Without warning: the startle factor

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'#$@! we're going to crash! This can't be true! But what's happening?' were the last words from pilot David Robert on board Air France flight 447 as it crashed into the Atlantic ocean, in June 2009 killing all 228 on board.

In 2012, the French Bureau of Enquiry and Analysis for Civil Aviation Safety (BEA) found flight 447 crashed after temporary inconsistencies between the airspeed measurements—likely due to ice crystals obstructing the aircraft's pitot tubes. This caused the autopilot to disconnect, after which the crew reacted incorrectly and put the aircraft into a stall.

The first officer's initial response to pull back hard on the sidestick was consistent with impaired information processing, decision-making and problem solving typical of startle reaction. His persistence in maintaining full back pressure on the stick all the way down was also consistent with either multiple startles or continued degraded information processing following startle. BEA chief investigator Alain Bouillard equated the reaction to curling instinctively into a foetal position.

What is the startle response?

The startle response (also known as limbic hijack) is the physical and mental response to a sudden unexpected stimulus. More commonly known as 'fight or flight', this physiological reaction occurs in response to what you may perceive as a harmful event, attack, threat to your survival or simply fear. The fight or flight response evolved to enable us to react with appropriate actions: to run away, to fight, or sometimes freeze to be a less visible target.

The body responds with increased activity such as:

- Circulation increasing blood supply to brain, muscles and to limbs (more O_2). Brain activity changes: we think less and react more instinctively.
- Heart beats quicker and harder—coronary arteries dilate.
- Blood pressure rises.
- Lungs take in more oxygen and release more CO_2.
- Liver releases extra sugar for energy.
- Muscles tense for action.
- Sweating increases to speed heat loss.
- Adrenal glands release adrenalin to fuel response.

In aviation, startle often occurs when the autopilot disengages and hands control to the pilot in a highly dynamic, time-critical condition. According to Human Factors SA psychologist Jo-Anne Hamilton, two systems in the brain—the reflexive fast system and the slow system—play different roles in our reaction to danger.

The reflexive fast system acts immediately—in one twelfth of a second—by sending information directly to the sense organs through the thalamus to the amygdala. The slow system sends sensory information to the hippocampus and cortex for further evaluation. It's slower because it requires conscious processing.

Hamilton says that pilots in these non-routine, emergency and abnormal situations will have difficulties in recognising that a problem has occurred and difficulties in getting out of the normal mode of operations.

‘It may be a series of startle responses or more like one “big one” where the brain is kind of hijacked,’ Hamilton says. ‘Then we make a decision and once we make the next decision and our frontal cortex shuts down so our thinking capacity is not working so well—that leads us to the next decision etc and we go down into a tunnel.

> *‘And it’s extremely difficult once someone is in that tunnel—and you can see that from the Air France example—to stop, step back and say, “s**t, we are doing something really dumb here”.*

‘We’ve evolved to confirm our decisions not to disconfirm them—it’s our natural human inclination.’

Automation versus stick & rudder

Arguments about whether pilots were better in the olden days have probably raged since the days of the Wright brothers. But hard numbers make one thing clear. Major in-flight events such as an engine failure are becoming rare in modern air transport aircraft. An airline pilot beginning their career today may never undergo such a test. But this safety improvement, paradoxically, brings its own dangers. Rare events are startling and underperformance—due to the effects of this startle on the body’s systems can be detrimental to the handling of such events.

According to Murray et al. (2012):

‘… one of the common themes as aircraft become more reliable is that pilots are surprised or startled by some event and as a result have either taken no action or alternatively taken the wrong action, which has created an undesired aircraft state, or in some cases, an accident. This surprise or startle is largely due to the enduring reliability of the aircraft and the aviation system, which has unwittingly created a conditioned expectation of normalcy among today’s pilots…The problem then is the level of expectation of novel or critical events is so low that the level of surprise or startle which pilots encounter during such events is higher than they would perhaps have had some decades ago when things went routinely wrong.’

In 2010, NASA’s Aviation Safety Program investigated loss of control. The NASA study determined that the, ‘deterioration of manual flying skills due to increased reliance upon automation is a strong contributor to manual handling errors…This deterioration in skill provides further encouragement to place even more emphasis on automation and less emphasis on manual flying. Thus, when piloting skill is needed to prevent or recover from a loss of control scenario, the basic manual flying skills are absent, either never having been fully developed or having atrophied to dangerous levels.’

Colgan Air Flight 3407 appears to fit this template. In 2009, the Bombardier Dash 8-Q400 was on instrument approach to Buffalo-Niagara International Airport, in the north-east US, when it stalled, dived and crashed into a house. Fifty people died. An NTSB investigation found the pilots had responded incorrectly to the stall warnings. Martin et al. (2012) agree that the cause was most likely due to the captain being, ‘initially very startled by the stick shaker and accompanied disengaging of the autopilot…His reactions were contrary to all previous stall training and could well have been induced by physiological effects from the startle reaction.’

Preventing startle

Of course, serious unusual events don’t always result in a startle response. In 2010, the crew of Qantas flight 32 prevented what could have been the world’s first A380 disaster after the plane experienced an uncontained engine failure.

QF32 captain Richard de Crespigny described how he handled the situation in his blog: ‘There was no startle effect, no panic on the flight deck. The cortex took and maintained control. We were able to "sit on our hands and initially do nothing". Then we knew what we had to do.'

Hamilton believes training pilots for non-routine situations is essential and QF32's de Crespigny and Chelsey Sullenberger of US Airways flight 1549 fame are a case in point—she describes them as 'pilots' pilots'.

'When I heard about the landing on the Hudson I said to my colleague, "Sullenberger has done that before". Obviously, he hasn't done that before but when I read his book he says he had visualised the water landing I thought to myself: 'wow that's a pilot's pilot".'

Largely as the result of Colgan Air flight 3407, the US Federal Aviation Administration finalised a rule that will require airlines to provide pilots with simulated 'extended envelope' training by 2018. The full-motion simulator-based training is to include upset recovery manoeuvres as well as recovery from full stalls and stick pusher activations, among other abnormal events.

While CASA does not have a formal policy with regards to 'startle factor training' as a specific issue, training in non-technical skills is required to recognise and manage situations that can occur in a sudden event. The idea is to give flight crew the skills to manage a 'startle' type event.

Training in full flight simulators for 'full stall recoveries and past stick shaker' also requires adequate modelling of the flight simulator itself.

Part 61 Manual of Standards (MOS) addresses competency requirements for Non-technical skills 1 and Non-technical skills 2. Competency standards are required across a range of part 61 qualifications. In addition, each of the FAA-termed 'extended envelope' elements are covered as part of the type rating. The MOS flight review and proficiency checks also pick up the training and assessment of competency for areas such as upset recovery.

In addition to this, approved CAR 217 training and checking systems addresses the issues organisations feel are relevant to their operations. For example, the Air France 447 event led to Jetstar conducting their own specific training to address the icing event.

> *CASA will also introduce evidence based training (EBT) system guidance in the near future. EBT is specifically designed to address real time issues through training and assessment.*

Training for startle situations—no matter how unlikely they may be—could prevent another Air France Flight 447 from happening in the future. Startle is a powerful mental force but it has two defences that every pilot can develop: confidence and competence.

References

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