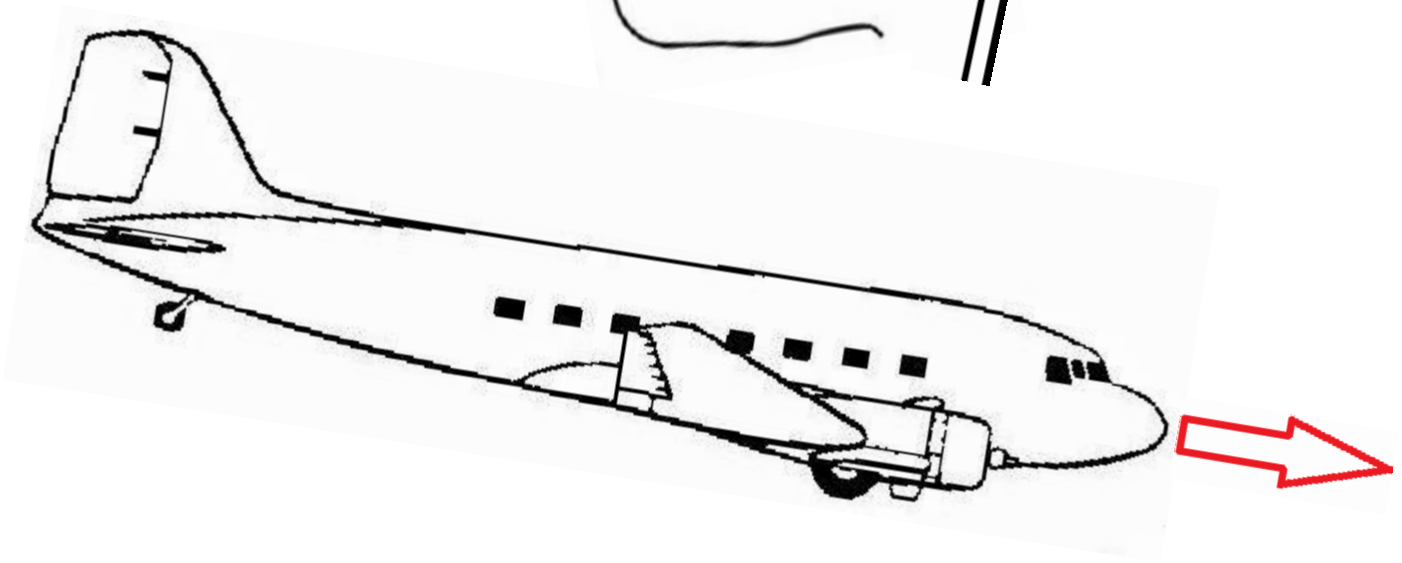
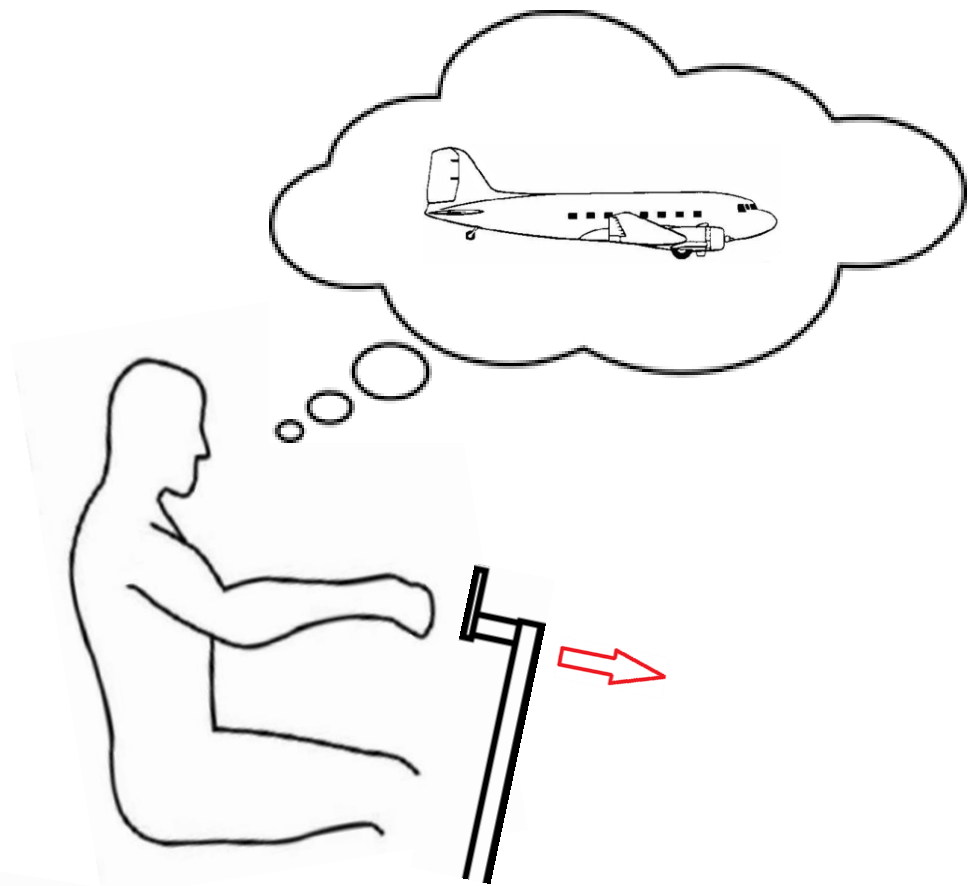
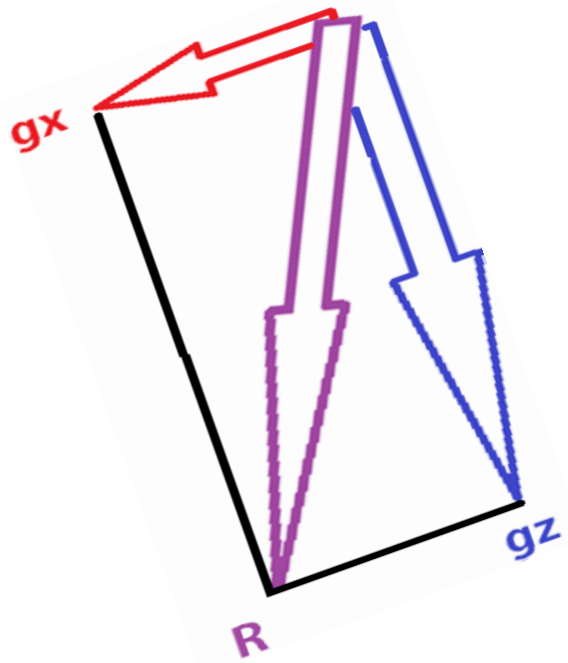
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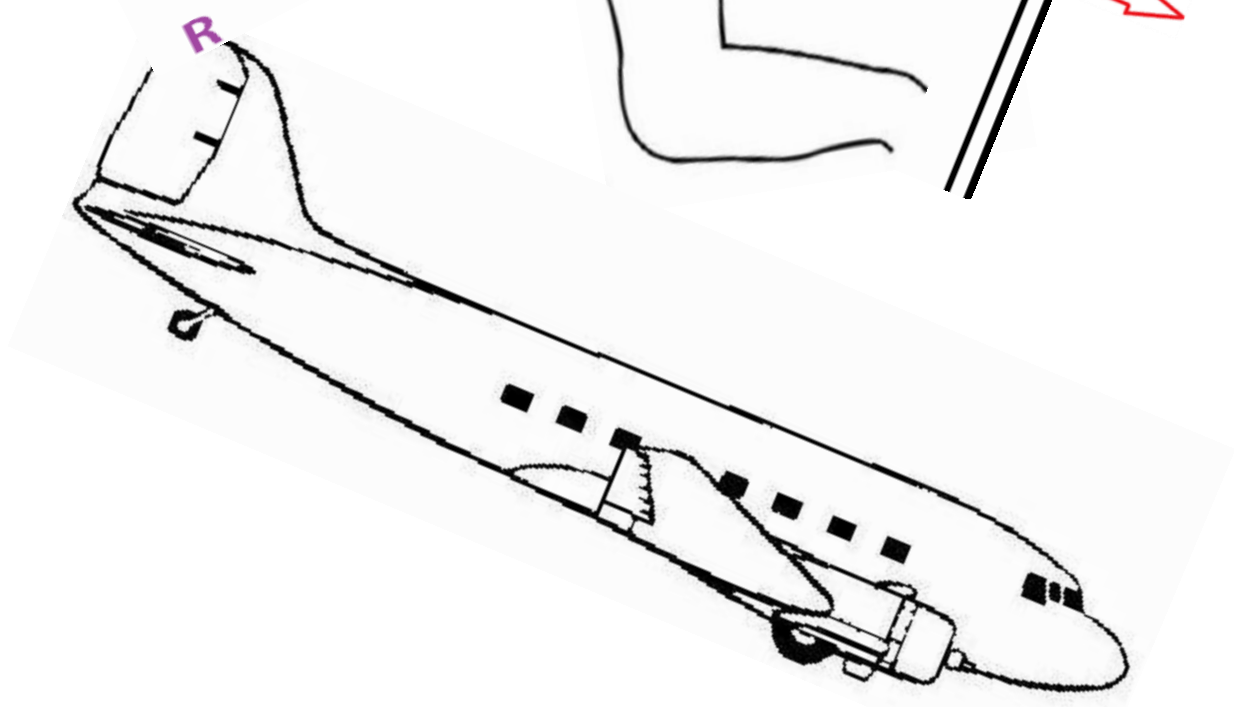
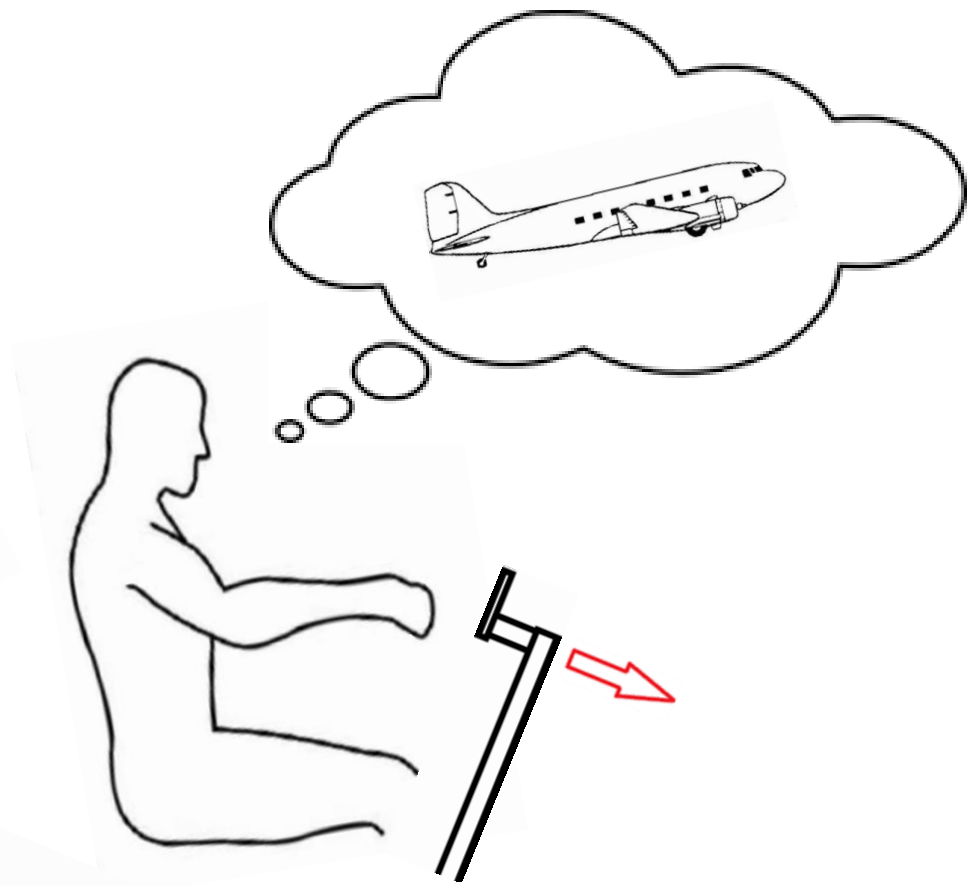
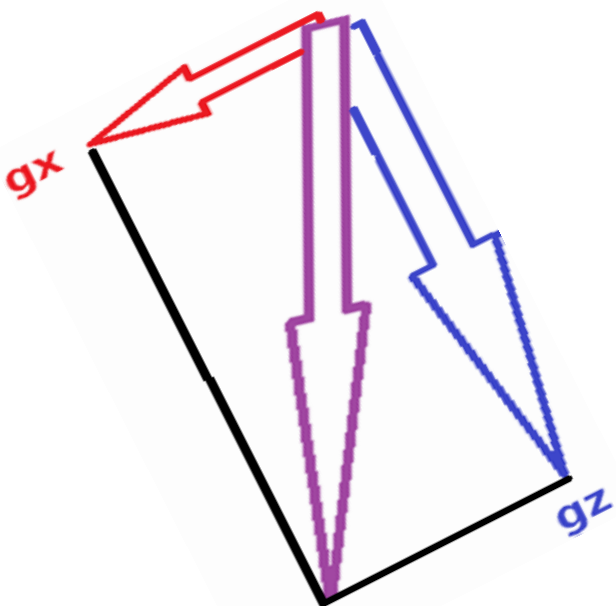














**DC2, Kunming, China,
1942. 13 Fatalities.**

Vickers Vanguard, London Heathrow, 1965. 30 Fatalities.

Image: Getty





A320, Bahrain 2000. 143 Fatalities.

Image: BBC



**A320, Sochi Russia
2006. 113 Fatalities.**

Image: Radio Free Europe



**A330, Tripoli,
Libya, 2010.
103 fatalities.**

Image: Fox News.

CRJ200, Almaty, Kazakhstan 2013. 21 fatalities *Image: MAK*





**ATR72, Pakse Laos
2013. 49 Fatalities**

Image: Aviation International News.

B737, Kazan, Russia, 2013. 50 fatalities.

Image: Russia Today





B737, Osh, Kyrgyzstan, 2015. No fatalities *Image: MAK*

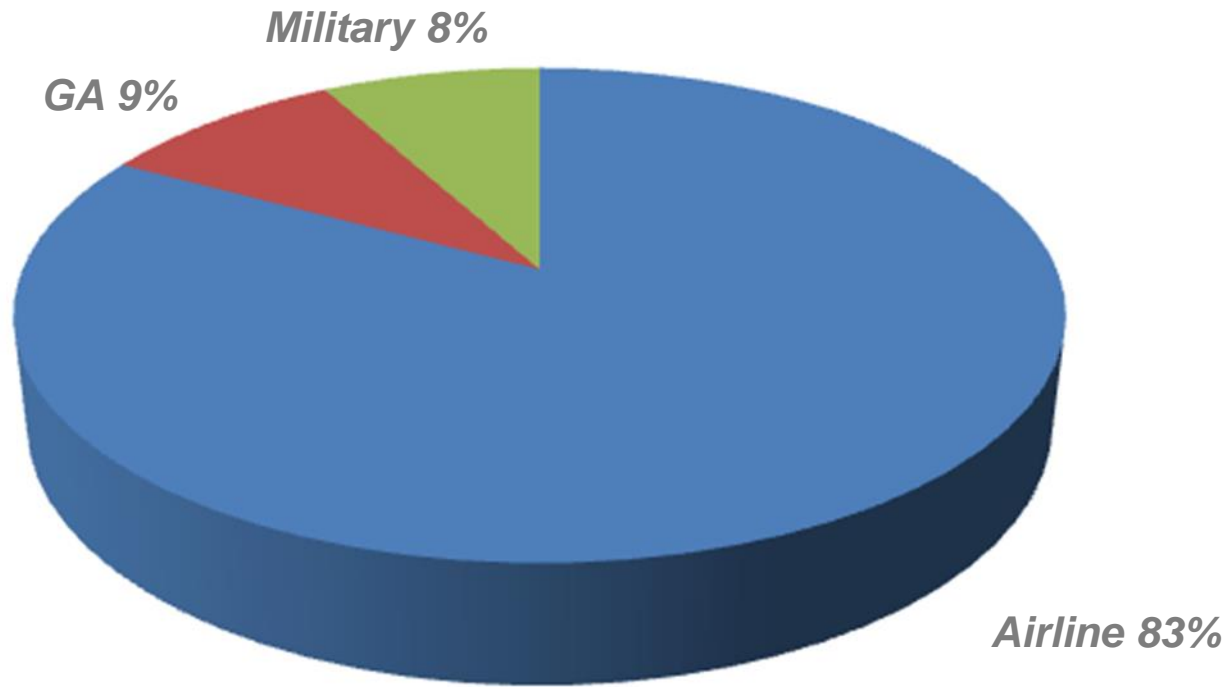
Since 2000: (SGI identified as a causal factor).

- 7 Large Transport Aircraft Crashes – 481 Fatalities.
- 15 Business Aviation Crashes – 21 Fatalities.
- 8 Commercial Helicopter Crashes – 20 Fatalities.
- 16 Private General Aviation Crashes – 31 Fatalities.
- 4 Military Crashes – 4 Fatalities.
- 1 Accident Currently Under Investigation (Nov 2016).

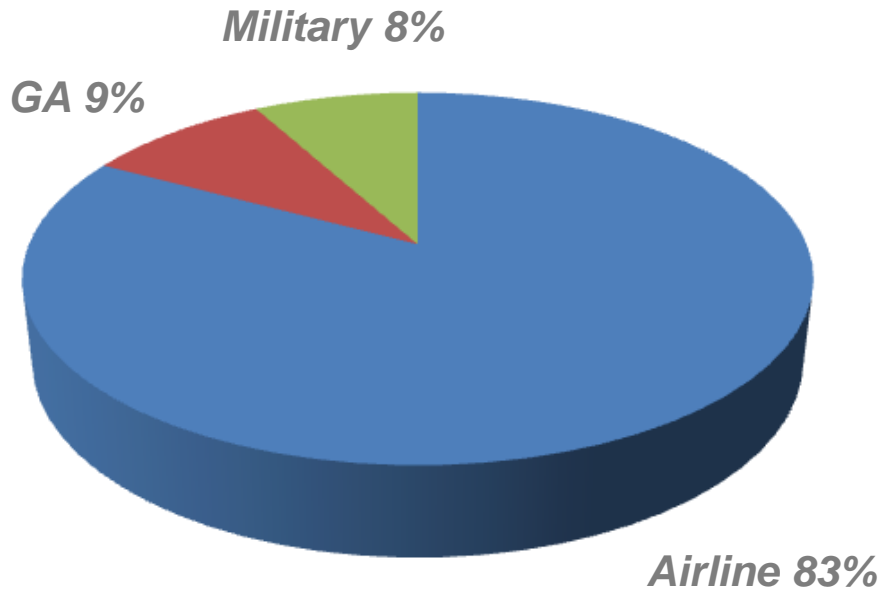
The situation is not improving!

Knowledge of SGI amongst the pilot workforce.

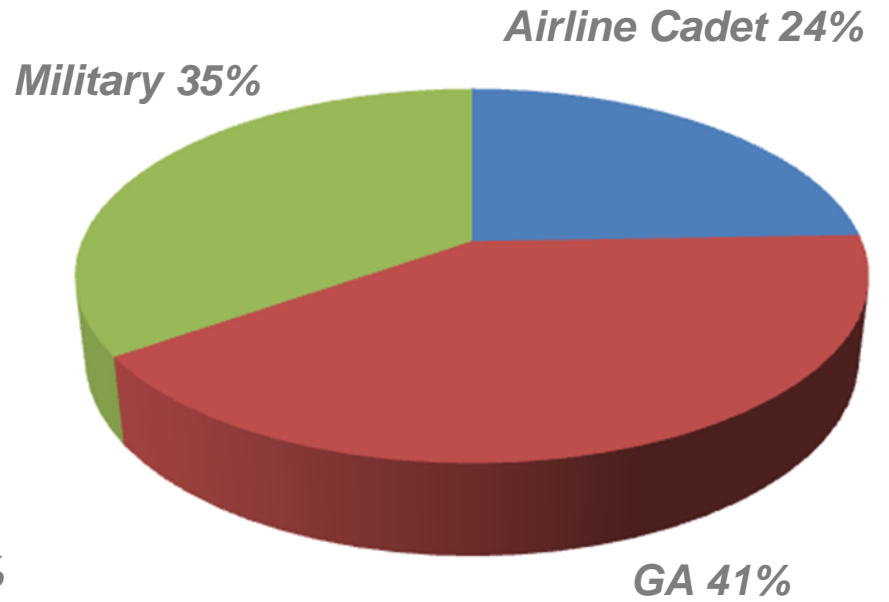
Survey of 585 pilots taken between Aug 2015 and Mar 2016



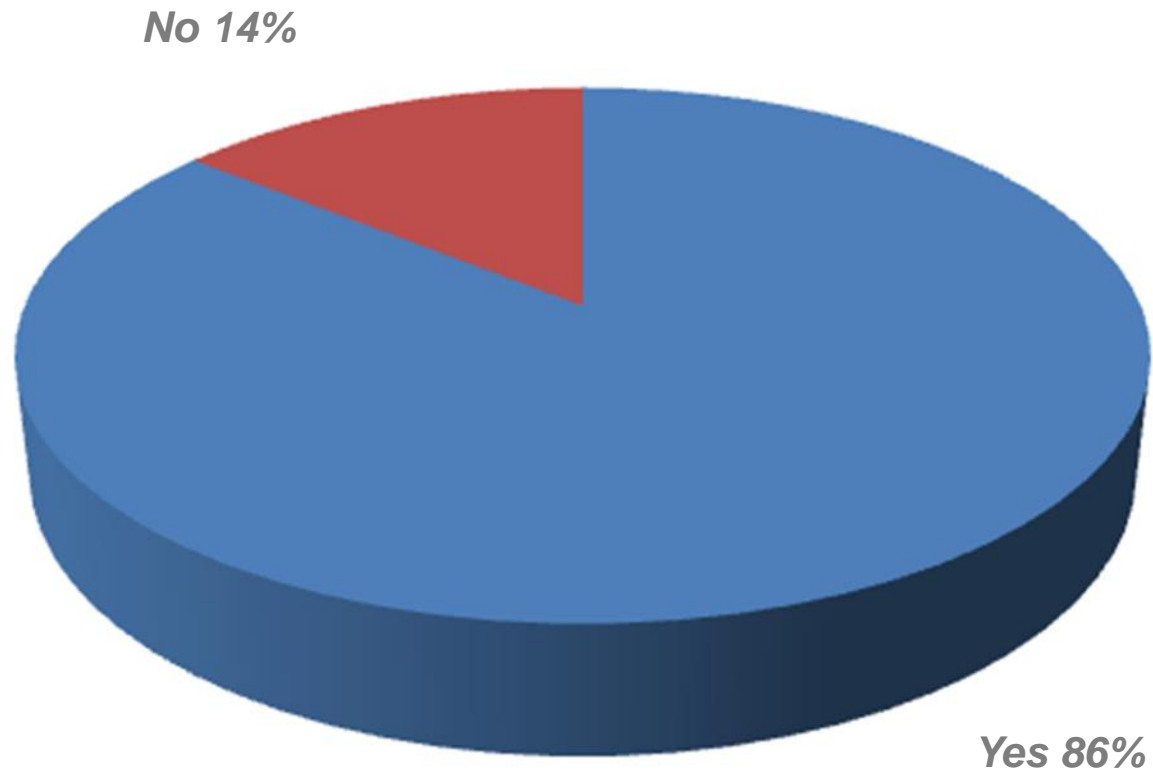
Current Employment



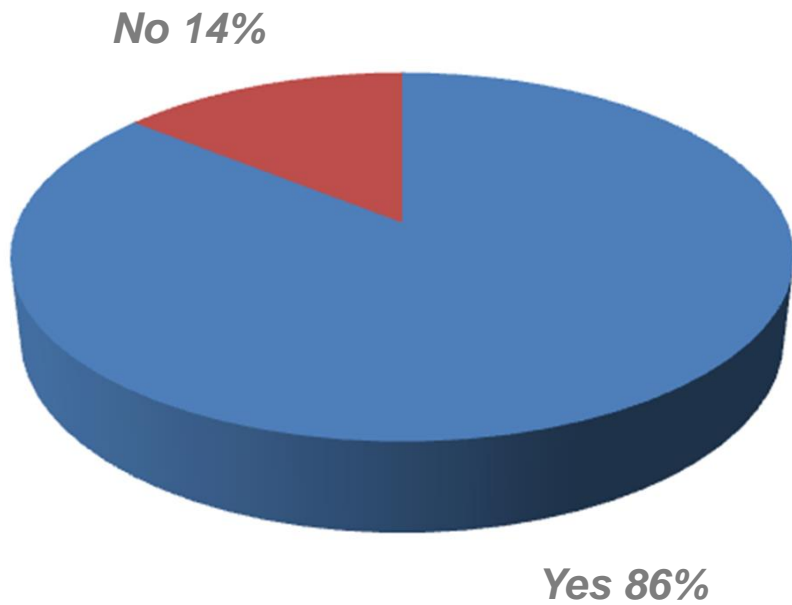
Current Employment



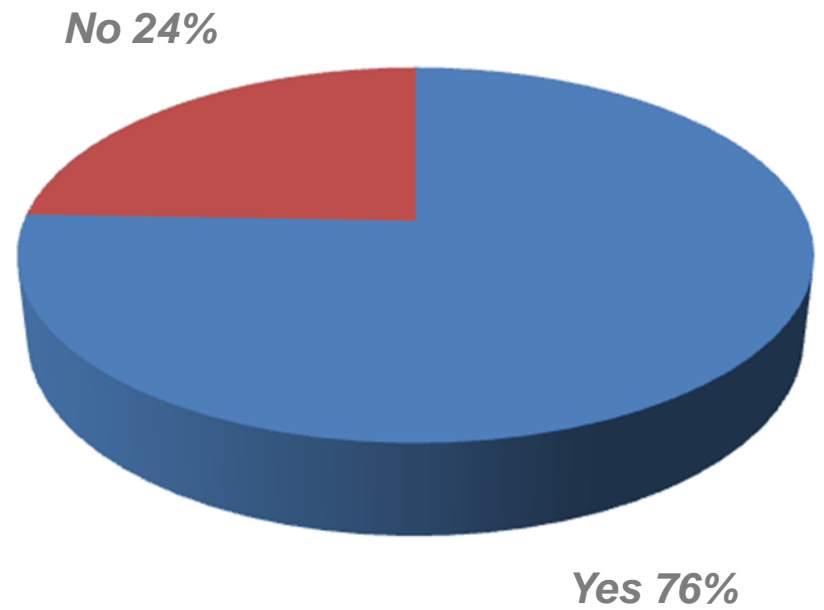
Training



Pilots who have heard of SGI



Pilots who have heard of SGI



Pilots who understand SGI

If I studied it on my course, I will take your word for it. But I have no recollection of doing so.

The technique I used to pass the exam was “learn and dump” with much of the study being done the night before. I have no recollection of the syllabus content.

I have no idea what you’re talking about. I have never heard of it!

Survey Conclusion:

The practical working knowledge of SGI amongst the pilot workforce needs to be improved.

Training for SGI.

Current civilian training (EASA).

- ICAO mandated HPL training in 1998.
- SGI included in EASA HPL syllabus.
- SGI questions in EASA HPL examination database.

However.

- Standard simulators cannot replicate SGI.
- Training aircraft cannot demonstrate the SGI.

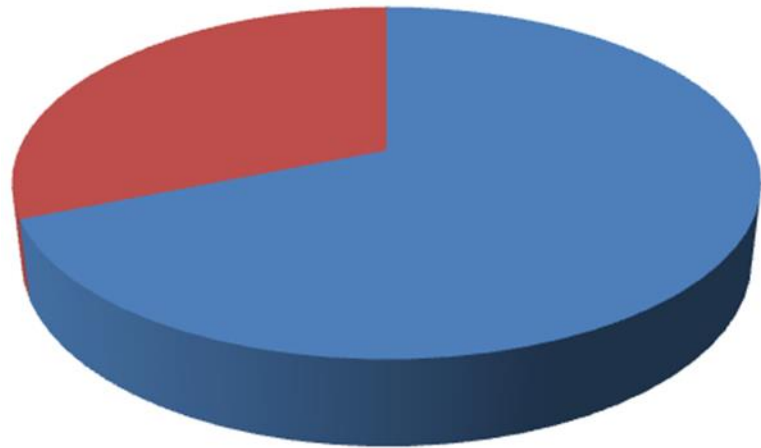
The only training currently available is from the technical subjects and pre-flight briefings during flying training.

There is currently no requirement for HPL refresher training.

Current military training (RAF).

- SGI included in aeromedicine training from 1985.
- Complies with NATO STANAG 3114
- 5 Days aeromedical training including disorientation simulator.
- SGI demonstrations are possible in flight.
- All pilots receive a refresher course every five years.

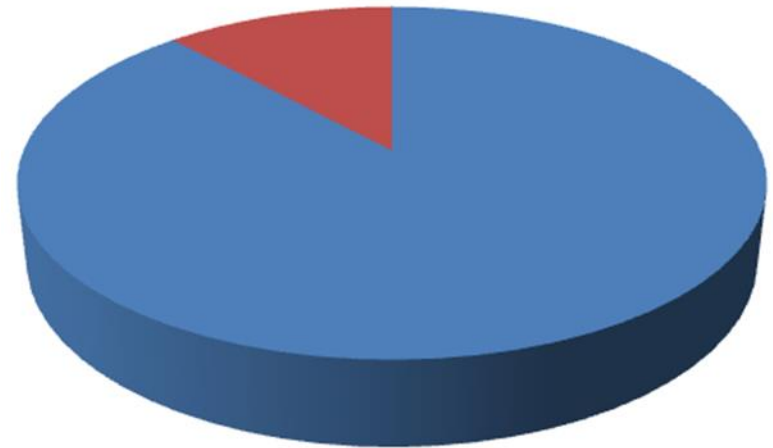
No 31%



Yes 69%

Civilian trained pilots
who understand SGI.

No 12%



Yes 88%

Military trained pilots
who understand SGI.

Factors Contributing to SGI.

Contributory Factors.

Fatigue.

- Identified as a contributory factor in a number of SGI accidents.
- Dark conditions often coincident with the end of a long duty.
- Degraded performance will probably lead to an ineffective instrument scan.



Image: Go Flight Med

Contributory Factors.

Ineffective instrument scan.

- Failure to maintain a safe flight path is the cause of all SGI accidents



Image: AOPA

- SGI is so powerful that pilots have ignored valid attitude indications believing them incorrect.
- Poor instrument design has been identified as a factor in some SGI accidents
- *“Degraded instrument scanning is an opened door to the somatogravic illusion”*

(Captain Bertrand de Courville, 2012)

Factors Mitigating SGI.

Mitigating Factors.

Experience.

- Greater experience does not reduce susceptibility of SGI.
- Evidence shows high time pilots are just as likely to experience it as low time pilots.

(From a survey of pilots ranging from 190 to 19000 hours total flight time - Australia 1995).



Image: Paramount Pictures

Mitigating Factors.

Multi crew operation.

- The second pilot should be able to warn of an undesirable flight path.
- However, both pilots may be experiencing the same SD effects.
- A steep 'cockpit gradient' or strong 'power distance' may render warnings ineffective.



Image: Paramount Pictures

Mitigating Factors.

Briefing.

- If conditions suggest that there is a likelihood of experiencing SD on departure or approach, crews can brief it as a threat.
- If an airport has features or conditions where SD could be a factor – a warning of the threat can be included in operations manuals.

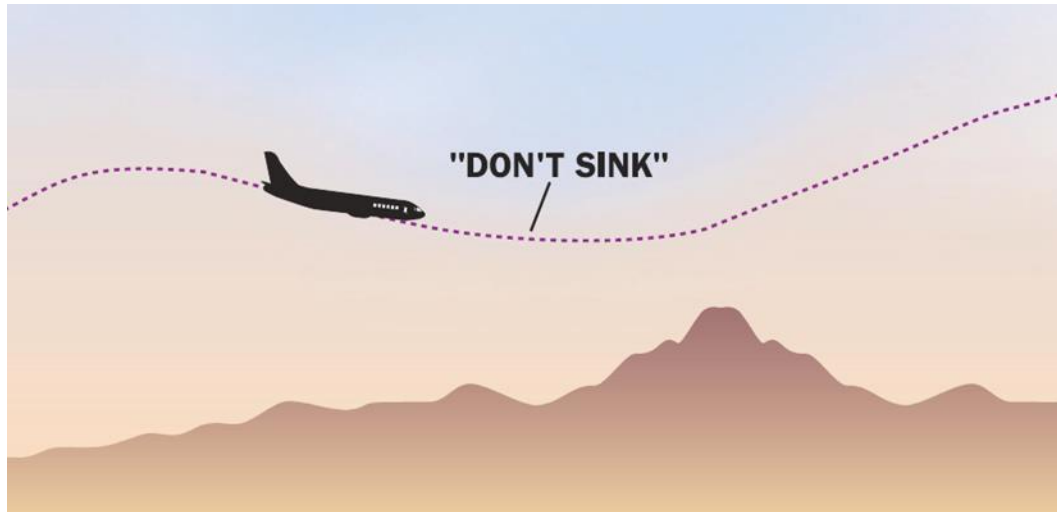


Image: Austrianwings

Mitigating Factors.

Warning systems.

- GPWS Mode 3 – warns crews “*Don’t Sink*” if a descent is detected after take off or a go-around.
- *But* – The sequence of events could start well above the trigger thresholds (1500ft Rad Alt / 300ft total loss) by which time, it may be too late.



- *And* – under high workload or stress, the human brain filters what is considered less important. Hearing will be ignored in favour of other sensory inputs.

Image: Honeywell International Inc

Mitigating Factors.

Recurrent training.

- Standard six axis simulators cannot replicate SGI.
- Currently, CRM training and briefings are the only training available.



Image: CAE

Mitigating Factors.

Auto flight systems.

- The auto-flight system references to highly reliable attitude information.
- It will maintain a safe flight path with the correct modes selected.

The Auto-pilot is the best option for maintaining a safe flight path!



Image: NASA

Reducing the threat of SGI. (Recommendations)

To Regulators.

- Initial SD training should emphasise situations where it is a threat, using real accident data as examples.
- HPL examinations should include at least one question about SGI in every paper and the questions relate to specific circumstances in which SGI could be encountered.
- Universally distributed and constantly available publications warning of the threat of SGI should be made available to pilots, operators and training organisations.
- Mandate periodic HPL refresher training to include SGI.

To Operators.

- The auto-pilot should be engaged soon after take-off on departures at night, and/or poor visibility.
- If an approach is conducted at night and/or in poor visibility, the auto-pilot should remain engaged until the required visual references have been established and the landing clearance received.
- If going around at above minima, the manoeuvre should not be rushed and the use of less than full thrust should be considered. If the selection of full thrust is required to initiate the go-around, the selection of lower thrust should be considered as soon as it is safe.
- Consideration should be given to flying go-arounds with the auto-pilot engaged. If the approach was flown manually, an auto-pilot should be engaged as soon as possible.

- If the approach is flown with the auto-pilot engaged, it should not be disengaged for a go-around.
- If the auto-pilot automatically disconnects on go-around with only one selected for the approach, the use of more than one auto-pilot on any approach in limited visibility and/or night, or any approach where a go-around is possible should be considered.
- The PM should carefully monitor the flight-path in the climb and go-around phases.
- Automation should be engaged if the attitude display does not correspond with the attitude sensed by the pilot(s).

To Air Traffic Control.

- That aircraft going around should be allowed to fly the published go-around profile without interruption, unless safety is compromised.

To Industry.

- Initiation of a go-around with automatic flight functions engaged should be one single pilot action engaging a dedicated go-around mode. It should not require the engagement of multiple modes.
- Flight directors must remain active after the initiation of a go-around. Flight Management should automatically switch to a lateral navigation mode which sequences the go-around track entered in the flight plan and simultaneously, a suitable vertical navigation mode.
- If the approach has been conducted without flight directors, they should select on automatically on go-around selection.
- Auto-pilots should not disconnect if a go-around is initiated. The facility to conduct a go-around with at least one auto-pilot engaged should be considered essential. If only one auto-pilot is engaged for the approach, it should not disengage on go-around initiation.

- Full thrust should not be required for a go-around. A reduced thrust or 'soft' go-around thrust setting should be available.
- Consider flight deck designs so that the primary flying display is directly in front of the pilot. It also needs suitably large and easy to interpret to command attention.



Thank You.

Safe Flying!