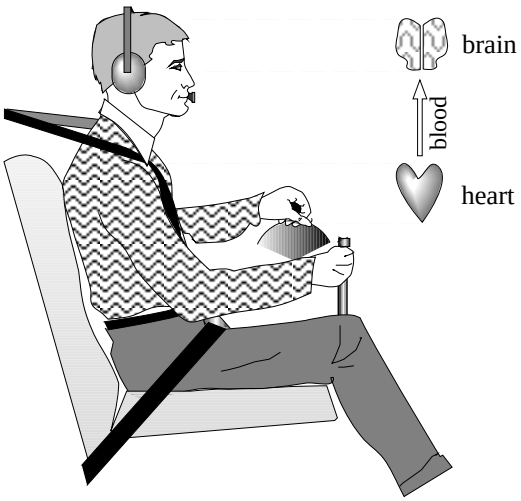


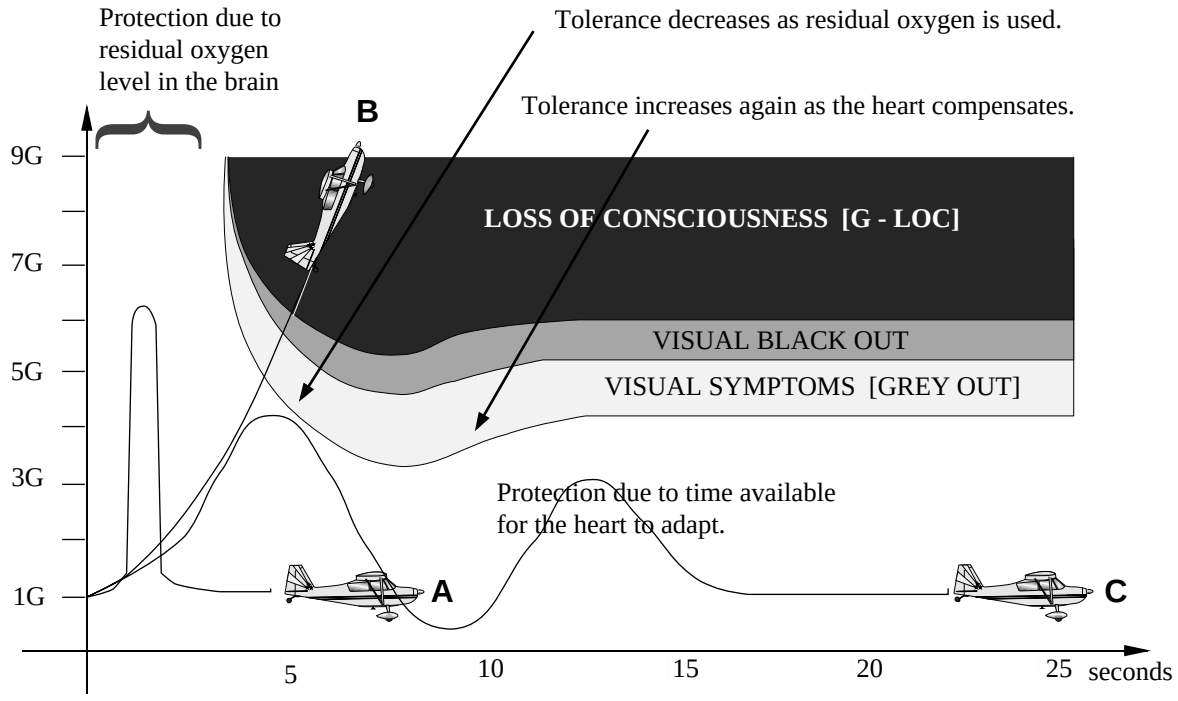
The physiological effects of G The apparent weight increase which accompanies a high positive G load applies to every component of the pilot's body, including the blood. Since the heart must pump blood 'up-hill' to oxygenate the brain, the rate at which blood flows to the brain reduces. This is aggravated by the fact that the heart, along with other internal organs, is forced downwards under the G load, stretching and elongating the arteries which connect it to the brain, which like all nervous tissue is particularly sensitive to lack of oxygen.

The heart responds to the crisis by increasing its pumping rate. This cardiovascular reflex is triggered by the drop in oxygen level in the brain, however it takes a few seconds for it to take full effect. The graph below represents an *average* response.

Aeroplane A pulls a high G load of very short duration, such as flying round the bottom corner of a square loop. Because it is all over in two or three seconds, the brain is able to cope due to the residual oxygen which was present before the manoeuvre. These are sometimes called transient loads.

Aeroplane B pulls a very high G load with a more gradual onset over about five seconds. The residual oxygen is used up before the cardiovascular system can fully compensate by increasing the heart rate. The resulting lack of oxygen causes grey out, black out and eventual loss of consciousness [G-LOC].

Aeroplane C performs a typical loop. The G loads range from about 4 in the initial pull-up, to less than one over the top, to about three or three and a half in the last quarter.



Grey out This is the name given to a partial loss of vision which usually occurs as the first physiological effect of sustained G loads. The low blood oxygen levels cause the peripheral vision to fade. Objects in the centre of the field of view can be seen but they appear to be surrounded by a grey haze. The pilot is still fully conscious and capable of flying the aeroplane. For a healthy person these effects will usually be first noticed at about 3.5 G.

Black out Above about 5 G, the grey haze envelops the entire field of view and almost immediately becomes black. The pilot is still conscious but cannot see.

Loss of consciousness [G-LOC] This will follow very quickly after black out if the high G load is sustained. The pilot is now unconscious and of course incapable of flying the aeroplane. Although consciousness is usually quickly regained when the G load is released [ie the pilot stops pulling back on the stick], there are situations in which some individuals may remain unconscious for a much longer period. The consequences of course can be catastrophic.

Factors which decrease tolerance to G loads Hypoglycaemia [low blood sugar levels] or diabetes can impair the heart's ability to compensate at the onset of high G loads, causing grey out and black out to occur at relatively low sustained G loads. Heat stress caused by a hot cockpit environment can cause a substantial decrease in G tolerance.

Hypoxia caused by operating at high altitudes without oxygen causes the blood oxygen level to be low even before the onset of any G load. Any respiratory infection, including the common cold can have significant effect on G tolerance.

Techniques for improving G tolerance One design feature found in many high performance aerobatic aircraft is a more reclined seating position for the pilot. This brings the heart and the brain closer to the same level lessening the effort required to pump blood to the brain [See figure at left].

Tensing the stomach muscles Under a high G load, blood tends to pool in the vascular spaces in the lower abdomen and legs. Tensing the stomach muscles [as if you had invited someone to hit you in the solar plexus], can reduce this effect and therefore reduce the loss in circulating blood volume. Pilots of some high performance aerobatic aircraft sometimes wear a G belt. This is a wide stiff belt not unlike that worn by weight lifters. Tightening the stomach muscles against the belt provides a more efficient means of preventing the pooling of blood. G suits as worn by jet fighter pilots go one step further by the action of inflatable panels strapped tightly to the stomach and upper legs. These panels inflate under high G loads to apply strong positive pressure to reduce the pooling of blood.

Physical fitness Tolerance to high G loads varies not only from one individual to another, but also from day to day for any one individual. Maintaining a good level of general fitness will assist performance under high G.

