Abstract
The modern airliner is a sophisticated and robust machine, with incredible rates of reliability. This reliability is not lost on the pilots who fly them, and while emergency training generally takes place around four days a year, ubiquitous aircraft reliability engenders a mindset of normalcy, with little expectation of actual emergencies. This conditioned expectation of normalcy can create a heightened stress response when some unexpected, novel, or emergency event does occur. Pilot reactions vary widely in such circumstances with instances of startle, freezing (dissociation) and denial evident in some cases. An analysis of various aircraft incidents and accidents is made where evidence of stress induced inaction has resulted in undesired aircraft states. Previous experience of novel and emergency events has a moderating effect on arousal levels and is therefore likely to create less likelihood of inaction type behaviours due to stress. Implications for further research and future training are discussed.

Introduction
With aircraft emergency training limited to perhaps only four days a year, and the profound reliability of modern aircraft, it is not uncommon for pilots to develop a mindset of normalcy on the line. When an emergency does occur, the pilot is likely to experience emotional and cognitive responses which may be autonomic, conditioned, or situationally reactive. The startle reaction is an autonomic bodily reaction to an unexpected and/or severe event, which is typical in sudden emergencies. Where a situation is perceived to be important and/or threatening then there may also be a moderate or severe stress reaction, to which individuals may apply some form of coping mechanism, such as dissociation or denial, both of which could have negative consequences on emergency outcomes. Denial and/or dissociation, characterised as inaction behaviours, may be momentary, or last for some prolonged time. The longer they persevere however, the more likely the negative effect on situation outcome.

The Startle Reaction
The startle reaction, or startle reflex, is the physical and mental response to a sudden unexpected stimulus. The reaction includes physical movement away from the stimulus, a contraction of the muscles of the arms and legs, and often blinking, accompanied by increased blood pressure, respiration, and breathing rate. The reaction is generally an aversive reflex reaction, which varies in intensity depending on existing emotional state and the prior allocation of attentional resources (Haerich 1994; Lang, Bradley & Cuthbert, 1990). Thackray (1988) examined the startle effect on pilots, and importantly showed that cognitive processing tasks, such as decision making were often impaired for up to 30 seconds after a startle event. This recovery from startle varies quite significantly with previous experience, expectation, and individual emotional state. While little data exists on the effects of startle in aviation, a delay of 30 seconds could conceivably have significant effects on situation outcome following an aircraft emergency.

The Freeze (Dissociative) Reaction
Simons (1996) describes the dissociative or freeze reaction as “a stupefied afterstate in which one is either silent and motionless or acts in some way like an automaton, vulnerable in a special way to the influence of external stimuli”. Leach (2004) studied the effect of “freezing” or immobility during a number of significant emergencies, both aviation related and otherwise. His research clearly showed a significant number of people were so badly affected by this phenomenon that they actually perished from perfectly survivable situations. This data was backed up by a study of human behaviour in aircraft cabin evacuations, both during clinical trials and in real life emergencies (Muir, Bottomley & Marrison, 1996). The data showed a propensity for some passengers to exhibit a stunned and
bewildered response, described by Muir et al as “behavioural inaction”, and analogous to the “freeze” reaction described here.

**Denial**

When an improbable event occurs many pilots have an initial reaction of disbelief or denial (Koonce, 2002). Dillinger, Wiegmann, & Taneja (2003) describe denial as “refusal to believe that the stressor exists or of trying to act as though the stressor is not real”. Breznitz (1983) has defined seven different kinds of denial, including denial of information, denial of threatening information, denial of personal relevance, denial of urgency, denial of vulnerability/responsibility, denial of affect, and denial of affect relevance. Denial is generally accepted as a low level stress coping or defense mechanism (Cramer, 1991; Lazarus, 1999; Lazarus & Folkman, 1984; Monat & Lazarus, 1991). Coping is defined by Lazarus & Folkman (1984) as “constantly changing cognitive and behavioural efforts to manage specific external and or internal demands that are appraised as taxing or exceeding the resources of the person”. A person using denial to cope with a threat is susceptible to disconfirmations by evidence to the contrary and is therefore forced to narrow their attention to only confirmatory experiences (Lazarus & Folkman, 1984). This narrowing of attention to avoid stressful environmental cues, is very likely to have a negative effect on situation outcomes in the complex and dynamic aviation environment.

**Appraisal**

Cognitive appraisal is an evaluative process that determines why and to what extent a particular transaction or series of transactions between the person and the environment is stressful. It is largely evaluative, focussed on meaning or significance, and takes place continuously (Lazarus & Folkman, 1984; Monat & Lazarus, 1991). This appraisal process is split into two separate, but interdependent processes known as primary and secondary appraisal. Primary appraisal is a pre-attentive process that decides if environmental cues are irrelevant, benign/positive, or likely to involve harm, loss, threat, or challenge. Secondary appraisal is a complex evaluative process which takes into account which coping options are available, the likelihood that a given coping option will accomplish what it is supposed to, and the likelihood that one can apply a particular strategy or set of strategies effectively (Lazarus & Folkman, 1984). The following model shows how the appraisal process functions.

![A Conceptual Model of Appraisal and Information Processing](image)

This model splits the secondary appraisal process into problem-focussed coping and emotion-focussed coping. Problem-focussed coping is generally applied where an appraisal is made that conditions are changeable and able to be controlled by the individual. Emotion-focussed forms of coping are more likely to occur when there has been an appraisal that nothing can be done to modify
harmful, threatening, or challenging environmental conditions. We use emotion-focussed coping to deny both fact and implication, to refuse to acknowledge the worst, or to act as if what happened did not matter, lending itself to an interpretation of self-deception or reality distortion (Lazarus & Folkman, 1984). This can result in inaction type behaviours such as denial, or dissociation.

**Aircraft Incidents and Accidents with Inaction Type Behaviours**

The following accident and incident briefs show examples where freezing (dissociation) and/or denial have had negative consequences on situation outcomes.

During a maximum weight takeoff the Captain correctly commenced a high speed Rejected Takeoff (RTO) following a problem. After initially closing the throttles however, he just continued to stare out the window, and the First Officer was forced to take over, deploying the thrust reversers and applying maximum braking. The aircraft was unable to stop in time and overran the runway by 600 feet. (Heaslip, Hull, McLeod & Vermij, 1991).

During an approach flown by the Captain, the Co-pilot noted that the aeroplane was not following the glide path. Following a “Below Glideslope” warning the Co-pilot repeated the warning then looked at the Captain who was simply staring at the instruments, both hands on the control column. The Co-pilot took over and manually pushed the throttles forward but the aircraft was unable to be recovered before striking the ground some 2150 metres from the runway (BEA, 2003).

During a takeoff the aircraft was over-rotated resulting in a significant tail-strike. The flight crew ignored a number of cues, including a substantial bang felt throughout the aircraft on rotate, a call from a taxiing aircraft that thought the aircraft had suffered a tail-strike, reports from the cabin crew that they had heard a loud bang from under the aircraft, and reports from ATC that a tail skid of the same colour as the aircraft had been found on the runway. The crew eventually stopped climbing at 28,000 feet, and returned to the airport (XXX Airline, 2007). (The normal procedure following a tailstrike is to remain depressurised and return for landing as soon as practicable due to the possibility of impaired fuselage integrity).

**Discussion**

While most pilots will intuitively react and manage unexpected events well, there are occasions where they don’t, and undesirable stress effects cause them to perform less than optimally, either momentarily, or in some cases for substantially longer. In a number of cases this has led to undesired aircraft states, significant incidents, or even accidents.

The brain’s neural network categorises stimuli into groups that form patterns and responds to patterns that have been established by past experience. Our minds can instantly retrieve similarly coded information relevant in one situation and use this formerly coded information in a similar way for the new situation (Lyons, 2003). Although general knowledge may be sufficient for interpreting a novel event, it might be inadequate for coping, which, in the psychoanalytical ego psychology model, coping is defined as realistic and flexible thoughts and acts that solve problems and thereby reduce stress. Without direct or vicarious experience with the encountered demands however, the person may not have had the opportunity to develop the specific coping skills required to deal with the demands (Lazarus & Folkman, 1984). Coping mechanisms are developed by individuals as both isolated and repetitious means of dealing with acute and chronic stressors. If a person is aware of the increased risk of error that accompanies the interpretation of a novel, ambiguous situation, they are likely to experience a high degree of uncertainty and threat. However, where individuals have previous experience with problematic events, then the primary appraisal process is more likely to perceive such events as challenging rather than threatening, and the secondary appraisal process may therefore entail more problem-focussed coping rather than some pathological emotion-focussed coping mechanism such as denial (Monat & Lazarus, 1991).

**Conclusions**

Acute stress can induce inaction type behaviors in pilots, however the transactional stress model suggests that previous experience of novel and emergency events has a moderating effect on arousal levels. Where pilots can make problem-focussed appraisals that suggest that they are familiar with a certain circumstance and have the tools to deal with it, then there is less likely to be inaction type behaviours more evident from emotion-focussed coping mechanisms. Prior experience of what would otherwise be novel situations is most likely therefore to equip pilots with the wherewithal to
manage those situations when they arise in real life. Where pilots can experience these “novel” events in a non-jeopardy training environment, under instruction, or with repetition to competence, then they are able to call on that positive experience store during appraisal of future iterations of the same or similar events. This is more likely to result in lowered stress levels, improved information processing, and better outcomes.

Unexpected and emergency events can invoke startle reactions and/or inaction type behaviours. An improved performance is most likely to occur when pilots have a realistic level of expectation of such events, and inherently positive self-assessments on their abilities to handle such events. Regular discussion of novel and emergency events is more likely to provide a cognitive database for pilots to call on for future events, and can be included as briefing items or as discussion items before flight or during flight where time exists. Discussion of such novel and emergency events, is likely to increase the level of expectation, bring the knowledge of how to manage such events into more easily accessed memory, to reduce the likelihood of inaction type behaviours, and to engender better responses as a result.

Further research is planned in this area.

References


